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May 7, 2020

Via Electronic Filing

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Harrisburg, PA 17105-3265

In re: Docket No. A-2019-3015173
Application of Aqua Pennsylvania Wastewater, Inc. pursuant to Sections 1102, 1329 and 507 of the Public Utility Code for Approval of its Acquisition of the Wastewater System Assets of the Delaware County Regional Water Quality Control Authority

Dear Secretary Chiavetta:

We are counsel to Aqua Pennsylvania Wastewater, Inc. ("Aqua" or "Company") in connection with its above referenced Application, filed with the Public Utility Commission ("Commission") on March 3, 2020, pursuant to Sections 1102, 1329 and 507 of the Public Utility Code, for approval of the acquisition of the wastewater system assets of the Delaware County Regional Water Quality Control Authority. The Bureau of Technical Utility Services is reviewing the Application and has asked that we address certain requests for additional information. We addressed several requests in a letter filed with you on May 6, 2020. Additional requests are addressed hereinafter. Requests not addressed in this letter and the May 6 letter will be addressed in a later submission.

INFORMATION REQUEST 18:
Checklist Item No. 20.f. – The Application's Page 11 indicates DELCORA recently updated its Long-Term Control Plan (LTCP) for the City of Chester's combined sewer system and submitted it for review. Please provide an electronic copy of DELCORA's LTCP and provide a list of the current actions DELCORA has planned or completed in its implementation of the LTCP.

RESPONSE:
An electronic copy of the LTCP is provided with this letter. An Implementation Schedule, which includes Project Milestones, is included in Section 10.3.6 of the LTCP.

INFORMATION REQUEST 20:
Checklist Item No. 22.a – The requested service territory depicted on the Application's Exhibit A3 does not appear to match the Springhill Farms service area depicted in Appendix II, Map 1 of the Update to Chadds Ford Township's Sewage Facilities Management (Act 537) Plan provided as part of the Application's Exhibit P3. Please explain this discrepancy.

RESPONSE:
Appendix II, Map 1 of the Update to Chadds Ford Township Act 537 Plan included as Application Exhibit P3, shows all areas of Chadds Ford Township that would have their default connection into Springhill Farms system. The areas delineated as Spring Hill Farms Service Area in the Chadds Ford Act 537 Plan that were not included in Aqua's proposed service territory in Application Exhibit A3 are not currently connected to the Springhill Farms system and are connected to on-lot septic. In the future if those residents of Chadds Ford Township had failing septic systems they would connect to the Springhill Farms system and Aqua would revise its service territory accordingly through a service territory expansion application.

INFORMATION REQUEST 28:
Checklist Item No. 25 – The Application's Exhibit F4, Supplemental Agreement dated November 26, 1952, is missing pages 1, 3, 5, 7, 9, 11 and 13. Please provide a complete copy of this agreement that includes the noted missing pages.

RESPONSE:
Aqua has submitted a Right-to-Know Request to Ridley Park Borough for a complete copy of the Agreement and will file the Agreement with the Commission after receiving the complete copy in response to its Request. A copy of the Right-to-Know Request is included with this letter.

INFORMATION REQUEST 31:
Checklist Item No. 25 – The copy of the Sanitary Sewer Improvements Agreement, dated March 2016, By and Among DELCORA and Brookhaven Acquisition LP, provided as the Application's Exhibit F67 is not complete or fully executed by all parties, as it does not include all required signatures and its Exhibits A through E are blank. Please provide a complete and fully executed version of this agreement.

RESPONSE:
A complete copy of the Agreement is included with this letter.

INFORMATION REQUEST 32:
Checklist Item No. 25 – The Application's Exhibit F101 is missing Exhibits A, B and C. Please provide copies of these exhibits.

RESPONSE:
Aqua has submitted a Right-to-Know Request to Rose Valley Borough for a complete copy of the Agreement and will file the Agreement with the Commission after receiving the

complete copy in response to its Request. A copy of the Right-to-Know Request is included with this letter.

INFORMATION REQUEST 33:
Checklist Item No. 25 – The Application's Exhibit F103 is missing its copy of its Exhibit A map area and boundary description. Please provide a copy of this exhibit.

RESPONSE:
Aqua has submitted a Right-to-Know Request to Rose Valley Borough for a complete copy of the Agreement and will file the Agreement with the Commission after receiving the complete copy in response to its Request. A copy of the Right-to-Know Request is included with this letter.

INFORMATION REQUEST 35:
Checklist Item No. 25 – The Application does not contain a list of "other" DELCORA contracts with associated dollar values as required in Checklist Item No. 25 that Aqua intends to continue after the completion of the acquisition. Please provide a comprehensive list of all other contracts, based as a revenue or expense, APW intends to maintain due to contractual obligations or for the continued operation of the wastewater assets.

RESPONSE:
The dollar values associated with DELCORA contracts is considered CONFIDENTIAL. A PUBLIC version, with CONFIDENTIAL information redacted, of the contracts that Aqua plans to maintain presently for the continued operation of the system is included with this letter. A CONFIDENTIAL version of the list is being provided to the Secretary of the Commission by email correspondence. Aqua will continue to review the contracts to determine which ones are necessary for operation of the system post-closing.

Please contact me with any questions about the foregoing.

Very truly yours,

THOMAS, NIESEN & THOMAS, LLC

By

Thomas T. Niesen

cc: Certificate of Service (w/encl.)
Alexander R. Stahl, Esquire (via email, w/encl.)
Thomas S. Wyatt, Esquire (via email, w/encl.)

LONG TERM CONTROL PLAN

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

CSO Long-Term Control Plan Update

VOLUME 1 of 3

FINAL - February 15, 2019

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA CSO Long-Term Control Plan Update.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	2/13/19 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	2/13/19 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	2/13/19 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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APPENDICES

This Long Term Control Plan Update was developed as a series of technical reports submitted to the USEPA and/or PADEP for their review and comment. Although these documents served as the basis for the final LTCPU, specific aspects of the final LTCPU Report have changed since the original technical memoranda were written. As such, these reference documents included as appendices here can be used to gain a deeper understanding of the methodologies used in developing the final LTCPU Report

Appendix A - Alternatives Evaluation Approach Report (Final), April 2016
Appendix B - Applicable Water Quality Standards Master Table
Appendix C - Identification of Sensitive Areas and Pollutants of Concern Report, May 2016
Appendix D - Hydrologic and Hydraulic Model Update and Calibration Plan (Final), October 2015
Appendix E - Typical Hydrologic Period Report (Final), Updated April 2016
Appendix F - Sewer System Hydrologic and Hydraulic Model Report, June 2017 with revised Appendix C updated March 1, 2018 to address USEPA comments
Appendix G - Rainfall and Flow Monitoring Quarterly Reports:
Quarterly Report No. 1, July 2016
Quarterly Report No. 2, October 2016,
Quarterly Report No. 3, January 2017
Quarterly Report No. 4, April 2017
Appendix H - Water Quality Modeling and Monitoring Work Plan, Updated July 2017
Appendix I - Water Quality Monitoring and Modeling Quality Assurance Project Plan (QAPP), Updated July 2017
Appendix J - Water Quality Model Report (Includes Sampling and Monitoring Report), February 2018

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Appendix K - Existing Service Area Characterization Report (Final), August 2017
Appendix L - Public Participation Plan (Final), Updated April 2016
Appendix M - Public Meeting Notes, Presentations and Comments with Responses
Appendix N – Corvias Green Stormwater Infrastructure Evaluation, November 2017
Appendix O - DELCORA Alternatives Analysis Contingency Breakdown and DELCORA Alternatives Analysis Opinion of Probably Cost Methodology Memos
Appendix P - WRTP Process and Hydraulic Evaluation, April 2011
Appendix Q - Draft Feasibility Study for Pipe Repairs from M.H. 329 to M.H. 3070 and Combination Flow Mitigation for C.S.O. No. 18, December 2016
Appendix R - Draft Financial Capability Assessment Report (Final), Revised April 2017
Appendix S - FCA Supplement, August 2017
Appendix T – Updated Model Calibration and Validation Results for Sewer System Hydrologic and Hydraulic Model Report and Existing Service Area Characterization Report, dated July 2018

Foreword

This Long Term Control Plan Update (LTCPU) has evaluated the Delaware County Regional Water Quality Control Authority's (DELCORA's) sewer systems according to United States Environmental Protection Agency (USEPA) requirements and guidance. The final plan addresses all aspects of the Consent Decree issued to DELCORA by USEPA. Although monitoring and modeling studies show DELCORA is not causing Water Quality Standards to be exceeded, the plan includes further investment to reduce Combined Sewer Overflow (CSO) discharges and improve water quality. The investments include improvements to the collection system, the treatment plant and the implementation of green infrastructure that will provide multiple benefits to DELCORA customers. These improvements increase the level of system wide annual average wet weather flow capture to over 90% of the total wet weather flow. This level of capture exceeds Federal Clean Water Act requirements under USEPA's "Presumption" approach.

Prior to this LTCPU, DELCORA has expended approximately $150 M in capital improvements to address CSOs as planned in the original 1999 Long Term Control Plan. This update adds over $120 M in life cycle costs to the prior and ongoing investment within an accelerated 10 year schedule. This additional investment is affordable if other program costs do not increase significantly.

DELCORA Monitoring and Modeling required by the DELCORA/USEPA/Pennsylvania Department of Environmental Protection Consent Decree has shown that high wet weather flows in the separate sewered areas result in Sanitary Sewer Overflows (SSOs) and contribute to increased CSO discharges. Projects planned under the LTCPU address the impact of CSO discharges as required by the Clean Water Act. However, while SSOs are reduced under the plan, the DELCORA/USEPA consent decree requires the elimination of SSOs. To address the Consent Decree, DELCORA will continue to monitor and model the hydraulically connected system to evaluate SSOs and identify additional areas where remediation is needed. While some of these areas in need of remediation are likely to be in a DELCORA owned system, it is known that there are significant areas in non-DELCORA owned satellite systems that will require investment to address SSOs and remain cost effective.

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Executive Summary

The Delaware County Regional Water Quality Control Authority (DELCORA) has prepared this report to describe the development and selection of the Combined Sewer Overflow (CSO) Long-Term Control Plan Update (LTCPU). Based on water quality monitoring and modeling, DELCORA's collection system is not the reason the receiving waters are not achieving the requisite water quality standards. Therefore, DELCORA's plan to meet the Presumptive Approach requirements of 85% wet weather volume capture is through improvements in the CSO community portion of the collection system. The evaluation of this LTCPU included the development of a hydraulic and hydrologic model which has concluded that separate storm sewer areas in the DELCORA collection system contribute significantly to the discharge of CSOs in the combined system. This plan addresses these issues in affordable manner as long as:

- Upstream communities' excessive Infiltration and Inflow (I/I) into downstream sewer infrastructure is affordably addressed;
- DELCORA's Eastern Service Area costs do not upset the City of Chester's financial capability to implement its share of these wet weather controls;
- Excess flow wet weather treatment as recommended at DELCORA's Western Regional Treatment Plant (WRTP) to obtain over 90%, is approved by Pennsylvania Department of Environmental Protection (PADEP) and/or United States Environmental Protection Agency (USEPA).

The LTCPU has been conducted in accordance with each item described in the Consent Decree to produce a detailed analysis, discussion, and proposed schedules, deadlines, and timetables for implementing each component of the LTCPU. The selected CSO controls set forth by DELCORA in this LTCPU are designed to meet the following overarching goals:

- Bringing all CSO discharge points into full compliance with the technology-based and water quality-based requirements of the Clean Water Act (CWA); and
- Minimizing the impacts of CSOs on water quality, aquatic biota, and human health.

The submission of this document to the USEPA and/or PADEP demonstrates DELCORA's readiness to begin implementing the proposed technologies in this document to meet the above goals.

The development of the LTCPU involves the completion, submission, and incorporation of a number of specific reports to the USEPA and/or PADEP required by the Consent Decree in paragraphs V.A.10 through V.A.22. The required reports scheduled by the Consent Decree have been submitted and approved by the USEPA and/or PADEP to date or have been submitted and are under review by USEPA and/or PADEP and awaiting comments or final approval.

DELCORA's Public Participation Plan (PPP) was developed to employ an on-going public participation process that actively involves the public by informing and soliciting input from stakeholders, including the public, customer communities and regulatory agencies as the LTCPU is developed and implemented and to meet the requirements of the USEPA's CSO Policy and DELCORA's Consent Decree. To encourage feedback and present the progress of the LTCPU, four public meetings were held in various locations throughout the DELCORA service area. After the presentation, the public could ask questions at the meeting hall, or submit a feedback form for DELCORA to incorporate their comments into the LTCPU. Presentation materials and feedback forms for each public meeting are posted to DELCORA's website for anyone who was not able to attend.

DELCORA has also maintained a working relationship with the municipalities and authorities in its service and has made efforts to coordinate any improvements to the LTCPU with them. Most notably is the City of Chester, where the Combined Sewer System (CSS) CSO outfalls are located. Chester City wanted to do more regarding stormwater runoff and developed the Stormwater Authority of Chester to coordinate these efforts with DELCORA, especially in the combined sewer areas. Chester City also hired a sub consultant, Corvias, to develop green infrastructure in the areas of the city where DELCORA could use the technology most.

The support of the serviced communities is instrumental to implementing the LTCPU, as DELCORA does not own all conveyance piping or pump stations within serviced area. The DELCORA service area comprises two distinct areas. The first is the "DELCORA owned" area, where DELCORA owns and operates all sewer infrastructure. The second is the "DELCORA Contracted" area where the satellite communities served continue to own and/or operate their sewer collection and conveyance infrastructure while delivering flows to DELCORA for treatment.

Flows in DELCORA's Eastern Service Area are still treated at the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWWPCP). While not a part of this long-term control plan, DELCORA and the municipal authorities it serves face significant challenges with its Eastern Service Area. The cost of providing service to this area has the potential to rise significantly in the near future. All other DELCORA service areas send flow through Chester to the DELCORA Western Regional Treatment Plant located in Chester, Pennsylvania. Most of the DELCORA service area has separate storm and sanitary sewers. There is a relatively small area where stormflows and sanitary wastewater are collected in the same combined sanitary and stormwater conveyance sewer. There are 25 permitted combined sewer overflow locations in Chester where combined stormwater and sanitary wastewater can discharge into Ridley Creek, Chester Creek and the Delaware River during wet weather, also referred to as CSOs. The combined flow shares conveyance piping to the treatment plant with the upstream separate sanitary areas, and restrictions into this shared conveyance piping contribute to CSOs. In a typical year, these CSOs average about 36 discharges a year, with half of the CSO outfalls activating more than 43 times a year. In addition, during less frequent, relatively large rainfall events, there are overflow locations in the separate sewer areas where the collection system can be overwhelmed with a combination of sanitary wastewater and stormwater that has leaked into the separate sewer system.

During certain moderate and large rainstorms, CSOs are more likely to occur in the 1,486 acre combined sewer area due to the wet weather flow of the approximately 50,000 acre collection system. In large storms, flows from the separate areas completely fill the conveyance system in the CSO area, and may on occasion fully utilize or exceed the capacity of the wastewater treatment plant. Under these conditions, the combined area flow delivered to the DELCORA treatment plant is greatly reduced or stopped by CSO regulator devices that restrict flow. The combined area flow rates to the conveyance system are controlled to allow most of the separate area flows to be delivered for treatment. However, even with these CSO regulator controls limiting the combined flow entering the system, some separate area flows escape the system, causing unauthorized releases.

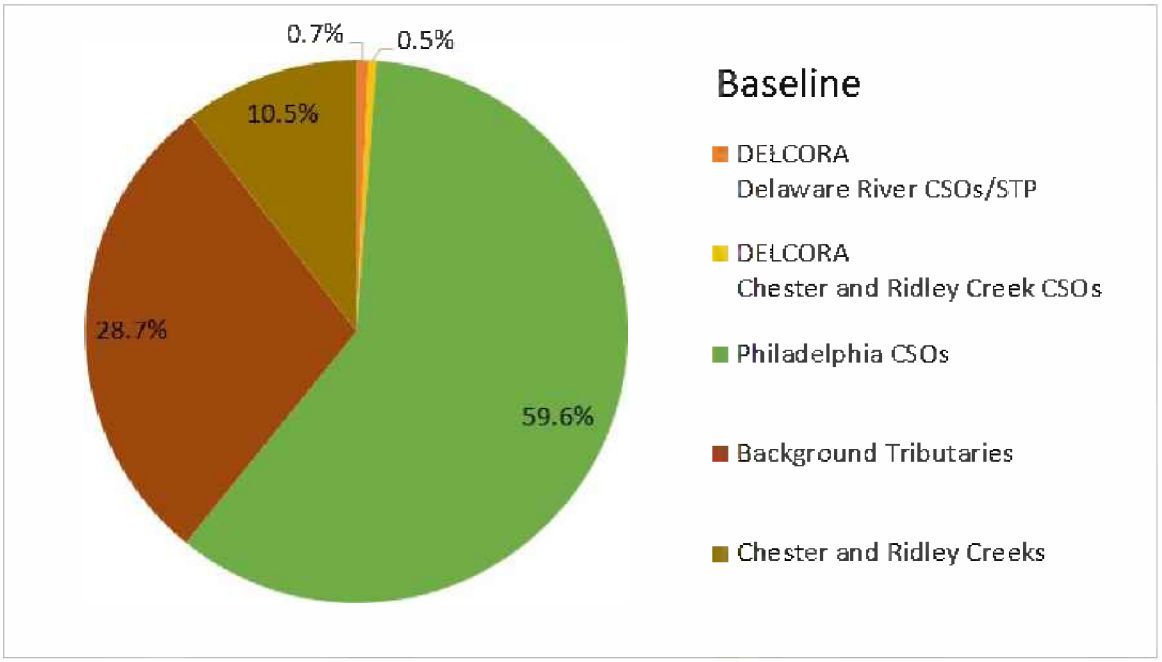
Monitoring and modeling of Ridley and Chester Creeks indicate that these creeks often do not meet water quality standards for recreation. Monitoring and modeling also show that the Delaware River meets recreational standards most of the time. The vast majority of the contamination in the creeks and Delaware River in the service area comes from sources outside of DELCORA's CSOs. The DELCORA CSO loads are small compared to the upstream and background bacteria loads entering the DELCORA

project area (see **Figure ES-1-1** for Enterococcus source loading in the Delaware River). These waters would not meet standards even if the DELCORA CSOs were completely removed. The CSOs by themselves do not prevent (preclude) meeting water quality standards. However, even though controlling CSOs alone will not fully address the problem, DELCORA is moving forward to address overflows from both the combined and separate areas to reduce pollution and prepare for a time in the future when the other pollution loads are better controlled.

DELCORA developed a long-term control program to address CSOs in 1999, which was approved by PADEP. Since that time, approximately $150M in capital investment has been made to the system because of the control program and its operating expenses to increase the amount of combined and separate area flow treated by DELCORA. These projects have included upgrades to the collection and conveyance system pipes, repair of damaged pipes to prevent additional water from leaking into the system, expanded and new pump stations, and increased capacity at the DELCORA wastewater treatment plant. After the installation of the first CSO regulator Tide Gate Monitoring System, DELCORA determined that the monitoring system improves system operation and significantly reduces dry-weather overflows by notifying operators at the WRTP that flow is passing over the diversion weir. DELCORA has since installed the monitoring system on all CSO regulators even though it was not required until the CSO regulator was replaced. DELCORA continues to use this system and it provides critical information to maintain proper operation of the CSO regulators.

DELCORA has conducted extensive flow monitoring and water quality receiving stream monitoring throughout the DELCORA service area, both in the DELCORA Satellite and DELCORA Owned areas. Based on this monitoring, it has been determined that there are collection system improvements that are needed in the separate areas in addition to what is recommended to address the CSOs in Chester.

Figure ES-1-1: Summary of Delaware River Enterococcus Loads by Source Type



In addition to the capital improvements for wet weather control, DELCORA continues to comply with requirements to invest and implement the Nine Minimum Controls (NMCs), which are best management practices designed to reduce CSOs and their effects on receiving water quality. One example of an implemented NMC was the investment in a 10-year inlet replacement program to help screen debris and prevent it from entering the collection system. DELCORA provided $75,000 a year for 10 years to the City of Chester (since discontinued), which in turn installed this control. Another example is DELCORA's implementation of public outreach, which includes periodic mail notifications.

The term "Sensitive Areas" is specifically defined under federal law as areas including Designated Outstanding National Resource Waters, National Marine Sanctuaries, waters with threatened or endangered species and their habitat, waters with primary contact recreation, public drinking water intakes or their designated protected areas, and shellfish beds. After study and evaluation, it has been determined that no sensitive areas as defined by federal law need to be addressed by the DELCORA plans in the Chester and Ridley Creeks or in the Delaware River. However, DELCORA conducted public outreach and three prior public meetings during the development of this plan that identified areas of special concern to the public which comprises the Chester Riverfront and specifically the boat ramp at Flower Street. The DELCORA recommended plan makes this area a high priority for CSO control.

DELCORA conducted a comprehensive alternatives analysis to identify and evaluate a wide range of options for applicability to local conditions. This included the type of control provided, cost, impact on the community, ancillary benefits, and more.

DELCORA evaluated over 50 traditional and innovative sewer overflow control technologies including:

- Source Control/Green Infrastructure
- Sewer Separation
- Conveyance to the Treatment Plant
- Storage in the System
- System Control Improvements

DELCORA developed and examined 15 alternative plans that utilized all five categories of the technologies described above. One alternative examined the use of subsurface tanks. These tanks would store combined flows that would otherwise discharge to the surface waters and release it back to the combined sewer system when the pipes can handle additional flow. Another alternative examined using deep underground tunnels. These two alternatives were examined further by incorporating green infrastructure to reduce tank sizes. Making improvements to the treatment plant and maximizing the combined flow conveyance was another alternative, as was complete sewer separation for the entire combined sewer system.

The remaining 9 alternatives all use system control improvements called regulator modifications, with the added technologies described above located in strategically targeted areas. Regulator modifications are meant to move water into available spaces in the sewer system instead of discharging to surface waters. Regulator modifications can be adjusted to find the appropriate increase in flow to the treatment plant without overwhelming the pipe system.

The alternatives were evaluated in a cost vs. performance comparison called a "Knee-of-the-Curve" graph, where the alternative Life Cycle Cost (initial construction cost with 20 years of operation and maintenance) is plotted for each CSO capture percentage. This method allows for identification of the

alternative beyond which each dollar spent has less improvement than the previous dollars. In other words, the point where spending more money provides less benefit for the additional investment.

The minimum-cost alternative where 88.8% of wet weather is captured exceeds the control required under Federal CSO policy's Presumption Approach (85%). Increasing to the next level of wet weather control, 89.9% capture, is slightly less cost effective, requiring more investment, but providing slightly higher CSO capture. This trend of slightly lower cost-effectiveness continues as the level of control increases to 91.2% and to 94%, but there is a significant increase in cost after the alternative providing 94% capture. Going beyond 94% provides much less capture for the increased cost. While not as cost effective as the 88.8% control, the 94% alternative still provides good public benefits for the additional investment. However, further increases in capture beyond the 94% alternative come with sharply increased costs, and the additional capture gained is not as justified.

Thus to make certain the 88.8% capture level of control, DELCORA will establish as its regulatory performance measure the achievement of 90% system wide wet weather capture during the design year. DELCORA's recommended plan comprises of the three elements incorporating the 88.8% and 94% control alternatives: Regulator Control Improvements, Targeted Overflow Reduction, and Adaptive Management.

DELCORA identified 19 locations in the existing collection system where modifying CSO regulator weirs, orifices, gates, and outflow pipes pushes more water into the conveyance piping, while also utilizing upstream pipes as temporary storage. These improvements increase the level of system wide annual average wet weather flow capture to 88.8%. This level of capture exceeds Federal Clean Water Act requirements under USEPA's "Presumption" approach.

While the regulator control improvements, in addition to the previous investments noted above, meet the presumption approach requirements, monitoring and modeling indicate that the frequency and volume of CSOs are exacerbated by excessive peak flows from the separate sewer areas. These separate area flows can be addressed cost-effectively by adding to the following additional controls to the prior improvements:

- Multiple locations for green infrastructure, with currently identified areas in Widener University's campus, between Providence Ave and Upland Street, on Edgmont Avenue north of I-95, Crozer Street, and other viable areas[1].
- Partial sewer separation of the neighborhood downstream of Veterans Memorial Park.
- Improving flow to bottlenecks in conveyance piping along the Delaware River by adding to, extending, and rehabilitating the existing piping.
- Installing storage tanks in the vicinity of the Taylor Arboretum, providing relief sewers in Upland Borough, and providing I/I sewer rehabilitation in the Rose Valley Service Area[2].
- Public outreach to inform the general public about the status of the DELCORA system.

[1] In addition to the specific Green Infrastructure Project in the (CSO 18 & CSO 19) Neighborhoods, DELCORA anticipates funding additional Green Projects where such projects contribute to the cost-effective reduction of overflows.
[2] The location of these facilities have not been determined and will be open to public comment after more study is completed and before implementation

Each of these CSO control technology projects have specifically targeted effects to further reduce overflows in the DELCORA service area. For example, the removal of the noted sewer bottlenecks significantly increases the peak wet weather flows that can be delivered to the wastewater plant. These controls will also significantly reduce the discharges in the vicinity of Flower Street Chester City Boat Ramp. Addressing interceptor bottlenecks will help to address unauthorized releases in the DELCORA system. In addition, each project will be optimized using adaptive management as the LTCP implementation proceeds.

As a result of delivering greater peak wet weather flows to the treatment plant through the regulator control improvements and these targeted overflow reduction projects, the current capacity of the treatment plant (88 MGD) would be exceeded about 3 times in the design year. While these flows could be discharged out the combined system, real-time controls will be evaluated during a post-construction monitoring period. It will be necessary to study the peak wet weather flows and determine if real-time motor operated valves and controls in the regulators and conveyance system are necessary. The evaluation will provide confidence that any increased flows do not back up into homes or deliver excessive flow to the treatment plant without losing hydraulic and process control. After the flows are evaluated, additional improvements to the WRTP will be addressed. Excess flow wet weather treatment will include screening to remove trash and grit settling, (settling of solids and removal of floatables). This treated excess wet weather flow will then be discharged out the existing CSO located adjacent to the plant. While not achieving full treatment of these excess CSO flows, DELCORA will reduce pollutant loadings before recombining these flows with untreated CSO volumes for discharge. This approach will simply capture more flow for partial treatment, whereas the flow would otherwise be discharged out of a CSO outfall without any treatment. Assuming that it is actually determined to be feasible and warranted and that PADEP will authorize this additional treatment approach, DELCORA is willing to include it in the LTCP.

The previous two elements address the CWA Requirements for CSOs by attaining a CSO annual average system wide wet weather capture of 90% or higher. In addition, the average occurrence across all 25 CSOs is reduced from 36 to less than 15 in the design year with some having more and most having fewer. The expected results meet the necessary requirements, but additional monitoring is still planned by DELCORA, especially in locations with CSOs that may continue at a higher frequency.

Adaptive management provides an opportunity for DELCORA to conduct post construction monitoring, after partially implementing the first two elements to re-assess the implementation schedule. These projects will be monitored to determine if they are operating as intended, and the Clean Water Act and community goals are met. If this post construction monitoring indicates more investment or actions are needed, those investments and actions will be evaluated, and a supplemental control plan will be developed for review and approval by the PADEP. This control plan will also incorporate any new technologies or group similar projects to reduce costs, pending regulatory approval and other anticipated factors. Minimizing community impacts is one of the cornerstones and key benefits of the Recommended Plan. However, DELCORA's plan will likely trigger some public and private impacts from construction/implementation activities. There will be some re-purposing of public land, a need for rights of way, and potentially the need for some land now in private ownership. Nevertheless, these impacts are expected to be relatively minor in comparison to other similar programs.

Special attention to locations with higher frequencies of activation will be evaluated during this post construction monitoring period, and based on results, DELCORA will continue to examine sewer system optimization through additional monitoring and potentially using real time control to further reduce the

frequency at these overflow points. Further measures will be implemented to the modeled area as necessary, depending on the technologies' performance, and will include a schedule that takes into the account the modeled area's financial capability at that time.

With regulatory approval to this LTCPU, the Regulator Control Improvements can proceed with the current and anticipated finances available to DELCORA. Targeted Overflow Reduction implementation is dependent on a number of factors including the following:

- Upstream communities' excessive infiltration and inflow into leaking pipes can be affordably addressed;
- DELCORA's Eastern Service Area costs do not upset Chester's financial capability to implement its share of these wet weather controls;
- Excess flow wet weather treatment as recommended at the DELCORA treatment plant to obtain over 90% capture, is approved by PADEP and/or USEPA.

If the above factors can be addressed, it is anticipated that the Regulator Control Improvements can begin implementation immediately and the Targeted Overflow Reduction projects can be fully implemented in approximately 10 years.

All Elements of the program will be evaluated as the program progresses in an adaptive management approach where the program may be adjusted as monitoring and modeling show cost-effectiveness. Initial life-cycle costs of the program are in **Table ES-1-1**. The implementation schedule will be examined as an on-going part of the adaptive management program. The initial iteration of this schedule is in **Table ES-1-2**. The timeline for all reports proposed by this plan can be found in **Table ES-3-1**. The O&M Plans will be updated 60 days after the full implementation of the Taylor Arboretum storage tank and again after the WRTP modifications are first placed in operation.

While not a direct component of the CSO Long-Term Control Plan, Federal and State law also require DELCORA to address peak excess flows in the sanitary systems. Such flows can cause sanitary sewer overflows, local sewer surcharging, and impact downstream users of the sewer system. Consistent with PADEP and USEPA requirements, DELCORA will continue to identify such peak excess flows, share that information with the communities and support ongoing control efforts by the tributary sanitary sewer systems.

DELCORA's plans involve actions within two areas:

- Addressing CSO controls in its owned and contracted service areas
- Addressing the cost of the Eastern Service Area treatment provided by Philadelphia Water

Given the localized nature of the peak wet weather flow issues and control measures proposed along with State delegation and oversight of program implementation, State oversight of our program implementation makes the most sense. DELCORA plans to propose a State implementation mechanism to both PADEP and/or USEPA in the near future for their consideration. Streamlined State implementation oversight is particularly warranted because EPA/DEP program approval will substantively control other State planning mechanisms, such as Act 537 plan updates. It will be important for PADEP to assist DELCORA to timely secure any actions required by DELCORA's satellite customers, such as the requirement that they update their Act 537 plans to reflect the EPA/PADEP-approved program, in order to maintain the approved implementation schedule.

Table ES-1-1: Estimated Capital & Life Cycle Costs of the Proposed Improvement Projects

Regulator Control Improvements	Capital Cost ($M)	Life Cycle Cost ($M)
Regulator Modifications	$ 5.1	$ 14.2
Targeted Overflow Reduction		
Parallel Delaware River Interceptor	$ 3.5	$ 3.6
WE Interceptor Rehab & Extension	$ 2.4	$ 2.5
CSO-5 Partial Sewer Separation	$ 4.4	$ 4.5
CSO 18 & 19 Green Infrastructure	$ 10.1	$ 11.7
RCI Arboretum Modifications	$ 7.2	$ 17.0
Upland Relief Sewer Line	$ 0.8	$ 1.0
Rose Valley I/I Controls	$ 3.0	$ 3.0
Monitoring and Modeling	$ 5.0	$ 5.0
Public Outreach	$ 3.0	$ 3.0
WRTP Plant Expansion/Upgrade	$ 15.2	$ 27.4
Visual CSO Public Notification System	$ 0.3	$ 1.4
Real Time Control	$ 0.4	$ 1.0
Crum Creek Diversion Pipeline	$ 8.6	$ 8.6
Adaptive Management		
Adaptive Management	$ 13.0	$ 13.0
Project Management	$ 5.0	$ 5.0
Total	$ 86.9	$ 121.9

Table ES-1-2: Proposed Project Milestone Deadlines

Project Milestone Deadlines[1]	
Project	**Placement in Operation**
6 Regulator Modifications Completed	December 31, 2020
Upland Relief Sewer Line	December 31, 2020
6 Additional Regulator Modifications Completed	December 31, 2021
RCI Regulator Manhole Modifications	December 31, 2021
CSO-5 Partial Separation	December 31, 2022
Green Stormwater Infrastructure	December 31, 2022
Rose Valley Infiltration & Inflow Improvements	December 31, 2022
Crum Creek Diversion Pipeline	December 31, 2024
Visual CSO Public Notification System	December 31, 2024
6 Additional Regulator Modifications Completed	December 31, 2025
West End Interceptor Rehab & Extension	December 31, 2026
Parallel Delaware River Interceptor	December 31, 2028
Western Regional Treatment Plant Modifications	TBD

[1] Assuming LTCPU approval by December 31st 2019

Table ES-1-3: Reporting Requirements

Reporting Submission Timeline[1]	
Project	**Date**
Rose Valley Infiltration & Inflow Evaluation Report	December 31, 2020
Five-Year Milestone and Post Construction Compliance Monitoring Report	Submitted with NPDES Permit Application
Adaptive Management Report	December 31, 2025
Western Regional Treatment Plant Flow Evaluation Report	December 31, 2025
Five-Year Milestone and Final Post Construction Compliance Monitoring Report	Submitted with NPDES Permit Application
Adaptive Management Report	December 31, 2030

[1] Assuming LTCPU approval by December 31st 2019

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Section 1 Introduction, Overview and Historical Review

1.1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal wastewater authority that owns, operates and maintains collection systems that serve approximately a half-million people in southeastern Pennsylvania, including 45 municipalities in Delaware and Chester Counties, and is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA owns and operates a combined sewer system (CSS) that is comprised of sewer sections that accept both stormwater runoff and sanitary wastewater that is treated at DELCORA's Western Regional Treatment Plant (WRTP), both of which are located in the City of Chester, Pennsylvania.

Combined sewer systems are remnants of the country's early wastewater infrastructure when communities built sewer systems to collect both stormwater and sanitary sewage in the same piping system. During dry weather periods, CSSs transport all of the wastewater directly to a wastewater treatment plant (WWTP) for proper treatment. However, during periods of heavy rainfall or snowmelt, stormwater is combined with the sanitary sewage and the volume of wastewater can sometimes exceed the capacity of the CSS or WWTP. When this occurs, regulator chambers in the CSS allow the excess volume of wastewater to discharge into nearby streams, rivers and other waterbodies.

Under its National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the PADEP, DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (#028-#031) and from 26 CSO regulators (#002-#005, #007-#026, #032 and #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek. There are a total of 26 combined sewer overflow regulators listed with 25 discharge points in DELCORA's existing NPDES Permit; Regulators #009 and #010 both discharge at Outfall #009.

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated Combined Sewer Overflow (CSO) Long-Term Control Plan (LTCP) to the United States Environmental Protection Agency (USEPA or EPA) and/or the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. This Long-Term Control Plan Update (LTCPU) Report has been developed for controlling discharges from DELCORA's CSOs to the receiving waters in satisfaction of the requirements of the Consent Decree and NPDES permit, and in accordance with the Federal Clean Water Act (CWA) and the 1994 Federal Combined Sewer Overflow Control Policy.

DELCORA has made considerable progress on mitigating CSOs over the last decade, including, but not limited to, improvements to their regulators and other early action items such as the upgrade of Pump Station 1 (EPS-1) to convey more flow to the WRTP. The design and construction of a Regulator Monitoring System, and the replacement of Regulator #s 002, 003, 004, 005, 010, 012, 013, 014, 015, 016, 023, 024 and 026 has already been completed. The upgrade of EPS-1 is competed and the new pump station is called "PS-6".

The progress DELCORA has made on mitigating CSOs to date is not withstanding the financial challenges of the City of Chester, as evidenced by 37% of Chester's citizens living under the poverty line and the median household income being stagnant. Additionally, the City of Chester is a financially distressed municipality as defined by Pennsylvania's 1987 Financially Distressed Municipalities Act 47 and appears destined to remain in the Act 47 program for the indefinite future.

1.1.1 Purpose of CSO LTCP Update

DELCORA has prepared this LTCPU Report to update its April 1999 LTCP and the July 2008 addendum to the LTCP.

The primary purposes of the CSO Long-Term Control Plan Update are as follows:

- To develop a long-term strategy to minimize the impacts of DELCORA's CSOs on the water quality of the receiving waters. Such strategy must be both technically viable and financially feasible and will result in compliance with water quality standards.
- To document the success of existing CSO control projects in achieving water quality and CSO control goals.
- To re-assess the remaining original CSO control projects using the latest data, information and control technologies.
- To evaluate alternative CSO control technologies and make recommendations for the most optimal CSO control projects to be implemented.

1.2 Regulatory Requirements

1.2.1 CSO Control Policy Requirements

The USEPA issued a national policy statement entitled *Combined Sewer Overflow (CSO) Control Policy* in April 1994 that established a consistent national approach for controlling discharges from CSOs to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program. In 2000, the CSO Control Policy was incorporated into the Clean Water Act (CWA) by reference. This policy provides guidance to permittees with CSOs and other parties on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA and allow for public involvement during the decision making process.

The USEPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* document from September 1995 provides guidance to CSO communities to assist them in developing appropriate, site-specific programs to control CSOs in compliance with documented NPDES permit program and Clean Water Act requirements. Among other things, this guidance identifies the following nine essential elements of LTCPs:

1. **Characterization, monitoring and modeling** activities as the basis for selection and design of effective CSO controls
2. A **public participation** process that actively involves the affected public in the decision-making to select long-term CSO controls
3. Consideration of **sensitive areas** as the highest priority for controlling overflows

4. **Evaluation of alternatives** that will enable the permittee, in consultation with the NPDES permitting authority, Water Quality Standard (WQS) authority, and the public, to select CSO controls that will meet CWA requirements
5. **Cost/performance considerations** to demonstrate the relationships among a comprehensive set of reasonable control alternatives
6. **Operational plan** revisions to include agreed-upon long-term CSO controls
7. **Maximization of treatment at the existing POTW treatment** plant for wet weather flows
8. An **implementation schedule** for CSO controls
9. A **post-construction compliance monitoring program** adequate to verify compliance with water quality-based CWA requirements and ascertain the effectiveness of CSO controls.

The CSO Control Policy contains four key principles to ensure that CSO controls are cost-effective and meet the requirements of the CWA:

- Provide clear levels of control that would be presumed to meet appropriate health and environmental objectives
- Provide sufficient flexibility to municipalities, especially those that are financially disadvantaged, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements
- Allow a phased approach for implementation of CSO controls considering a community's financial capability
- Review and revise, as appropriate, WQS and their implementation procedures when developing long-term CSO control plans to reflect the site-specific wet weather impacts of CSOs.

These key principals were incorporated during the development of this LTCP Update report.

1.2.2 Long Term Control Plan Approach

The USEPA's CSO Control Policy expects that a CSO Control Plan will develop a "reasonable range" of alternatives and should adopt one of the following approaches: the "Presumption" approach, or the "Demonstration" approach. DELCORA will utilize the Presumption approach for the LTCP Update.

- Under the "Presumption" approach a CSO LTCP is presumed to meet water quality provided one of the three following criteria is satisfied: (1) no more than an average of four overflow events per year; (2) eliminate or capture for treatment 85% of the annual combined sewage volume; (3) eliminate or remove the mass of pollutants for the volume eliminated or captured for treatment.
- The "Demonstration" approach states that a CSO LTCP is adequate if it meets the current state and local WQS of the receiving waters. With this approach there are no specific limits on CSO events, flow or pollutant loading.

It is to be noted that DELCORA had originally planned to utilize the Demonstration approach for each of its receiving water, as was documented in its *Alternatives Evaluation Approach Report* that was approved by the USEPA on October 13, 2016. This document can be found in **Appendix A**. The Demonstration approach relies on data collection and model simulation to demonstrate that the proposed LTCPU will meet applicable water quality standards and designated uses, and it provides a reliable tool to identify, evaluate and compare the selection and recommendation of the CSO control measures to be installed.

However, after the water quality model was developed, two major observations were made from the water quality modeling application results. One is that background sources dominate the modeled Pollutant of Concern (POC) concentrations, and by extension, DELCORA's CSO loads are small (modeled at 1.3% percent – See **Figure ES-1-1** and **Figure 5-4**) compared to background loads), and the second is that the DELCORA CSOs by themselves do not cause non-attainment, or preclude the attainment, of WQS. Moreover, the modeling results show that regardless of additional CSO controls, even complete separation, water quality standards would still be exceeded under current conditions because background sources typically prevent compliance with WQS. The water quality modeling results are supported by the water quality data results from the wet weather sampling program, which show that wet weather concentrations at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek (and to a lesser extent in the Delaware River) often exceed the monthly geometric mean and standard threshold value (STV) WQS concentration for the three bacteria POCs. These monitoring and modeling data taken together indicate the upstream bacteria loads prevent the attainment of Water Quality Standards in the tidal waters through CSO control.

While the Consent Decree addresses the issue of background sources by requiring CSO controls to also be assessed, assuming that background sources are reduced to 75% of the applicable WQS, using the results of such a scenario in decision making is arbitrary and irrational. There is no current plan for reducing background loads in the Chester and Ridley Creeks, and the planned reductions in the Delaware River will still result in DELCORA's Enterococcus loads being less than 1% of the total load as shown in **Figure 1-1**. The CSO Policy states that "*where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads*". Such apportionment of loads does not currently exist for the Ridley and Chester Creeks for bacteria.

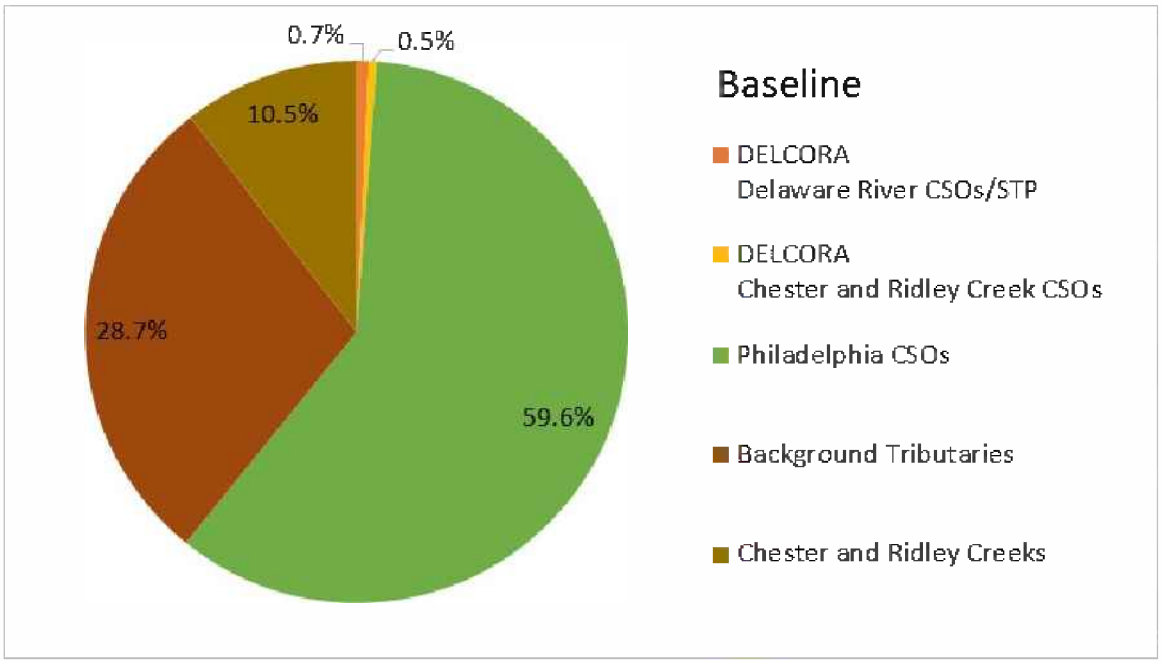
As stated previously, the intended use of the water quality modeling framework is to evaluate CSO control alternatives with respect to applicable water quality standards and demonstrate that alternatives selected for the LTCPU program will meet the water quality-based requirements of the Clean Water Act and Consent Decree. As discussed in the Final Water Quality Modeling Report that was submitted to the USEPA and PADEP on February 27, 2018 and approved on April 17, 2018:

> *"The water quality model is adequate to assess Presumption levels of control to show that the CSOs after controls are in place do or do not preclude the attainment of water quality standards…As such, DELCORA will utilize the Presumption approach, which is shown…to be reasonable in light of the data and analysis as called for in the National CSO Policy."*

The model framework can also be used to assess the Demonstration approach. Currently, the modeling shows that CSOs alone do not cause WQS violations, do not preclude the attainment of WQS, and background loads are currently causing WQS violations upstream of the CSOs and the CSO influence.

Given these in-stream realities and the need for DELCORA to develop the LTCP Update, DELCORA will utilize the Presumption approach instead. This conclusion was documented in the Water Quality Model Report and determined to be appropriate in light of the monitoring data and modeling analysis as called for in the National CSO Policy.

Figure 1-1: Baseline Summary of Delaware River Enterococcus Loads by Source Type



The Presumptive approach requires that one of three criteria be met for compliance to be presumed:

- No more than an average of 4-6 overflow events per year;
- The elimination or the capture for treatment of no less than 85% by volume; or
- The elimination or removal of no less than the mass of the pollutants identified as causing water quality impairment equivalent to the 85% capture by volume.

The Presumption approach criteria selected for this LTCPU is to achieve a minimum 85% system-wide capture by volume on an annual average (typical year) basis.

Use of the Presumption approach is reasonable because the water quality modeling demonstrates that the CSOs alone are a very small source of bacteria to the receiving waters and the CSO discharges themselves do not cause any exceedances of applicable bacterial water quality standards. Thus, the presumption is appropriate in that 85% capture of the Chester CSO flows will be consistent with water quality requirements. Notably, this is the same conclusion that PADEP and USEPA reached with regard to the City of Philadelphia's CSO program. It is also the most appropriate approach for DELCORA to take unless and until there is a realistic plan to control the other sources that dominate bacteria loadings to the receiving streams.

1.2.3 Consent Decree Requirements

The objectives of the Consent Decree are for DELCORA to take the steps necessary to achieve full compliance with the Clean Water Act, the Clean Stream Laws and with all of the terms and conditions of its NPDES permit.

Paragraph V.A.9 of the Consent Decree requires the development of an Updated Long-Term Control Plan no later than three and one half years (42 months) after the Date of Lodging of the Consent Decree. The Consent Decree states that the LTCPU shall include, at a minimum, a detailed analysis and discussion of each item described in Paragraphs V.A.10 through V.A.22 for the entire Model Area and shall include proposed schedules, deadlines and timetables for implementing each component of the LTCPU. The Consent Decree states that the LTCPU shall conform to the requirements of the USEPA's CSO Control Policy and Guidance for Long-Term Control Plan, and that the selected CSO controls set forth in the LTCPU shall be designed to meet the following overarching goals:

a. Bringing all CSO discharge points into full compliance with the technology-based and water quality-based requirements of the CWA; and

b. Minimizing the impacts of CSOs on water quality, aquatic biota, and human health

Paragraph V.A.14.b of the Consent Decree describes the "Model Area" as follows:

> *… all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area").*

DELCORA's service area is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to, and thus is hydraulically connected to, DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWWPCP) rather than to the WRTP. Therefore, municipalities connected to these pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area. In summary, the Model Area (or project area/study area) includes the municipalities in the Western Service Area plus those municipalities in the Eastern Service Area that are connected to the Central Delaware Pump Station.

1.2.4 Report Submissions

The development of the LTCPU involves the completion, submission and incorporation of a number of specific reports to the USEPA and PADEP required by the Consent Decree in Paragraphs V.A.10 through V.A.22. **Table 1-1** lists the required reports have been submitted and approved by the USEPA to date. **Table 1-2** lists required reports that have been submitted and that are under review by USEPA and awaiting comments or final approval.

Table 1-1: Required Reports Submitted and Approved by USEPA to Date

Consent Decree Reference	Report	USEPA / PADEP Approval Date / Status
V.A.11	Identification of Sensitive Areas and Pollutants of Concern	Approved October 13, 2016
V.A.12	Typical Hydrologic Period Report	Approved May 23, 2016
V.A.13	Alternatives Evaluation Approach Report	Approved October 13, 2016
V.A.14	Hydrologic and Hydraulic (H&H) Model and Calibration Plan	Approved March 1, 2016
V.A.17	Public Participation Program Plan	Approved April 28, 2016
V.A.18	Draft Financial Capability Assessment Report (FCA)	Submitted 2nd revision 4/21/17, (Pending see below)
VII	Semi-Annual Reports 1, 2, 3, 4, 5, and 6	Submitted 2015, 2016 and 2017, 2018 No Comments received. Assumed Approved.
V.A.14.e	Rainfall and Flow Monitoring Quarterly Reports 1, 2, 3 and 4	Submitted 2016 and 2017, No Comments
V.A.15.a	Updated Water Quality Monitoring and Modeling Work Plan and Quality Assurance Project Plan (QAPP)	Submitted January 11, 2017 Submitted update July 31, 2017 Approved April 16, 2018
V.A.16	Existing Service Area Characterization Report	Submitted August 15, 2017 Approved April 16, 2018
V.A.14.f	Sewer System H&H Model Report	Submitted June 30, 2017 Resubmitted Appendix C - 3/1/18 Approved April 17, 2018
V.A.15.b	Water Quality Modeling Report	Report was submitted to USEPA on February 27, 2018 meeting Consent Order deadline. Approved April 17, 2018

Table 1-2: Required Reports Submitted and Under Review by USEPA

Consent Decree Reference	Report	Submittal / Status
V.A.18	Third round of USEPA comments were received for the Draft Financial Capability Assessment Report (FCA).	Submitted April 28, 2016 Submitted 2nd revision 4/21/17 and response to comments. Submitted FCA Supplement August 17, 2017. Submitted responses to USEPA and PADEP comments on October 31, 2017. No further comments received to date.
VII	Semi-Annual Report 7	Submitted December 28, 2018 to meet Consent Order Date of January 1, 2019.

1.2.5 Nine Minimum Controls

Paragraph V.B.25 of the Consent Decree requires that concurrently with the submission of the LTCPU, DELCORA shall submit to USEPA and/or PADEP for review and approval a revised and updated Nine Minimum Controls (NMCs) Plan. The Consent Decree states that "The NMC Plan shall evaluate and document the current level of implementation of the NMCs within the Combined Sewer System and shall identify actions necessary for achieving compliance with the CSO Control Policy for all NMCs and include an implementation schedule for completing those actions". For this reason, the details of the current level of implementation of the NMCs within DELCORA's CSS are not specifically addressed in this LTCP Update as they are addressed in the NMC Plan.

1.2.6 Early Action CSO Control Measures

Paragraph V.B.26 of the Consent Decree requires DELCORA to place in operation a new EPS-1 Pump Station to reduce discharges from CSO Outfalls #002, #003, #004, #005 and #007 by December 31, 2018. The construction of the new pump station "PS-6" is complete; it has been in operation since November 3, 2018 and located adjacent to the now-abandoned EPS-1.

DELCORA has also made progress on a range of other CSO control measures including the design and construction of a Regulator Monitoring System, and the replacement of Regulator #s 002, 003, 004, 005, 010, 012, 013, 014, 015, 016, 023, 024 and 026. Pipe grouting and other miscellaneous repairs have been made to the Ridley Creek Interceptor. The Chester East and Chester West Interceptors have also had grouting work performed on their pipe joints. Additionally, property has been purchased to expand the available area for future projects relating to the LTCPU. Additional details of the work DELCORA has done to implement the Original LTCP are included in Subsection 1.5.

1.3 Water Quality Standards

1.3.1 Receiving Water Use Designations and General Water Quality Standards

Information about the applicable water quality standards and designated uses for the three receiving water bodies impacted by DELCORA's CSOs were obtained from the PADEP's 2014 Integrated Water Quality Monitoring and Assessment Report (or "303(d) list"), the Pennsylvania Code, the Delaware River Basin Commission's (DRBC's) Water Quality Regulations (WQRs) and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment.

For the Delaware River and the tidal portions of its tributaries, the DRBC's Water Quality Regulations are the prime source for the water quality standards, and the PA Code Chapter 93 WQS for the designated use serves as a secondary source. The DRBC's regulations have primacy over the PA Code for the Delaware River and the tidal portions of its tributaries. For the non-tidal portions of the Chester Creek and Ridley Creek, the specific designated use for the water body in the PA Code serves as the prime source of the WQS. If a parameter is not listed in the DRBC's Water Quality Regulations or in the PA Code, then there is not a WQS for that parameter that applies to the Delaware River, Chester Creek or Ridley Creeks.

A conservative approach was taken in the identification of the applicable WQS, such that the more stringent standard was used where the standards from the DRBC's Water Quality Regulations and the PA Code overlapped. The methodology for identifying the applicable WQS was complicated by the fact that the

WQS vary for the three receiving water bodies and can also vary within the same water body depending on where the sample was taken.

General descriptions of the information sources used for the determination of the applicable water quality standards for the Delaware River, Chester Creek and Ridley Creek are presented in the following subsections. The details for the determination of the applicable water quality standards are presented in the Identification of Sensitive Areas and Pollutants of Concern Report in **Appendix C.** The Applicable Water Quality Standards Master Table that was developed to identify the specific WQS for each of the three receiving water bodies is presented in **Appendix B**.

1.3.2 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report (303(d) list)

The primary source of information about the causes of impairment, and the Total Maximum Daily Load (TMDL) status of the water bodies (if any) is the 2014 PA Integrated Water Quality Monitoring and Assessment Report (PA Integrated Report), which satisfies Pennsylvania's requirement of both Section 303(d) and 305(b) of the Clean Water Act. The PA Integrated Report lists all impaired surface waters within Pennsylvania that are not attaining designated and existing uses, even after appropriate and required pollution control technologies have been applied. A TMDL is designed to reduce pollutant loads to impaired waters and enable these waters to meet water quality standards.

1.3.3 PA Code Chapter 25 §93.9g

The primary source of information for the Critical Use Designation for each section of the three receiving water bodies is Chapter 25 §93.9g – Drainage List from the Pennsylvania Code. The relevant Critical Use Designations for DELCORA's receiving water bodies include Warm Water Fishes (WWF), Migratory Fishes (MF), Trout Stocking (TSF), and Water Contact Sports/Recreation (WC).

Critical Use Designations for the Delaware River:
All stretches of the Delaware River in the area impacted by DELCORA's CSOs are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). Additionally, the Delaware River has a Water Contact (WC) designation downstream of River Mile 81.8, which is located directly adjacent to the City of Chester between CSO #009 and #011.

Critical Use Designations for the Chester Creek:
All stretches of the non-tidal portions of the Chester Creek in the area impacted by DELCORA's CSOs are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). The DRBC's water quality standards apply to the tidal portions of the Chester Creek.

Critical Use Designations for the Ridley Creek:
All stretches of the non-tidal portions of the Ridley Creek in the area impacted by DELCORA's CSOs are designated as Warm Water Fishes (WWF) (maintenance only), Migratory Fishes (MF) (passage only), or Trout Stocking (TSF). The TSF stretch only applies in the sections of the Ridley Creek upstream of the Chestnut Street bridge crossing. The DRBC's water quality standards apply to the tidal portions of the Ridley Creek.

1.3.4 DRBC's Water Quality Regulations and PA Code Chapter 25 §93.7

The applicable water quality standards for the three receiving water bodies were found in the Delaware River Basin Commission's Water Quality Regulations, and in Water Quality Criteria lists found in Chapter 25 §93.7 and §93.8c of the Pennsylvania Code. For the Delaware River, the water quality standards are dictated by the DRBC's WQRs that have primacy over the standards in the PA Code. The water quality standards in the PA Code apply to the non-tidal portions of the Chester Creek and Ridley Creek, and to the Delaware River if there is no standard listed for a particular parameter in the DRBC's WQRs.

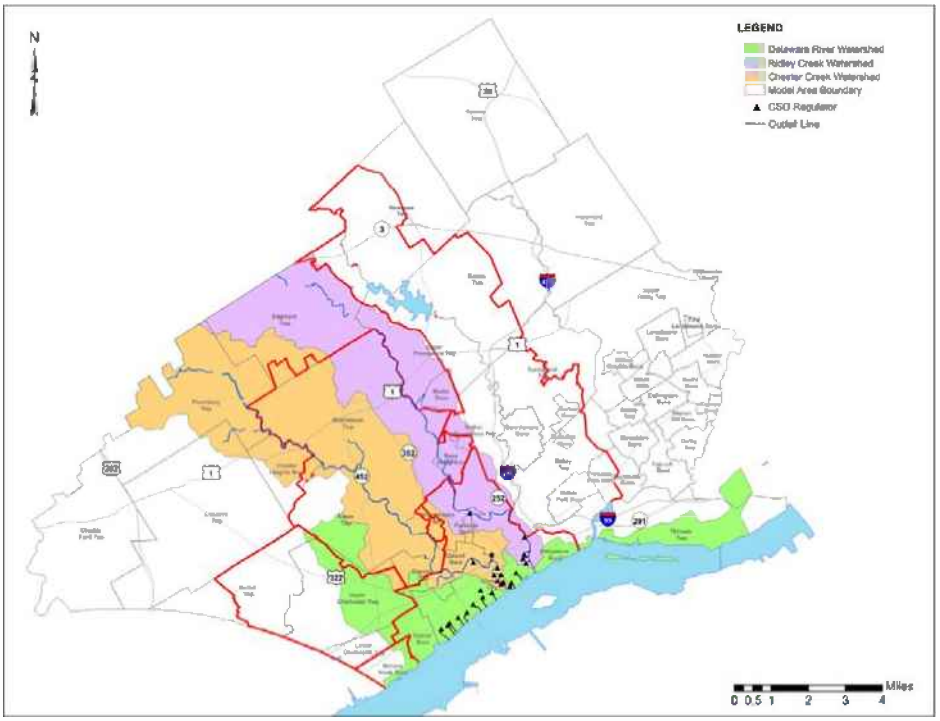
1.3.5 DRBC's 2014 Delaware River and Bay Water Quality Assessment

The DRBC's 2014 Delaware River and Bay Water Quality Assessment (2014 Assessment) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commission's Water Quality Regulations for the period October 1, 2008 through September 30, 2013. The 2014 Assessment involves the comparison of key water quality parameters with the applicable DRBC water quality regulations. The states of Pennsylvania, New Jersey, Delaware and New York consider the DRBC's Assessment report as part of their determinations as to whether sections of the Delaware River should be listed on the state 303(d) list for a certain pollutant.

1.4 Watersheds

The watersheds of concern that are impacted by DELCORA's CSS include portions of the Delaware River, Chester Creek and Ridley Creek watersheds. **Figure 1-2** illustrates the watershed boundaries along with the boundaries of the Model Area.

Figure 1-2: Watershed Boundaries



1.5 Overview of DELCORA's Facilities

DELCORA owns and operates an extensive conveyance system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in **Figure 1-3**. The total service area served by DELCORA, as shown on **Figure 1-4** is approximately 76,439 acres and illustrates that DELCORA serves a significant and widespread portion of Delaware County. The acreage division of the ownership and serviced areas within the service area can be found on **Table 1-3**. Note that DELCORA owns conveyance facilities in less than 6% of the collection system area.

To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers and over 14 miles of large-diameter (>24-inch) force mains. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-six (26) combined sewer regulators that discharge to twenty-five (25) combined sewer outfalls, as CSO Regulators #009 and #010 both discharge to CSO Outfall #009. The combined sewer area simulated in DELCORA's Hydrologic and Hydraulic (H&H) model is located within the City of Chester and consists of a drainage area of approximately 1,486 acres. It comprises approximately half of Chester City's serviced area. The location of Chester City's service area is illustrated on **Figure 1-4**.

In addition to the DELCORA owned and operated facilities, additional facilities are owned by satellite authorities and municipalities that are contracted with DELCORA to utilize the DELCORA owned system. These authorities and municipalities are listed along the top of **Figure 1-3**.

DELCORA has characterized its service areas as "Eastern" and "Western". Historically, the Eastern service area has discharged to the Philadelphia Water Department's Southwest Water Pollution Control Plant while the Western Service Area discharged to DELCORA's Western Regional Treatment Plant.

Figure 1-3 and **Figure 1-4** show the interconnections in DELCORA's system. The left side of the figures indicates the Western Service Area and the right side indicates the Eastern Service Area. This interconnectivity coupled with the legal agreements DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates.

1.5.1 City of Chester CSO System

As noted previously, the combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The inlets, stormwater-only sewers that connect to the combined sewer system, and stormwater-only outfalls are owned by the City and maintained by the Stormwater Authority of Chester (SAC). The SAC is responsible for the maintenance of the stormwater system, street sweeping, enforcement of storm water regulations and standards, public information and education, and planning, zoning, and development of capital storm water facilities.

Figure 1-3: DELCORA's Conveyance System

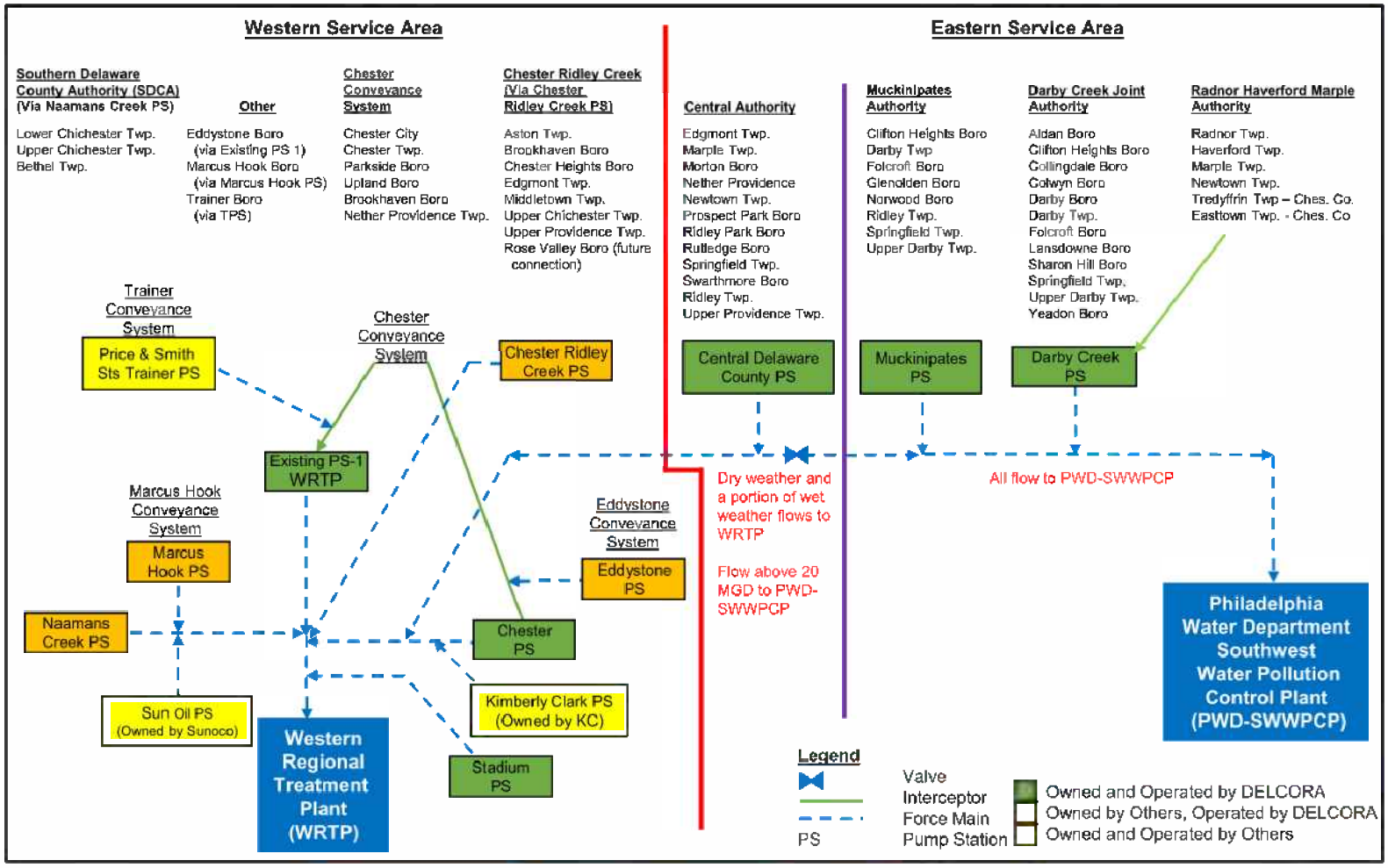


Figure 1-4: DELCORA's Service Areas

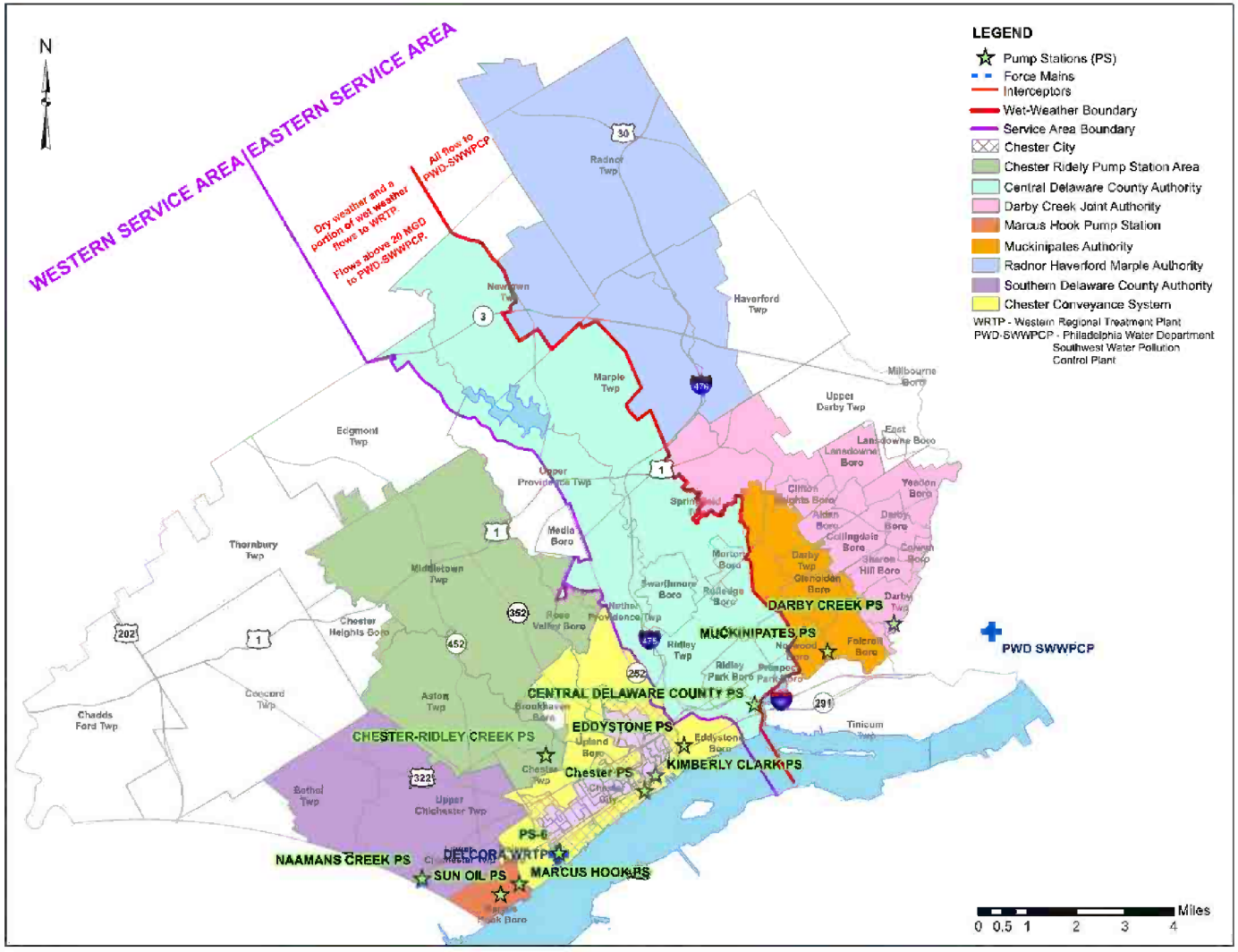


Table 1-3: DELCORA Service Area Distribution

Service	Area (Ac)
Owned and Serviced by DELCORA	5,598
Serviced by DELCORA	23,655
Serviced by DELCORA and PWD	18,806
Eastern Service Area (Serviced by PWD)	28,379

The Chester CSO system contains 26 permitted DELCORA outfalls as listed in **Table 1-4**, and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. However, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. **Figure 1-5** depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility.

Figure 1-5 also provides a sewer system characterization and illustrates the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. **Figure 1-6** is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

1.5.2 DELCORA's Treatment Facilities

DELCORA's primary treatment facility is the WRTP located at 3201 W. Front Street in Chester, PA. The WRTP was built in 1974 and it is an activated sludge treatment plant. A process schematic of the plant is shown in **Figure 1-7**. Based on data obtained for the period March 18, 2016 to May 1, 2017, the annual average dry weather flow to the WRTP is approximately 28 MGD. Due to record rainfall, recent flows have been higher. This facility treats all wastewater from the Model Area which includes all flow from the Western Service Area as well as up to 20 MGD from the Central Delaware County Authority. The WRTP was originally designed to treat 44 MGD. As is typical, the WRTP was designed to treat peak flow of 2-times the average design flow (of 44 MGD), or 88 MGD. The PADEP and the Delaware River Basin Commission have approved a re-rate of the WRTP to 50 MGD. DELCORA is currently working to extend the WRTP discharge outfall into the Delaware River to meet DRBC regulatory requirements for a re-rate to 50 MGD.

After the 1999 LTCP was approved, NMCs were implemented in the DELCORA sewer system, including the maximization of flow to the WRTP treatment. The purpose of this practice is to decrease CSOs in the collection system. Reducing CSOs in this manner sends more flow to the WRTP for short periods of time. At the WRTP, once wet weather flows exceed 88 MGD, there is an incremental reduction in hydraulic and process controls. Under most conditions, short periods of wet weather flows above 88 MGD can be processed through the treatment facility. The WRTP has demonstrated treatment capacity up to and above 104 MGD, while meeting discharge requirements. However, if operating conditions are not idea (such as the plant biomass not settling well) and the high flows continue too long, a wash out of biomass from the WRTP's secondary treatment system and severe property damage can occur. Typically, operating the plant above 88 MGD is acceptable if operating conditions are normal and settling, as indicated by the SVI, is not an upset condition. However, with the implementation of the LTCP and more wet weather flows being delivered to the plant, the current plant operations will not provide the best practice to address unusual operating conditions. Other means of addressing high sustained wet weather flows will be

Table 1-4: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River(2)	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W
Ridley Creek(2)	033	Elkington Boulevard and Ridley Creek	39°52'22"N	75°22'29"W

Notes:

(1) CSO #010 discharges to the Delaware River through CSO #009.

(2) No mechanical regulator used for this outfall.

Figure 1-5: Location of Regulators and CSO Outfalls with Drainage Areas

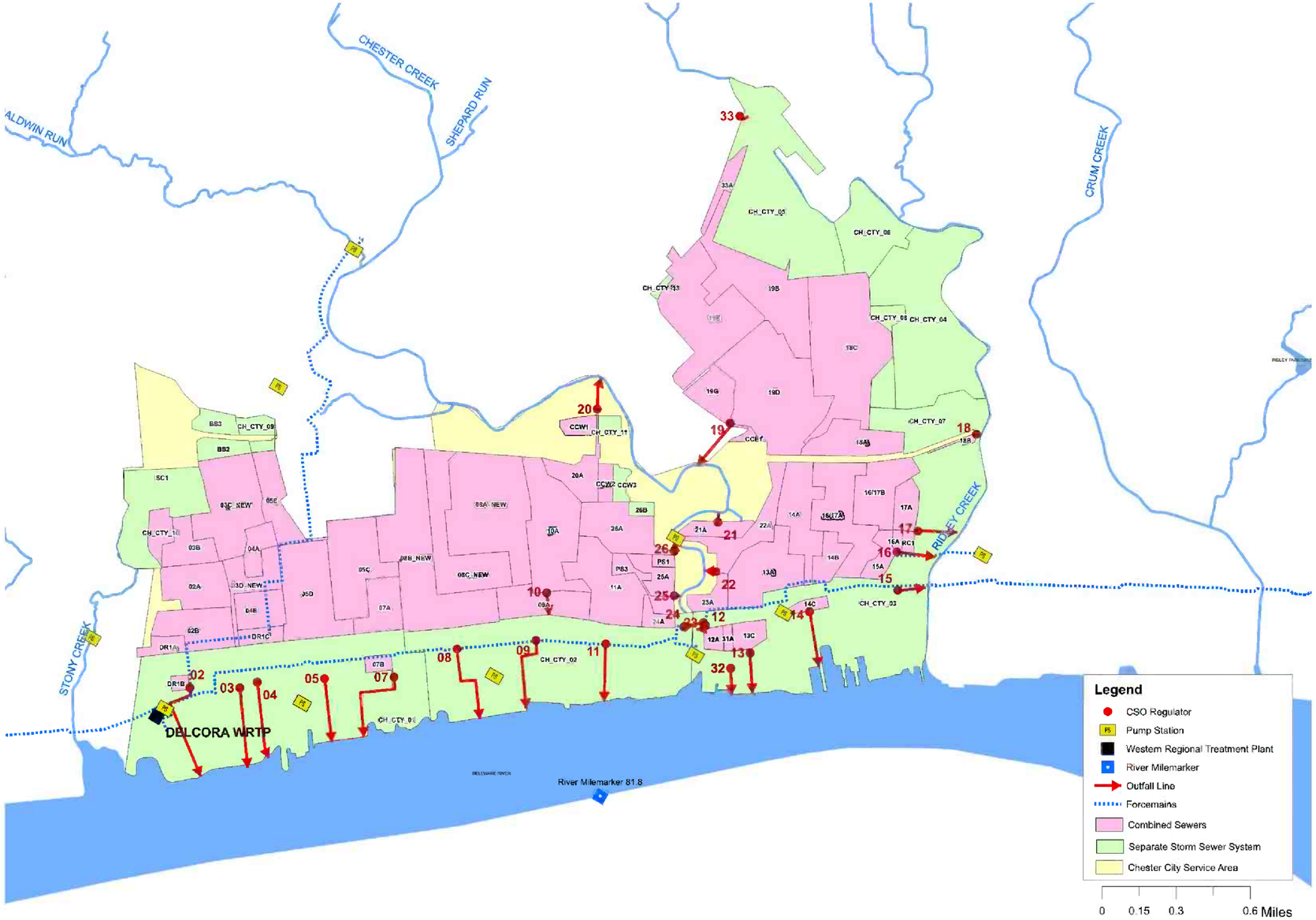


Figure 1-6: Schematic of Chester CSO System

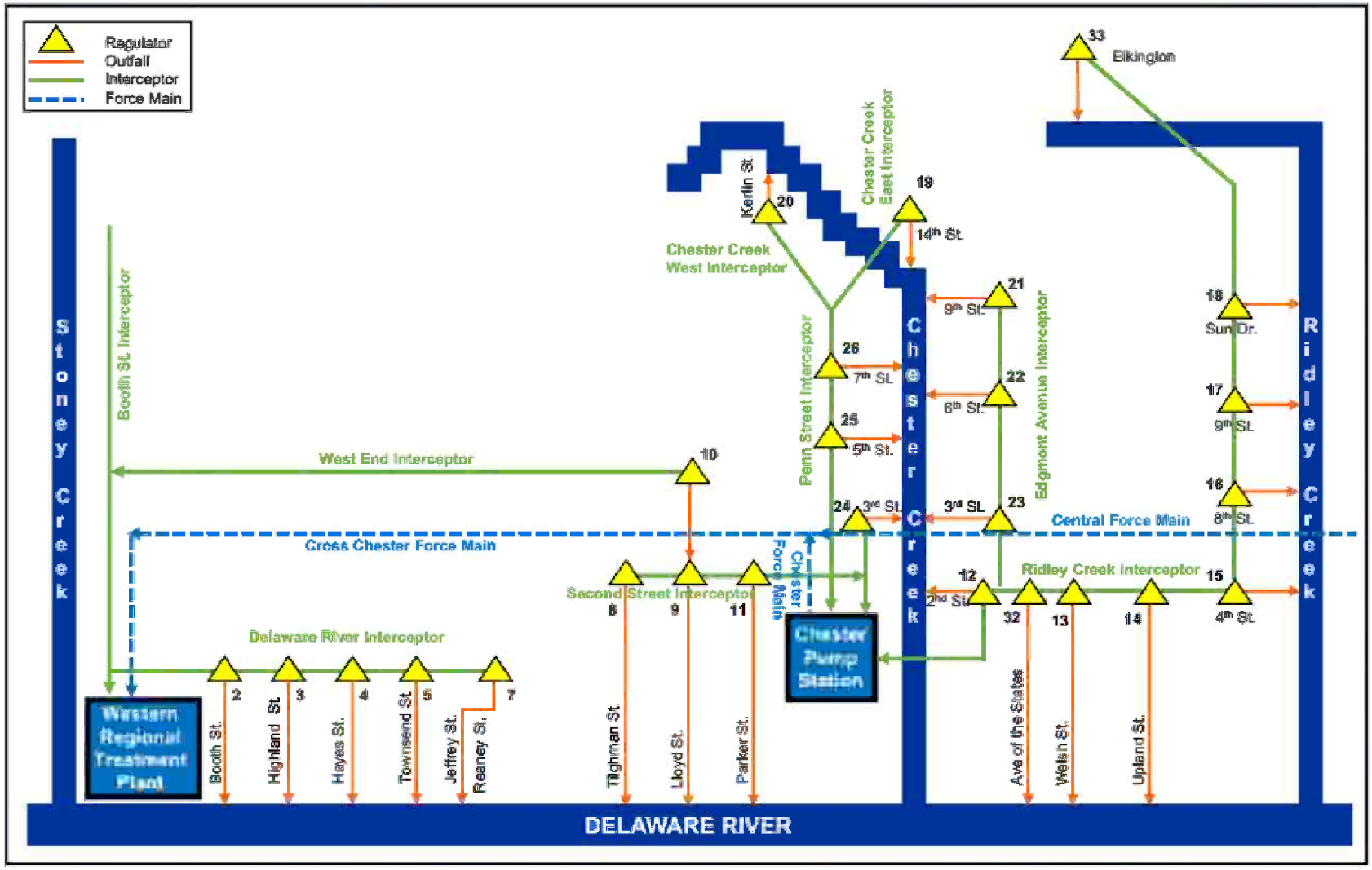
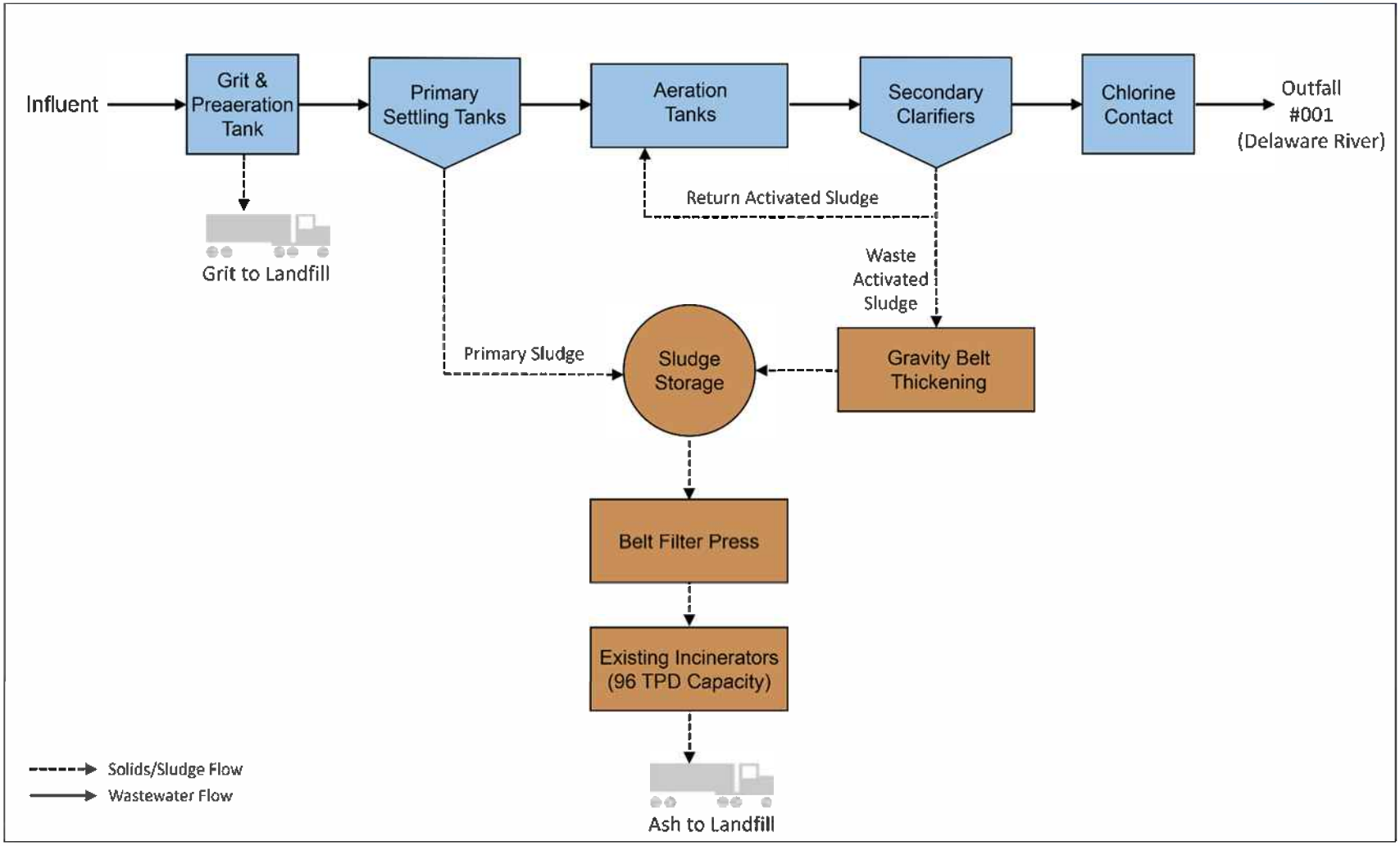


Figure 1-7: Western Regional Treatment Plant Schematic



needed. The WRTP operations procedures will address the need to maximize treatment of wet weather flows, while not risking permit non-compliance or the loss of treatment.

All wastewater from the Muckinipates Authority, Darby Creek Joint Authority, and the Radnor Haverford Marple Authority are transported to the PWD-SWWPCP for treatment and disposal. The Central Delaware Pump Station can direct flow to the WRTP via the Central Diversion Force Main or to the PWD-SWWPCP. DELCORA has an agreement with the City of Philadelphia for the disposal of wastewater. This agreement specifies DELCORA's flow thresholds to the PWD-SWWPCP not exceed an annual average of 50 MGD, a daily maximum of 75 MGD (24 consecutive hours), and an instantaneous peak flow of 100 MGD (5 consecutive minutes). Flows above these thresholds are subject to exceedance charges.

DELCORA also purchased the Rose Valley Treatment Plant in 2009; it is currently no longer in operation and the WRTP receives its flow. The Rose Valley Treatment Plant was permitted at 0.13 MGD and located in Delaware County. On March 1, 2010, DELCORA purchased the Riverside Treatment Plant in Pocopson Township, Chester County. It is permitted at 0.045 MGD.

1.6 Overview of DELCORA's Service Areas

As mentioned previously and depicted in **Figure 1-4**, DELCORA serves a significant and widespread portion of Delaware County and has characterized its service areas as the "Eastern" and "Western." The Western Service Area discharges to the Western Regional Treatment Plant. The Eastern Service Area discharges to the Philadelphia Southwest Water Pollution Control Plant.

In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Western Service Area's Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area now discharges to the WRTP while only those CDPS flows above 20 MGD are to be directed to the PWD-SWWPCP.

1.6.1 Eastern Service Area

The Eastern Service Area is composed of four subareas that are served by conveyance authorities. These areas are the Radnor Haverford Marple (RHM) Authority, Darby Creek Joint Authority (DCJA), Muckinipates Authority (MA), and Central Delaware County Authority (CDCA) and are delineated in **Figure 1-4**. Each of these authorities has a legal agreement with their member municipalities to dispose of their wastewater. In turn, DELCORA has legal agreements with each of the authorities, except RHM, to receive and dispose of the collected wastewater. RHM discharges to the DCJA.

DELCORA owns and operates three large pump stations that serve DELCORA's Eastern Service Area; they are the Central Delaware County Pump Station, the Muckinipates Pump Station, and the Darby Creek Pump Station. These pump stations are designed to pump the wastewater from DELCORA's Eastern Service Area to the Philadelphia Southwest Water Pollution Control Plant for treatment. Originally constructed in the 1970s, the Central Delaware Pump Station (serving CDCA) is rated for 40 MGD. As originally designed, the Central Delaware Pump Station discharges though a 1.9-mile, 36-inch-diameter pre-stressed concrete cylinder pipe (PCCP) force main that runs northeast toward the Muckinipates Pump Station. The next pump station is the 24-MGD Muckinipates Pump Station (serving

MA). Here the force main increases to 48 inches in diameter and continues approximately 1.65 miles northeast to the Darby Creek Pump Station. Upon reaching the 60-MGD Darby Creek Pump Station (serving DCJA and RHM), the force main increases in diameter to 66 inches and continues approximately 2.5 miles on to the PWD-SWWPCP.

As noted previously, the operation of the Central Delaware Pump Station was modified in 2002 to allow for flow from the CDPS to be discharged to the WRTP. Currently, wastewater flows up to 20 MGD are discharged to WRTP and the wastewater flows in excess of 20 MGD are conveyed to the PWD-SWWPCP.

1.6.2 Western Service Area

DELCORA's Western Service Area is also shown in **Figure 1-4**. All wastewater flows from the Western Service Area are treated at DELCORA's WRTP. DELCORA owns and operates the collection system in the following communities in the Western Service Area:

- Chester City
- Chester Township[3]
- Marcus Hook Borough
- Parkside Borough
- Rose Valley Borough[4]
- Upland Borough
- Trainer Borough

DELCORA does not own or operate the collection system in the following communities in the Western Service Area:

- Brookhaven Borough
- Lower Chichester Township
- Nether Providence Township
- Eddystone Borough

[3] DELCORA owns only a portion of the collection system in Chester Township.
[4] Rose Valley Borough collection system discharges to its own treatment plant and a portion is discharged to the WRTP via Nether Providence's collection system.

1.7 Implementation of the Original LTCP

DELCORA has worked in a diligent manner to implement its April 1999 LTCP and the July 2008 addendum to the LTCP until the Long-Term Control Plan Update is approved. DELCORA is required to implement Phases I and II of the existing LTCP as outlined below:

A. Phase I - Implementation of the Nine Minimum Controls
Implementation of the NMCs is currently underway and is continuing in accordance with DELCORA's NMC Plan "*Delaware County Regional Water Quality Control Authority (DELCORA) Western Regional Treatment Plant (WRTP) Nine (9) Minimum Controls (NMC) for Correction of Combined Sewer Overflows (CSO)*" dated July 1995, and revised February 2019.

B. Phase II - Completion of Capital Improvements Projects
DELCORA's implementation of the required Capital Improvements Projects has met or exceeded the original LTCP schedule, including the required Regulator Replacements and installation of the Tide Gate Monitoring Systems. The CSO LTCP projects DELCORA has completed since the original LTCP was approved are as listed in **Table 1-5**.

It is to be noted that after the installation of the first CSO regulator Tide Gate Monitoring System, DELCORA determined that the monitoring system improves system operation and significantly reduces dry-weather overflows by notifying operators at the WRTP that flow is passing over the diversion weir. DELCORA has since installed the monitoring system on all CSO regulators even though it was not required until the CSO regulator was replaced. DELCORA continues to use this system and it provides critical information to maintain proper operation of the CSO regulators.

Table 1-5: Completed CSO LTCP Projects

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	CSO Regulator Type	Regulator Replacement Status
002	Front & Booth	Delaware River	Brown & Brown	Replaced
003	Front & Highland	Delaware River	Brown & Brown	Replaced
004	Front & Hayes	Delaware River	Brown & Brown	Replaced
005	Front & Townsend	Delaware River	Brown & Brown	Replaced
007**	Delaware & Reaney	Delaware River	Brown & Brown	Replaced
008	2nd & Tilghman	Delaware River	Brown & Brown	Replaced
009	2nd & Lloyd	Delaware River	Brown & Brown	Replaced
010*	5th & Pusey	Delaware River	Brown & Brown	Replaced
011	2nd & Parker	Delaware River	Brown & Brown	Replaced
012	2nd & Edgmont	Chester Creek	Brown & Brown	Replaced
013	2nd & Welsh	Delaware River	Brown & Brown	Replaced
014	3rd & Upland	Delaware River	Brown & Brown	Replaced
015	4th & Melrose	Ridley Creek	Brown & Brown	2022
016	8th & McDowell	Ridley Creek	Brown & Brown	Replaced
020	Kerlin & Finland	Chester Creek	Brown & Brown	Replaced
021	9th & Sproul	Chester Creek	Brown & Brown	Replaced
022	6th & Sproul	Chester Creek	Brown & Brown	Replaced
023	3rd & Edgmont	Chester Creek	Brown & Brown	Replaced
024	3rd & Dock	Chester Creek	Brown & Brown	Replaced
025	5th & Penn	Chester Creek	Brown & Brown	Replaced
026	7th & Penn	Chester Creek	Brown & Brown	Replaced
032	2nd & Avenue of the States	Delaware River	Weir Structure	Removed Mechanisms
033	Elkington Blvd. and Ridley Creek	Ridley Creek	Weir Structure	See Notes***

Notes:
* CSO Regulator 010 discharges at Outfall 009.
** CSO Regulators 006 ad 007 have been disconnected from CSS and removed from NPDES permit
*** CSO Regulator 033 has been disconnected from the CSS but had not been removed from NPDES permit at the date of this Report.

Section 2 Identification of Sensitive Areas and Pollutants of Concern

2.1 Background

Paragraph V.A.11 of DELCORA's Consent Decree (Identification of Sensitive Areas and Pollutants of Concern) requires that within six (6) months after the Date of Lodging, DELCORA shall submit a report to the USEPA and/or PADEP that identifies all Sensitive Areas and Pollutants of Concern that are impacted by CSOs and that are within the Model Area for each of its receiving waters. DELCORA met this submission deadline, and the Identification of Sensitive Areas and Pollutants of Concern Report was delivered to the USEPA and PADEP on May 20, 2016 and approved on October 13, 2016. This Section of the LTCP Update summarizes information that was presented in that report. The full version of the approved Identification of Sensitive Areas and Pollutants of Concern Report is included in **Appendix C**.

2.2 Regulatory Requirements

2.2.1 Consent Decree Requirements

For the Identification of Sensitive Areas, Paragraph V.A.11 of the Consent Decree specifically states:

> *"For each of its Receiving Waters, DELCORA shall contact appropriate agencies, access available data sources, and collect additional data as necessary to identify Sensitive Areas. DELCORA shall fully document all such contacts and the associated responses, and all additional investigations carried out to identify Sensitive Areas. DELCORA shall also identify any additional areas that, while not Sensitive Areas, have been identified by DELCORA as being appropriate for prioritization ("Priority Areas")."*
>
> Additionally, *"For each of its Receiving Waters, DELCORA shall conduct community outreach and appropriate studies to determine whether and to what extent primary contact recreation is occurring in each Receiving Water, and shall fully document its outreach and study methods, and its findings."*

For the Identification of Pollutants of Concern, Paragraph V.A.11 of the Consent Decree specifically states:

> *"For each of its Receiving Waters, DELCORA shall review existing water quality data and recent PADEP CWA § 303(d) listings to identify POCs. Even if a water body has not been formally listed as out of compliance with its water quality standards and designated uses, if available data indicate such impairment exists and such impairment involves pollutants associated with CSOs, DELCORA shall consider the related pollutants to be POCs."*

2.2.2 Requirements of the USEPA's CSO Control Policy and Sensitive Areas Definition

The USEPA's CSO Control Policy (Federal Register 59 [April 19, 1994]: 18688-18698) "expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas" (Section II.C.3). The CSO Control Policy states the six (6) criteria for defining an area as a "Sensitive Area" include:

1. Designated Outstanding National Resource Waters
2. National Marine Sanctuaries
3. Waters with threatened or endangered species and their habitat
4. Waters with primary contact recreation
5. Public drinking water intakes or their designated protected areas
6. Shellfish beds

The CSO Control Policy states that if Sensitive Areas are present and impacted, the LTCP should include provisions to:

- Prohibit new or significantly increased overflows
- Eliminate or relocate overflows wherever physically possible and economically achievable
- Treat overflows where necessary
- Where elimination or treatment is not achievable, reassess impacts each permit cycle

Sensitive Areas should be considered prior to the evaluation of CSO control alternatives. This allows a CSO community to identify and estimate costs for controls that could eliminate or relocate CSOs from Sensitive Areas where pollutant loadings pose a high environmental or public health risk and where control efforts should be focused.

After study and evaluation, it has been determined that no sensitive areas as defined by federal law need to be addressed by the DELCORA plans in the Chester and Ridley Creeks or in the Delaware River.

2.2.3 Priority Areas Definition

The term "Priority Areas" is not specifically defined by the USEPA in the Consent Decree nor in the CSO Control Policy or Guidance Document. For the purposes of this report, the term "Priority Areas" is defined as follows:

> *"Areas having some environmental significance but not to the level of "sensitive areas" as defined in the federal CSO Control Policy. These priority areas may include: public access areas (i.e., near marinas, schools, playgrounds, parks, or athletic fields); or use of shallow streams for recreational activity, with something less than full contact (i.e., wading)".*

In compliance with the Consent Decree, DELCORA conducted community outreach in order to determine whether and to what extent primary contact recreation is occurring in each Receiving Water. In order to cover DELCORA's large service area, a public survey was deemed to be the most comprehensive method to actively solicit community outreach. The public survey results are provided in **Appendix M**. Multiple regulatory agencies and environmental organizations were also contacted.

DELCORA conducted public outreach and held four public meetings during the development of this plan to identify areas of special concern to the public. The boat ramp at Flower Street along the Chester Riverfront was identified and, as discussed below, the DELCORA recommended plan makes this area a high priority for CSO control.

2.3 Summary of Sensitive Areas and Priority Areas

As documented in the Identification of Sensitive Areas and Pollutants of Concern Report (Final) dated May 2016, a comprehensive review of online databases, correspondences with regulatory agencies and local environmental organizations, and a review of responses to the public survey was conducted to identify potential Sensitive Areas and Priority Areas within the combined sewer system portion of the collection system. The further details and discussion about the identified areas can be found in the Identification of Sensitive Areas and Pollutants of Concern in **Appendix C**, and the public survey results in **Appendix M.**

2.4 Regulatory Requirements for the Identification of Pollutants of Concern

2.4.1 Sources of Information

The primary source of information about the causes of impairment, and the Total Maximum Daily Load status of the water bodies (if any) is the 2014 PA Integrated Water Quality Monitoring and Assessment Report (PA Integrated Report), which satisfies Pennsylvania's requirement of both Section 303(d) and 305(b) of the Clean Water Act (CWA). The PA Integrated Report lists all impaired surface waters within Pennsylvania that are not attaining designated and existing uses, even after appropriate and required pollution control technologies have been applied. A TMDL is designed to reduce pollutant loads to impaired waters and enable these waters to meet water quality standards.

The PA Integrated Report uses a five-part categorization (lists) of water according to their use attainment status. The categories represent varying levels of use attainment, ranging from Category 1, where all designated water uses are met to Category 5, where impairment by pollutants required the development of a TMDL to correct. Each segment of the waterbody is placed into one of these five categories. "Impairment" of a receiving water body is indicated to exist for a particular parameter if the parameter appears in Categories 4A and 5, as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters. The Category 5 list constitutes the Section 303(d) list that the USEPA will approve or disapprove under the CWA. For the purposes of the determination of Pollutants of Concern, Categories 4A and 5 are the relevant categories as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters. For DELCORA's drainage area, the HUC for the Lower Delaware River (02040202) was used for searching the data in the PA Integrated Report for all three of DELCORA's receiving water bodies.

The primary source of information for the Critical Use Designation for each section of the three receiving water bodies is 25 Pa. Code §93.9g – Drainage List. The relevant Critical Use Designations for DELCORA's receiving water bodies include Warm Water Fishes (WWF), Migratory Fishes (MF), Trout Stocking (TSF), and Water Contact Sports/Recreation (WC).

The applicable water quality standards for DELCORA's three receiving water bodies are found in the Delaware River Basin Commission's Water Quality Regulations, and in Water Quality Criteria lists found

in 25 Pa. Code §93.7 and §93.8c. For the Delaware River, the water quality standards are dictated by the DRBC's WQRs that have primacy over the standards in the PA Code. The water quality standards in the PA Code apply to the non-tidal portions of the Chester Creek and Ridley Creek, and to the Delaware River if there is no standard listed for a particular parameter in the DRBC's WQRs.

The DRBC's 2014 Delaware River and Bay Water Quality Assessment (DRBC, 2014) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commissions' Water Quality Regulations for the period October 1, 2008 through September 30, 2013. The 2014 Assessment involves the comparison of key water quality parameters with the applicable DRBC water quality regulations. The states of Pennsylvania, New Jersey, Delaware and New York consider the DRBC's Assessment report as part of their determinations as to whether sections of the Delaware River should be listed on the state 303(d) list for a certain pollutant.

2.4.2 Delaware River Regulatory Requirements

2.4.2.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

The 2014 PA Integrated Water Quality and Assessment Report ("the 303(d) List") lists a 61.02 mile segment of the Lower Delaware River in Category 4A as having an approved TMDL for polychlorinated biphenyls (PCBs) from an unknown source related to its fish consumption use. The USEPA approved a TMDL for PCBs for Zone 2 through Zones 5 in 2003, and a second PCB TMDL was approved for Zone 6 in 2006. The TMDLs for PCBs encompass the Delaware River Estuary and stretch from the mouth of the Delaware River upstream to the Trenton, NJ /Morrisville, PA Bridge. The segment of the Delaware River having an approved TMDL for PCBs is shown in yellow in the map in **Figure 2-1**, which was derived from the PADEP's eMapPA website.

As noted in **Subsection 2.5.2.1**, while the Delaware River is impaired from PCBs the PCBs are not normally associated with CSOs. Additionally, PCB impairment begins well upstream of DELCORA's service area and additional CSO sampling results from November/December 2015 showed all samples below the Reporting Detection Limit (RDL). For these reasons it was determined that PCBs are not associated with DELCORA's CSO discharges and are not considered a Pollutant of Concern.

2.4.2.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code

The Critical Uses for the Delaware River in the area of DELCORA's CSO discharges are designated as WWF (maintenance only) and MF (passage only). Additionally, the Delaware River has a WC designation downstream of River Mile 81.8, which is located directly adjacent to the City of Chester between CSO #009 and #011.

For WC-designated waters, 25 Pa. Code §93.7 establishes the following as the water quality criterion for fecal coliform bacteria:

- Fecal Coliform – A geometric mean of 200 colonies/100 mL from May 1 - September 30 based on a minimum of five samples collected during a 30-day period. For the remainder of the year, the maximum fecal coliform level is a geometric mean of 2,000 colonies/100 mL based on a minimum of five samples collected during a 30-day period. There are no fecal coliform bacteria

Figure 2-1: Non-Attaining Streams and TMDL Streams within DELCORA's Service Area

- criteria for the Delaware River or tributaries that are not designated as Water Contact or Public Water Supply (PWS) waters.

For WWF and MF waters, the WWF designation is the more restrictive of the two and 25 Pa. Code §93.7 establishes the following additional standards for WWF waters:

- Dissolved Oxygen: Minimum above 5.0 mg/L, with the 7-day average value above 5.5 mg/L
- Alkalinity: A minimum of 20 mg/L as CaCO3, except where natural conditions are less
- Ammonia Nitrogen – the maximum total ammonia nitrogen concentration (in mg/L) shall be the numerical value given by un-ionized ammonia nitrogen (NH3-N) x (log-1[pKT-pH] + 1)
- Iron: 30-day average 1.5 mg/L as total recoverable
- pH: From 6.0 to 9.0 inclusive
- Temperature: A table is included within 25 Pa. Code §93.7 for maximum water temperatures in the receiving water body at various times of the year
- Total Residual Chlorine: Four-day average 0.011 mg/L; 1-hour average 0.019 mg/L

2.4.2.3 Designated Zone and Water Quality Regulations from the DRBC

Chapter 25 Pa. Code §93.9 lists the DRBC regulations for Water Quality Zone 4 as exceptions to PA Code's specific water quality criteria. The DRBC's water quality regulations have primacy over the standards in the PA Code for the Delaware River.

The segment of the Delaware River directly impacted by DELCORA's CSO discharges is referred to as Zone 4" by the DRBC. The DRBC defines Zone 4 as that part of the Delaware River extending from R.M. 78.8 to R.M. 95.0, the Pennsylvania-Delaware state boundary line to the upstream side of the Philadelphia Navy Yard, including the tidal portions of the tributaries thereof. The extent of Zone 4 is represented in **Figure 6-6.** The DRBC states that the quality of Zone 4 waters shall be maintained in a safe and satisfactory condition for the following uses:

- Industrial water supplies after reasonable treatment
- Maintenance of resident fish and other aquatic life
- Passage of anadromous fish
- Wildlife
- Recreation - secondary contact above R.M. 81.8
- Recreation (all water-contact sports) below R.M. 81.8
- Navigation

The DRBC's Stream Quality Objectives for Zone 4 are as follows:

1. Dissolved Oxygen
   - 24-hour average concentration shall not be less than 3.5 mg/L.
   - During the periods from April 1 to June 15, and September 16 to December 31, the DO shall not have a seasonal average less than 6.5 mg/L.

2. Temperature shall not exceed:
   - 5°F (2.8°C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or
   - A maximum of 86°F (30.0°C), whichever is less.

3. pH between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions

4. Phenols maximum 0.02 mg/l, unless exceeded due to natural conditions

5. Threshold Odor Number not to exceed 24 at 60°C

6. Synthetic Detergents. (M.B.A.S.). Maximum 30- day average 1.0 mg/L

7. Radioactivity
   - Alpha emitters - maximum 3 pc/L (picocuries per liter);
   - Beta emitters - maximum 1,000 pc/L.

8. Bacteria
   - Fecal Coliform
     - Above R.M. 81.8: maximum geometric average 770 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 200 per 100 milliliters
   - Enterococcus
     - Above R.M. 81.8: maximum geometric average 88 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 33 per 100 milliliters

9. Total Dissolved Solids not to exceed 133% of background
   (NOTE: The background TDS concentration is at present undefined, according to the DRBC's 2014 Delaware River and Bay Water Quality Assessment.)

10. Turbidity unless exceeded due to natural conditions
    - Maximum 30-day average 40 units (NTU)
    - Maximum 150 NTU

11. Alkalinity between 20 and 120 mg/L

12. Toxic Pollutants
    - Applicable criteria to protect the taste and odor of ingested water and fish are presented in the DRBC's WQRs Table 4.
    - Applicable freshwater stream quality objectives for the protection of aquatic life are presented in the DRBC's WQRs Table 5.
    - Applicable freshwater stream quality objectives for the protection of human health are presented in the DRBC's WQRs Tables 6 and 7.

2.4.2.4 DRBC Evaluation of Use Attainment Status

Table 2-1 presents a summary of Table 23 from the DRBC's 2014 Delaware River and Bay Water Quality Assessment for Zone 4 of the Delaware River.

Table 2-1: 2014 DRBC Integrated Assessment for Zone 4 of the Delaware River

Zone	Designated Use			
	Aquatic Life	Drinking Water	Recreation	Fish Consumption
4	NS	N/A	S	NS

Notes:
N/A - Not applicable
NS - The Designated Use is not supported
S - The Designated Use is supported

Table 2-1 shows whether or not the designated use is being attained for the Delaware River in Zone 4. According to the table, the designated use for Water Contact Recreation is being attained but the designated use for Aquatic Life and Fish Consumption are not being attained. The DRBC's Assessment Report (DRBC, 2014) states, "*the composite aquatic life assessment for 2014 yields a result of "Not Supporting" for all assessment units* (or zones). *It is important to note, however, that this result is largely driven by the requirement to categorize as not meeting criteria any assessment unit* (or zone) *with 1 exceedance plus 1 confirmatory exceedance.*" The DRBC's Assessment Report also states: "*Data showed multiple exceedances of aluminum acute and chronic freshwater objectives for the support of aquatic life in Zone 4. Of 35 surface water samples tested for aluminum in Zone 4 during the assessment period, 34 exceeded the chronic criterion and 8 exceeded the acute criterion at 21PA_WQX-WQN0182 near Marcus Hook, PA. No exceedances of aluminum were reported in Zones 2, 3, 5 and 6.*" As part of the Recommendations for Future Action at the end of the report, the DRBC states that the "*exceedances of aluminum criteria in Zone 4 warrant further attention*".

The Fish Consumption designated use is not being attained. The Assessment Report states that their assessment criterion for fish consumption is based on the presence of fish consumption advisories from the four Basin states for the main stem of the Delaware River. If a fish consumption advisory is present, this resulted in the DRBC making an assessment of "not supporting the designated use". Violation criteria for PCBs also supported this assessment, with the presence of measureable concentrations of PCBs in the river that exceeded the surface water quality standard. The 2016 Commonwealth of Pennsylvania Fish Consumption Advisories for Zones 2, 3, and 4 of the Delaware River (Trenton, NJ/Morrisville, PA Bridge to PA/DE border) are as shown below in **Table 2-2**. These advisories identify PCBs as a pollutant of concern in fish tissue.

Table 2-2: PA Fish Consumption Advisory Summary for PCBs in the Delaware River

Fish Species	Meal Frequency	Contaminant
White Perch	1 meal/month	PCB
Flathead Catfish	1 meal/month	PCB
Channel Catfish	1 meal/month	PCB
Striped Bass: over 28 inches in length	1 meal/month	PCB
Carp	6 meals/year	PCB
American Eel	Do Not Eat	PCB

2.4.3 Chester Creek Regulatory Requirements

2.4.3.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

Chester Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its recreational use due to pathogens, and for not meeting its aquatic life use due to siltation. "Pathogens" were listed in 2006 for three segments totaling 0.94 miles, and a TMDL is anticipated in 2019. The source for the pathogens is listed as "unknown", and these three stream segments are all well upstream of DELCORA's service area. Therefore, it appears that the noted impairment of the Chester Creek due to pathogens is not related to DELCORA's CSO discharges.

"Siltation" was listed in 2014 for four segments of the creek totaling 18.41 miles, and a TMDL is anticipated in 2027. The source for the siltation was identified as "urban runoff/storm sewers". The majority of Chester Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located upstream of DELCORA's service area and are shown in red in the map in **Figure 2-2**. However, one of DELCORA's CSO outfalls does discharge to the furthest downstream segment of the Chester Creek that is impaired by siltation, which is Outfall #020 near Kerlin Street and Finland Drive.

The impairment of Chester Creek by siltation primarily occurs upstream of DELCORA's service area as shown in **Figure 2-1**. The term "Siltation" is not defined in the 2014 PA Integrated Water Quality & Assessment Report, but through various sources can be defined as:

> *"the pollution of water by fine particulate terrestrial clastic material, with a particle size dominated by silt or clay. It refers both to the increased concentration of suspended sediments, and to the increased accumulation (temporary or permanent) of fine sediments on bottoms where they are undesirable. Siltation is most often caused by soil erosion or sediment spill."*

There is not a water quality standard for "siltation", however, siltation can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. For this reason, "Turbidity" was reviewed further as a surrogate for siltation to determine if it might be considered as a POC. As noted in **Subsection 2.5.2.1**, per available USEPA Storage and Retrieval (STORET) data the Turbidity concentrations on the Chester Creek were found to be below the WQS and therefore siltation was screened-out as not being a POC.

Category 4A lists a 0.81-mile segment of Chester Creek at its mouth that does not meet its designated use for fish consumption due to PCBs from an unknown source, and for which a TMDL for PCBs was issued in 2006. This is shown in yellow in the map in **Figure 2-1** and is related to the TMDL for PCBs in the Delaware River Estuary.

2.4.3.2 Designated Critical Uses and Water Quality Criteria from PA Code

The Critical Uses for the Chester Creek in the area of DELCORA's CSO discharges are designated in 25 Pa. Code §93.9. All stretches of the Chester Creek in this area are designated as WWF (maintenance only) and MF (passage only). The same specific water quality criteria apply to the WWF and MF Critical Use designations for Chester Creek as apply for the Delaware River.

2.4.4 Ridley Creek Regulatory Requirements

2.4.4.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

Ridley Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its aquatic life use due to siltation. The "Siltation" was listed in 2012 for five segments totaling 26.76 miles, and a TMDL is anticipated in 2025. The source for the siltation was identified as "unknown" or from "urban runoff/storm sewers".

In actuality, it appears that the majority of Ridley Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located well upstream of DELCORA's service area and are shown in red in the map in **Figure 2-1**. All of Ridley Creek within DELCORA's service area is shown as impaired for aquatic life due to siltation. As with the Chester Creek, the Ridley Creek is listed in the 2014 PA Integrated Water Quality & Assessment Report as impaired for Aquatic Life from siltation, with Urban Runoff/Storm Sewers identified as the source.

However as noted for the Chester Creek, there is not a water quality standard for "siltation" but it can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. As noted in **Subsection 2.5.2.1**, per available USEPA STORET data the Turbidity concentrations for the Ridley Creek were found to be below the WQS and therefore siltation was screened-out as not being a POC.

2.4.4.2 Designated Critical Uses and Water Quality Criteria from PA Code

The Critical Uses for the Ridley Creek in the area of DELCORA's CSO discharges are designated in 25 Pa. Code §93.9. All stretches of the Ridley Creek in this area are designated as WWF (maintenance only), MF (passage only), or TSF. The TSF stretch only applies in the sections of the Ridley Creek upstream of the Chestnut Street bridge crossing.

The same specific water quality criteria apply to the WWF and MF Critical Use designations for Ridley Creek as apply to the Chester Creek and Delaware River, except for the parameters of Dissolved Oxygen and Temperature – which are more stringent in the TSF stretch because of the high oxygen needs of trout.

Specifically, for TSF waters 25 Pa. Code §93.7 establishes the following additional standards:

- Dissolved Oxygen – For the period February 15 to July 31 of any year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 6.0 mg/L. For the remainder of the year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 5.5 mg/L.
- Temperature – A separate table is included within 25 Pa. Code §93.7 for maximum water temperatures in the receiving water body at various times of the year for TSF waters.

2.5 Assessment of Pollutants of Concern

A comprehensive review of existing receiving water quality data was conducted to identify the Pollutants of Concern and this review was performed in accordance with the requirements of the Consent Decree and the CSO Guidance Manual. This review included on-line USEPA STORET data from the years 2010-2015, results of sampling performed during the preparation of DELCORA's 1999 LTCP and additional CSO sampling.

2.5.1 Methodology for Identification of the Parameters Considered

For the identification of the POCs, DELCORA took an inclusive approach to determine that all relevant water quality parameters were appropriately considered and evaluated. The first step was to develop a comprehensive list of the overall "Parameters Considered", which was then further evaluated and refined to determine the list of the applicable POCs. Development of the list of Parameters Considered was meant to cast a wide net as the first step towards identifying any parameters that might possibly be of concern.

The initial list of the Parameters Considered was compiled from six (6) primary reference sources from the USEPA, PADEP and the DRBC. The Parameters Considered list initially consisted of those specific parameters listed in the USEPA's CSO Guidance Document. Additional parameters to consider were added from the parameters requiring sampling per DELCORA's NPDES permit, from the PA Code's specific water quality criteria for DELCORA's three receiving water bodies, from the DRBC's Water Quality Regulations for Zone 4 of the Delaware River, from the 2014 PA Integrated Water Quality Monitoring and Assessment Report (a.k.a. "303(d) List"), and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment report. **Appendix C** provides a summary of the initial Parameters Considered list that was developed by compiling the parameters listed in each of the six primary reference sources.

Once the initial list of Parameters Considered was developed, additional parameters including Metals Nutrients, and Toxics were added onto the list if they had been detected during the historical sampling data of the influent to the WRTP, or in the existing CSO monitoring data. One year's worth of DELCORA's plant influent historical sampling data from September 1, 2014 through September 1, 2015 was collected and analyzed to identify additional Parameters Considered.

It is important to state that that the historical sampling data noted above for the influent to the WRTP also included industrial wastewater from DELCORA's forty-five (45) Significant Industrial Users (SIUs). The industrial wastewater from forty-three (43) of DELCORA's SIUs is trucked directly to the WRTP and is discharged downstream of all CSOs into the combined sewer flow prior to the plant's influent sampling location. Consequently, the historical sampling data for the influent to the plant detected

twenty-eight (28) industrial-type chemicals from these SIUs that are not normally associated with sanitary sewage or combined sewer overflows. Since the trucked-in industrial wastewater is discharged directly to the WRTP, it is not able to migrate back into the combined sewer system and, therefore, this industrial wastewater cannot be discharged from any of DELCORA's CSOs. However, as part of the due diligence to address all possible POCs, the 28 industrial chemicals that were detected in the historical sampling of the plant influent were added onto an expanded list of Parameters Considered.

To help eliminate from the expanded list of the Parameters Considered the industrial chemicals that were detected as a result of the SIUs discharging to the WRTP, it was determined that additional wet weather sampling at the CSOs was required. The purpose of the additional sampling was to verify and confirm that the industrial-type chemicals not normally associated with CSOs that were detected in the historical sampling of the plant influent were in fact actually from the trucked-in industrial wastewater and not a part of the normal flow within the CSS that might overflow at a CSO. The CSO sampling results were used to screen non-detected parameters from the list of the Parameters Considered. The additional sampling results more accurately reflect the actual characteristics of the wastewater discharged at the CSOs, than the historical data at the plant influent since the trucked-in industrial wastewater only goes into the plant and does not enter into the CSS. Therefore, if a parameter on the expanded Parameters Considered list was not detected in the November and December 2015 wet weather sampling of the CSOs, those parameters were not considered further as POCs.

2.5.2 Methodology for Identification of the Pollutants of Concern List

Once the Parameters Considered list was narrowed using the November/December 2015 additional sampling results at the CSOs, the parameters remaining on the narrowed list of Parameters Considered were further evaluated to determine if they are Pollutants of Concern, or Parameters of Potential Concern (POPC). A parameter is considered a "Pollutant of Concern" for a water body if more than 10% of the samples exceeded the applicable water quality standard. This criterion is based on guidance provided by the USEPA, which recommends a "greater than 10% exceedance percentage" for determining that waters only partially meet their designated use for aquatic life support. A parameter is considered a "Parameter of Potential Concern" if 2 – 10% of the samples exceeded the water quality standard.

Water quality data for the parameters on the narrowed Parameters Considered list were collected from the STORET data repository for the one-year period from September 1, 2014 to September 1, 2015 from the water quality monitoring stations on each of the three receiving water bodies.

The segments of the Delaware River, Chester Creek and Ridley Creek have unique water quality standards that apply to them depending on the regulating authority, their designated uses, and the specific location within the waterbody. The Water Quality Standards Master Table that was developed to identify the applicable WQS is presented in **Appendix B**. The maximum concentrations detected for each of the Parameters Considered were compared against the applicable surface water quality standards to determine which parameters were exceeding their standards. The Delaware River was evaluated in two sections; one for the Delaware River upstream of R.M 81.8 ("upper Delaware") and one for the Delaware River downstream of R.M 81.8 ("lower Delaware") based on the Water Contact Recreation designated use for the Delaware River below R.M. 81.8 and the more stringent requirements associated with primary contact. The receiving stream water quality data from the USEPA STORET data warehouse was compared against the applicable WQS to check for exceedances. Both the acute and chronic conditions

for the Parameters Considered were compared to the WQS, where applicable, to determine if there were exceedances.

A flowchart was created to help illustrate the decision-making methodology used for developing the Pollutants of Concern list. The flowchart represents the process used for answering five (5) screening questions about the Parameters Considered in order to determine if a parameter is to be considered a Pollutant of Concern, a Parameter of Potential Concern, or neither. **Figure 2-2** presents the Methodology Flowchart used for developing the list of POCs and POPCs, and the following subsection provides additional details about the methodology used to answer the 5 screening questions.

2.5.2.1 Screening of Parameters Using the Methodology Flowchart

The Methodology Flowchart for POC and POPC Determination in **Figure 2-2** shows that the first step is to determine if a Parameter Considered has an applicable PA State or DRBC water quality standard. If a parameter does not have an applicable water quality standard, there is no standard to exceed. Therefore, those parameters without a water quality standard are not considered further as a POC or a POPC. These include many of the Parameters Considered. Of the 76 Parameters Considered, 25 were removed from further consideration because they do not have an applicable water quality standard.

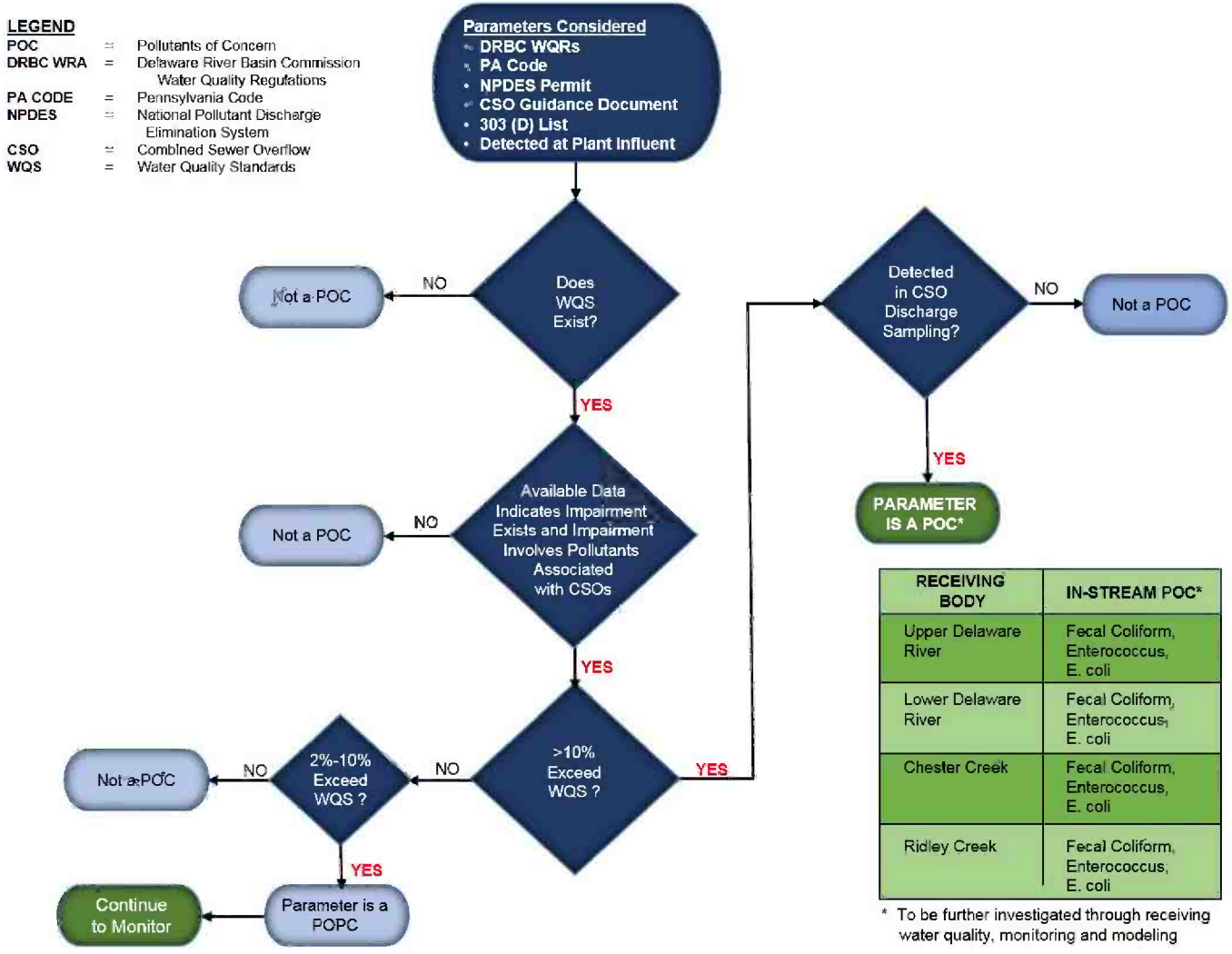
For the 51 Parameters Considered that do have an applicable water quality standard, the Methodology Flowchart shows that the second screening decision is to determine if existing water quality data indicate impairment of the receiving water bodies exists and the impairment involves pollutants associated with CSOs. The inclusion of this determination comes directly from the requirements of the Consent Decree.

"Impairment" of a receiving water body is "indicated" to exist in one of two ways. First, the receiving water body is considered impaired for a particular parameter if the parameter appears in the 2014 PA Integrated Water Quality & Assessment Report (303(d) List). The PA Integrated Report identifies surface water bodies that are not attaining their designated and existing uses as "impaired". Secondly, for the purpose of this report, a receiving water body is also considered impaired for a parameter if any of the available sampling data for that parameter in the water body shows that there had been an exceedance of the applicable water quality standard. Those parameters that showed exceedances of the WQS and that may be associated with CSOs were evaluated further to determine if they should be considered as a POC.

The 2014 PA Integrated Water Quality & Assessment Report shows the Delaware River to be impaired for Fish Consumption by PCBs from an unknown source, and there is a PCB TMDL on the Delaware River stretching far upstream to Trenton, NJ. While the Delaware River is impaired from PCBs, the PCBs are not normally associated with CSOs. Given this reason, and the fact that the PCB impairment begins well upstream of DELCORA's service area – PCBs were screened as not being a POC. Furthermore, the additional CSO sampling results from November/December 2015 show that PCBs were found to be at a lower concentration than the Reporting Detection Limit. For this additional reason it was determined that PCBs are not associated with DELCORA's CSO discharges.

For the Chester Creek and Ridley Creeks, the 2014 PA Integrated Water Quality & Assessment Report shows that both of the creeks are impaired for Aquatic Life from siltation, with Urban Runoff/Storm Sewers identified as the source. The impairment of the Chester Creek and Ridley Creek by siltation primarily occurs upstream of DELCORA's service area as shown in **Figure 2-2**. There is not a water quality standard for "siltation", however, siltation can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. Per available USEPA STORET data,

Figure 2-2: Methodology Flowchart for POC and POPC Determination



the Turbidity concentrations on all of the three receiving water bodies were found to be below the WQS and therefore siltation was screened-out as not being a POC.

The concentrations of those Parameters Considered that were detected within the receiving water bodies from USEPA's STORET data for the Years 2010 - 2015 were compared to the applicable water quality standards to determine if a Parameter Considered should be viewed as a Pollutant of Concern. If 10% or more of the total number of samples for a Parameter Considered exceeded the WQS, then the parameter was further evaluated to see if it was detected in the CSO discharges. If 2% - 10% of the total number of samples for a Parameter Considered exceeded the WQS, then the parameter was considered a Parameter of Potential Concern. The concentrations of the Parameters of Potential Concern will continue to be monitored over time, and re-evaluated should the monitoring show their concentrations to increase over time. Per the flowchart, if 2% - 10% of the total number of samples for a Parameter Considered do not exceed the WQS, then the parameter was not considered to be a POC or POPC.

The Methodology Flowchart shows that additional analysis is required for those parameters that exceeded the water quality standards for the receiving water bodies in more than 10% of the samples. For those parameters, the concentration of the parameter detected in the November/December 2015 sampling of the CSO discharges was reviewed.

If the parameter was "Not Detected (ND)" or was below the Reporting Detection Limit in the November/December 2015 CSO sampling results, it indicates that the parameter was not observed in DELCORA's CSO discharges. In this case, the parameter is not considered to be a POC. In this manner, the industrial-type chemicals that had been originally detected in the historic sampling results from the influent to the WRTP were able to be removed from further consideration as a POC or POPC.
If the parameter was detected within the November/December 2015 CSO sampling results, it indicates that the parameter was in DELCORA's CSO discharge. In these cases, the parameter is considered as a POC, and is to be further investigated through additional receiving water quality monitoring and modeling.

2.5.3 Discussion of the Pollutants of Concern and Parameters of Potential Concern

The following discussion of the individual parameters is focused only on those parameters that were shown to be either a POC or a POPC.

2.5.3.1 Fecal Coliform Bacteria

Fecal coliform bacteria are the most common microbiological contaminants of natural waters and are used to indicate contamination by human pathogens. Fecal coliform live in the digestive tracks of warm-blooded animals, including humans, and are excreted in the feces. The DRBC collects fecal coliform bacteria data at Stations 332049 and 892062 on the Delaware River. Additionally, DELCORA sampled the Chester and Ridley Creeks in 2010 for fecal coliform concentrations.
There are no PA Code, Chapter 93 fecal coliform bacteria water quality standards for streams designated WWF, MF or TSF with no other qualifiers. However, the DRBC's Delaware River Zone 4 has a Stream Quality Objective for fecal coliform of no more than 770 CFU/100 mL for the section upstream of R.M. 81.8, which includes the tidal portions of the Chester and Ridley Creeks, and 200 CFU/100 mL for the section of the river downstream of R.M. 81.8.

Of the six samples taken by DELCORA in 2010 on Ridley Creek, four show exceedances of the Stream Quality Objective for fecal coliform. These values indicate that Ridley Creek was not meeting the DRBC Stream Quality Objective. Of the six samples taken by DELCORA on Chester Creek, four show exceedances of the Stream Quality Objective for fecal coliform. These values indicate that Chester Creek was also not meeting the DRBC WQS at that time. More sampling was recommended to further confirm these results. The available data indicates that there were no exceedances observed of fecal coliform in the Delaware River.

Given the exceedances of fecal coliform WQS at both the Ridley and Chester Creeks, fecal coliform should be considered as a POC for the two creeks. However, although the existing data for the Delaware River has demonstrated that there were no exceedances observed of fecal coliform, since fecal coliform is a primary pollutant typically associated with CSO discharges it has been decided to also include it as a POC for the Delaware River in the interest of minimizing potential impacts to human health and the environment.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the upper Delaware River (Upstream of R.M. 81.8)
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the Chester Creek
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the Ridley Creek
  - Fecal Coliform considered to be a Pollutant of Concern.

2.5.3.2 *Enterococcus* Bacteria

Enterococcus is a second bacteria genus that also resides in the digestive system of humans and animals, and that is used to indicate the presence of human pathogens. They have been long recognized as important human pathogens and are becoming increasingly so.

Unlike fecal coliform, the DRBC does not collect *Enterococcus* bacteria data at Stations 332049 and 892062 on the Delaware River, and DELCORA did not collect samples for *Enterococcus* bacteria in 2010 as it did for fecal coliform. *Enterococcus* are used as an indicator bacteria for marine waters.
As with fecal coliform, there are no PA Code, Chapter 93 water quality standards for *Enterococcus* bacteria for streams designated WWF, MF or TSF with no other qualifiers. However, the DRBC's Delaware River Zone 4 has a WQS for *Enterococcus* bacteria of no more than 88 CFU/100 mL for the section upstream of R.M. 81.8, which includes tidal portions of the Chester and Ridley Creeks, and 33 CFU/100 mL for the section of the river downstream of R.M. 81.8.

Very little existing data was available for *Enterococcus* bacteria concentrations in the Delaware River, Chester Creek and Ridley Creek in the area of DELCORA's CSO discharges. However, *Enterococcus* bacteria and fecal coliform bacteria are similar to each other, they are both produced in the human digestive tract, and are both considered to be parameters typically associated with CSOs. For this reason, it was decided to also include *Enterococcus* bacteria as a POC at the same locations identified for fecal coliform bacteria, which includes all three of DELCORA's receiving water bodies.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - *Enterococcus* considered to be a Pollutant of Concern.
- For the upper Delaware River (Upstream of R.M. 81.8)
  - *Enterococcus* considered to be a Pollutant of Concern.
- For the Chester Creek
  - *Enterococcus* considered to be a Pollutant of Concern.
- For the Ridley Creek
  - *Enterococcus* considered to be a Pollutant of Concern.

2.5.3.3 *Escherichia Coli* Bacteria

Escherichia coli (also known as *E. coli*) is a facultative anaerobic, rod-shaped bacterium of the genus Escherichia that is commonly found in the lower intestine of warm-blooded organisms. *E. coli* is expelled into the environment within fecal matter. Fecal material can enter the environment from many sources including wastewater treatment plants, CSO discharges, livestock or poultry manure, sanitary landfills, septic systems, sewage sludge, pets and wildlife.

E. coli was not listed as an initial Parameter Considered because it is not listed in the applicable reference sources from the PA Code or DRBC. However, in consultation with the PADEP it is understood that *Enterococcus* bacteria could be replaced with *E. coli* in future regulations (on the anticipation that national standards for *E. coli* will be adopted in Pennsylvania) and therefore *E. coli* is included as a POC for all the receiving water bodies.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - *E. coli* considered to be a Pollutant of Concern.
- For the upper Delaware River (Upstream of R.M. 81.8)
  - *E. coli* considered to be a Pollutant of Concern.
- For the Chester Creek
  - *E. coli* considered to be a Pollutant of Concern.
- For the Ridley Creek
  - *E. coli* considered to be a Pollutant of Concern.

2.5.3.4 Metals

None of the CSO receiving waters are listed as being impaired for metals. Because 43 of 45 significant industrial users of the DELCORA system truck their wastes to the plant, DELCORA's CSO discharges will have significantly lower industrial contributions of metals and other pollutants than other CSO communities. Moreover, these CSO discharges only occur during wet weather events when significant instream dilution is available. Therefore, the appropriate control measures to address metals from DELCORA's CSO discharges are the continued implementation of and compliance with the Nine Minimum Controls as required by DELCORA's NPDES permit.

The NPDES permit requires DELCORA to submit an annual report each year to the PADEP, with appropriate documentation demonstrating the continued implementation of and compliance with the NMCs required on a system wide basis.

For the removal of metals, the most applicable Nine Minimum Controls include the maximum use of the collection system for storage, the review and modification of pretreatment requirements to ensure that CSO impacts are minimized, maximization of flow to the POTW for treatment and pollution prevention programs (such as street sweeping) to reduce these contaminants in the CSOs.

For these reasons, like almost every other CSO community's LTCP, metals are not considered POCs.

2.6 Identified Pollutants of Concern

In the effort to identify Pollutants of Concerns related to its CSO discharges, DELCORA has reviewed the 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) List), the historic sampling data for the influent to the Western Regional Treatment Plant, the USEPA's STORET Data repository, historic water quality sampling data from the Chester and Ridley Creeks, and additional sampling results from the CSOs from November and December of 2015.

Three (3) POCs were determined as identified in Table 2-3. These include Fecal Coliform bacteria, *Enterococcus* bacteria and *E. coli* bacteria. These three POCs are parameters typically associated with CSO discharges. The concentrations of these identified POCs in the Delaware River, Chester Creek and Ridley Creek will be further investigated through receiving water quality monitoring and modeling.

No Parameters of Potential Concern were identified.

Table 2-3: List of Pollutants of Concern (POC)

No.	Upper Delaware River		Lower Delaware River		Chester Creek		Ridley Creek	
Pollutants of Concern (>10% of observed samples exceed WQS)								
1	Fecal Coliform[b]	100%	Fecal Coliform[b]	100%	Fecal Coliform[a],[b]	100%	Fecal Coliform[a],[b]	100%
2	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%
3	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%

[a] Based on historical sampling conducted in 2010 upstream and downstream of CSO outfalls only on Chester and Ridley Creeks.

[b] Fecal Coliform and Enterococcus are listed as POCs due to both being parameters typically associated with CSOs.

[c] DRBC regulations are available for Enterococcus and it is typically associated with CSOs and therefore it is included as a POC. However, in consultation with PADEP Enterococcus could be replaced with E. coli bacteria in the future (based on the anticipation that national standards on E. coli will be adopted in Pennsylvania) and therefore E.coli is also included as a POC.

Section 3 Typical Hydrologic Period

3.1 Introduction

3.1.1 DELCORA's Consent Decree

According to the Consent Decree between the USEPA, PADEP, and DELCORA, within ninety (90) days after the lodging date of August 17, 2015, DELCORA shall submit to Plaintiffs a report or technical memorandum describing DELCORA's statistical evaluation of long-term local rainfall patterns and the identification of an appropriate typical period for LTCPU development purposes. To satisfy this Consent Decree requirement, DELCORA submitted the Hydrologic and Hydraulic Model Update and Calibration Plan (**Appendix D**) in October 2015 and the Typical Hydrologic Period Report (**Appendix E**) on November 15, 2015, which was updated and re-submitted on April 22, 2016, and approved by PADEP and USEPA on May 23, 2016. The remainder of this Section is based on the approved Typical Hydrologic Period Report.

The statistical evaluation in the Typical Hydrologic Period Report utilizes local long-term rainfall record from the Philadelphia International Airport. It considers various appropriate rain year characteristics, including distributions of event rainfall totals, event durations, and peak and average rainfall intensities.

3.1.2 Typical Year for CSO LTCPU Development

Precipitation generates urban storm water, combined sewer overflows, and increased wet weather flows to the wastewater treatment plant. These will contribute bacteria and pollutants to the Delaware River and its tributaries. The effect of these contributors on the Delaware River mainly depends on the magnitude and duration of rainfall events and on the prevailing ambient river conditions controlling dilution and transport of the pollutants. This variability and complexity poses a significant challenge for assessing the performance of wet weather and CSO control alternatives.

In accordance with the USEPA CSO Control Policy, the CSO control alternatives should be assessed on a "system-wide, annual average basis". This is accomplished by continuous simulation using a typical hydrologic period for the combined sewer system and receiving water quality modeling applications. The CSO Policy supports continuous simulation modeling, i.e., using long-term rainfall records rather than records for individual storms. Long-term continuous rainfall records enable simulations to be based on a sequence of storms so that the additive effect of storms occurring close together can be examined. They also enable storms with a range of characteristics to be included.

In this study, a three-year period was evaluated to balance between manageable model simulation time and representation of various rainfall/river conditions. The representative three-year period was intended to contain a relatively wet year, a dry year and an average year. Hourly rainfall data from the Philadelphia International Airport was obtained from the National Oceanic and Atmospheric Administration from 1900 through 2013. This provided sufficient data to evaluate climate change impact in the area. In the past 114 years, annual rainfall ranged from 29.3 to 64.33 inches, with the wettest year in 2011. The 10-year rolling average rainfall indicates that precipitation in the area runs through various dry and wet cycles, however with more extreme conditions (both dry and wet) in recent years.

Considering the climate change impact, it was determined that the Typical Hydrologic Period for the LTCPU be selected based on statistical analysis of rainfall records from the most recent 30 years (i.e., 1984-2013).

3.1.3 Methodology of Typical Year Selection

The Typical Hydrologic Period is selected to provide representative and unbiased approximations of expected future conditions in terms of both averages and historical variability. Representativeness is assessed using objective criteria for each of the ambient factors (i.e., river flow and rainfall). As indicated in the previous subsection, the selection of the Typical Hydrologic Period was based on the historical records in the past 30 years from 1984 through 2013.

The following datasets were used for the analysis of the typical hydrologic period:

- Hourly precipitation data for the National Climate Data Center gauge at Philadelphia International Airport for 1984 - 2013.
- Daily Delaware River stream flow data from the U.S. Geological Survey gauge at Trenton, NJ (USGS 01463500) for 1984 - 2013. This is the closest USGS gauge with daily river flow available.

Key hydrologic parameters used in the evaluation were given a weighting factor to describe the individual importance on the normality of the analyzed time period. The parameters that are given the highest impact weighting included the following:

- The total annual rainfall depth, which drives the total runoff volume.
- The maximum peak intensity, which usually defines the biggest overflow event.
- The median Delaware River flow (the impact of sewer overflows on the water quality of the receiving water is dependent on the magnitude of the flows in river, and in the project area, intense local rainfall events are typically independent from watershed-wide high flow events).

3.2 Typical Year Selection for DELCORA

3.2.1 Annual Rainfall and River Flow Analysis

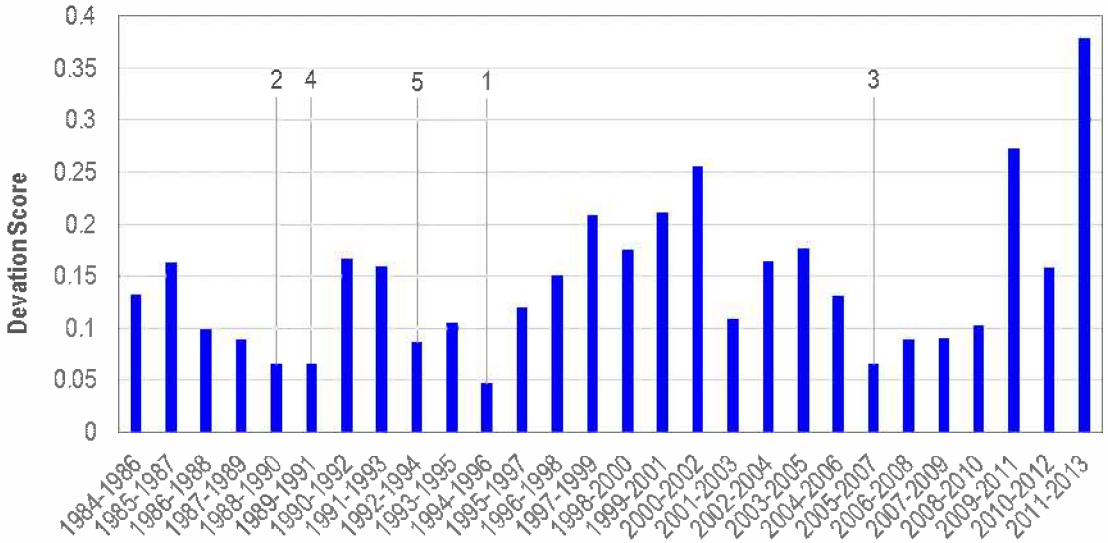
All rainfall events within the 30-year data period (1984 - 2013) were analyzed and evaluated for duration, inter-event duration, total rainfall amount, as well as maximum and average rainfall intensities. A total of 1,934 rainfall events were counted for the period of 1984 - 2013. Once annual rainfall and river flow statistics were determined for the 30-year period, three-year rainfall and river flow characteristics were developed based on an annual average of the three consecutive years. The goal of using a three-year analysis period was to find a period that had a relatively dry year, a relatively wet year, and a relatively average year. That way, any evaluations done using the typical hydrologic period have a more diverse spectrum of wet weather events and dry weather periods.

3.2.2 Ranking Analysis

From the weighting parameters listed in **Subsection 3.1.3**, a deviation score was developed for each individual period. The 3-year periods were then ranked based on the deviation score. The lower the

deviation score (Figure 3-1 Y-axis), the higher the rank for the hydrologic period (i.e., the closer it is to the average condition). **Figure 3-1** shows the ranking results of the 28 hydrologic periods, with a ranking of 1 being the highest and a ranking of 28 being the lowest ranked hydrologic period. Hydrologic period 1994-1996 is ranked No.1 because it has the lowest deviation score of 0.047.

Figure 3-1: Ranking Score of 3-year Periods, 1984-2013



3.2.3 Selected Hydrologic Period

The 3-year period 1994-1996 (Rank 1) was selected as the Typical Hydrologic Period for the CSO LTCPU. This period contains a wide range of storms and antecedent conditions. The hydrologic period of 1994-1996 was also evaluated for longer historical rainfall records up to 100 years. It is ranked No. 1 for the 50-year records and No. 2 for the 100-year records.

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Section 4 Sewer System Hydrologic and Hydraulic Model Update and Calibration

4.1 Introduction

The Sewer System Hydrologic and Hydraulic (H&H) Model Report was submitted to USEPA and PADEP on June 30, 2017, as was approved on April 17, 2018 after DELCORA responded to comments received on January 2, 2018. The approved report is included in **Appendix F**. It is to be noted that the H&H model was updated and recalibrated after the June 2017 submission as a result of receiving additional monitoring data, pump station operation data, and sewer system characteristics data. The H&H Model Calibration and Validation Results (updated July 2018) are provided in **Appendix T**.

4.1.1 Regulatory Requirements

Consent Decree Requirements

DELCORA's original Hydrologic and Hydraulic Model was updated to meet the requirements of Paragraph V.A.14 of the Consent Decree (Hydrologic and Hydraulic Model (H&H model) Update and Calibration Plan). Consent Decree Paragraphs V.A.14.a-f detail the specific requirements for the update and calibration of the H&H Model, which are listed in **Table 4-1**.

Table 4-1: Summary of Consent Decree Section V.A.14

Consent Decree Requirement
§V.A.14.a *"a. Not later than sixty (60) Days after the Date of Lodging of this Consent Decree, DELCORA shall submit a detailed plan to update, calibrate, and validate the H&H Model to Plaintiffs for review and approval pursuant to Section VI (Review and Approval of Submittals). The plan shall address:* *(i) Model Update Methodology.* *(ii) Hydrologic and Hydraulic Model Refinement.* *(iii) Flow Data Assessment, and additional Rainfall and Flow Monitoring to be Carried Out.* *(iv) Dry Weather Flow Calibration, including quantitative and qualitative calibration criteria.* *(v) Wet Weather Flow Calibration, including quantitative and qualitative calibration criteria.* *(vi) Model Validation; and* *(vii) Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to this Consent Decree.",*
§V.A.14.b *"The updated H&H Model shall specifically include hydrologic representation of all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area")."*

Consent Decree Requirement
§V.A.14.c *"The H&H Model shall accurately represent the response of the Model Area to wet weather events, including the flows that result from wet weather events to and from DELCORA's CSOs and to the WRTP. To accomplish this, the model shall explicitly include all interceptors, diversion structures, CSOs, pump stations and major trunk sewers within the Collection System, as well as such pipes and appurtenances within the areas outside the Collection System that are needed to ensure adequate H&H Model accuracy. The H&H Model shall also include all sewers required for model continuity and/or that hydraulically impact or are downstream of known chronic unpermitted releases. DELCORA shall investigate and collect current system attribute information as necessary to update the H&H Model.",*
§V.A.14.d *"Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve (12) months, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*
§V.A.14.e *"For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data.*
§V.A.14.f *"Within 30 Days after the H&H Model is revised, calibrated, and validated in accordance with the schedule set forth in the plan, DELCORA shall submit a Sewer System H&H Model Report to Plaintiffs for review and approval in accordance with the requirements of Section VI (Review and Approval of Submittals). The Sewer System H&H Model Report shall specifically address each item set forth in Subparagraphs 14(a)(i)-(vii) hereof."*

4.2 DELCORA's Facilities and Service Areas

A detailed overview of DELCORA's Facilities and its service areas is provided in **Subsections 1.3** and **1.4** of this report respectively.

4.3 Rainfall and Flow Monitoring

As per the Consent Decree, DELCORA was required to perform a Rainfall and Flow Monitoring program for at least 12 months and submit quarterly reports to document the findings of the program. This program started on March 18, 2016 and was completed on April 4, 2017. The rainfall and flow monitoring data were collected on a monthly basis. The network of rainfall and flow monitoring instrumentation, outline the monitoring program, and description of data collection and analysis of rainfall and flow monitoring data for use in the H&H Model calibration and validation is discussed in detail in **Appendix F**, with updated model calibration and validation results from July 2018 in **Appendix T**. The Rainfall and Flow Monitoring Reports can be found in **Appendix G**. The subcatchment names and the total areas associated with each metershed used in the H&H model are presented in **Table 4-2**.

Table 4-2: Metersheds in the H&H Model

Metershed ID	Subcatchment ID	Metershed Area (ac)
In-02	02A	112.80
	02B	
	SC1	
In-03	03B	94.09
	03C	
	03D	
In-05	05C	161.24
	05D	
	CH_TWP_2	
In-08	08A	184.87
	08B	
In-09	09A	27.02
In-10	10A	59.93
In-11	11A	43.54
In-13	13A	50.43
	13C	
In-14	14A	52.99
	14B	
	14C	
In-16	16A	2.18

Metershed ID	Subcatchment ID	Metershed Area (ac)
In-16,In-17	16/17A	77.38
	16/17B	
In-17	17A	11.83
In-18	18A	29.71
	18B	
In-19-1	18C	305.07
	CH_CTY_08	
	19B	
	19D	
	PA_BORO_1	
In-19-2	19E	141.09
	19G	
	UPL_BORO_1O	
In-25	25A	11.84
In-26	26A	37.1
	26B	
INT-2nd St	24A	6.24
INT-DRI	04A	57.01
	04B	
	07A	
	07B	
INT-Ridley 2	15A	15.02
	31A	
	RC1	
INT-Ridley 3	21A	51.8
	22A	
	23A	
	12A	
INT-West End	DR1A	77.21
	DR1C	
	CH_CTY_10	
	08C_NEW	
MH-26	CH_CTY_07	44.31
MH-28 (Sep-4)	CH_CTY_04	135.72
MH-30	CH_CTY_06	1035.73

Metershed ID	Subcatchment ID	Metershed Area (ac)
	NP_TWP_2	
MH-32	PA_BORO_2	794.55
	33A	
	BR_TWP_6	
	CH_CTY_05	
	BR_TWP_3	
	BR_TWP_4	
	BR_TWP_5	
	BR_TWP_6	
Chester PS (PS-1)	CH_CTY_02	519.75
	CH_CTY_03	
Eddystone PS (PS-10)	EDD_BORO_1	666.23
Marcus Hook PS (PS-11)	LC_TWP_1	1401.76
	MH_BORO_1	
Naamans Creek PS (PS-15)	BE_TWP_1	6527.64
	UC_TWP_1	
Chester Ridley Creek PS (PS-24*)	EDG_TWP_2	14072.95
	MI_TWP_1	
	NP_TWP_3	
	UPR_TWP_2	
	AS_TWP_1	
	BR_TWP_7	
	CH_BORO_1	
	CH_TWP_4	
	UC_TWP_3	
Existing PS-1 (PS-3)	TR_BORO_1	1021.16
	DR1B	
	CH_CTY_01	
Central Delaware PS Total and Central Delaware PS to WRTP (PS-7)	EDG_TWP_1	18828.95
	MA_TWP_1	
	MO_BORO_1	
	NE_TWP_1	
	NP_TWP_1	
	PR_BORO_1	
	RI_TWP_1	
	RP_BORO_1	

Metershed ID	Subcatchment ID	Metershed Area (ac)
	RU_BORO_1	
	SP_TWP_1	
	SW_BORO_1	
	UPR_TWP_1	
Sep-1	CH_TWP_3	295.75
	UC_TWP_2	
Sep-2	CH_CTY_09	72.74
	CH_TWP_1	
	05E	
Sep-3	BR_TWP_1	540.16
	CH_CTY_13	
	PA_BORO_3	
	UPL_BORO_1A	
	UPL_BORO_1B	
	UPL_BORO_1C	
	UPL_BORO_1D	
	UPL_BORO_1E	
	UPL_BORO_1F	
	UPL_BORO_1G	
	UPL_BORO_1H	
	UPL_BORO_1I	
	UPL_BORO_1J	
	UPL_BORO_1K	
	UPL_BORO_1L	
	UPL_BORO_1M	
	UPL_BORO_1N	
	BR_TWP_2	
	BR_TWP_3A	
Side-1	20A	56.87
	CCE1	
	CCW1	
	CCW2	
	PS1	
	PS3	
	CH_CTY_11	
	CCW3	

Metershed ID	Subcatchment ID	Metershed Area (ac)
Side-2	BS3	19.62
	BS2	

4.3.1 Wet Weather Event Selection for Model Calibration and Validation Flow Analysis

Based on the rainfall and flow monitoring data analysis, the rainfall events shown in **Table 4-3** were selected for model calibration and validation. The events were selected to cover variations in terms of rainfall depth, intensity, duration and antecedent conditions. Event E4 was added as more monitoring data was received.

Table 4-3: Calibration and Validation Rainfall Events

Event	Start	End
E1	5/29/16 19:00	5/30/16 5:00
E2	9/28/16 12:00	9/30/16 10:00
E3	11/29/16 7:00	11/29/16 20:00
E4	3/30/17 21:00	4/1/17 3:00
E5	5/21/16 11:00	5/22/16 21:00
E6	7/28/16 15:00	7/29/16 9:00

4.4 Model Update

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was updated and expanded over the years to account for changes in the CSO system, but it was not re-calibrated during the development of the 2012 LTCPU (Weston, 2012). The project team reviewed the 2012 version of the H&H model in order to:

- Assess adequacy of the original model for use in DELCORA's LTCPU,
- Identify gaps with the original model in meeting the requirements in the Consent Decree,
- Identify updates required to reflect current hydrologic and hydraulic conditions of DELCORA's collection system, and
- Determine refinements needed for the model update.

Results from the review of the 2012 H&H Model are presented in the **Appendix D**. (Greeley and Hansen, 2015).

4.4.1 Model Update Methodology

The purpose of this part of the Report is to describe the model update methodology and summarize the revisions incorporated into the updated H&H model.

4.4.1.1 Hydrologic Representation

Instead of including only the combined area for the subcatchments as in the 2012 H&H model, the updated model has added subcatchments for both the combined and separated service areas. All the areas that contribute dry weather flow and/or wet weather flow to DELCORA's CSOs and/or the WRTP were

included in the updated Model Area. Wet weather flows generated from surface runoff in the combined area and Rainfall dependent inflow and infiltration (RDII) parameters in the separated areas were simulated in the updated model.

4.4.1.2 Hydraulic Representation

The 2012 H&H model included only the combined sewer system area of DELCORA's collection system, which is located within the boundaries of the City of Chester. The CSS area is shown in **Figure 1-4**. The combined CSS area according to the 2012 H&H model is shown in **Figure 4-1**. Per the requirements of the Consent Decree, the H&H model was updated to include the entire Model Area. Pipe networks in the updated model were extended to the updated service areas for both the combined and separated areas. All hydraulic structures that control flows in the collection system, including pump stations, siphons, regulator orifices and weirs, and their operating rules, were simulated in the updated model.

4.4.2 Model Refinement

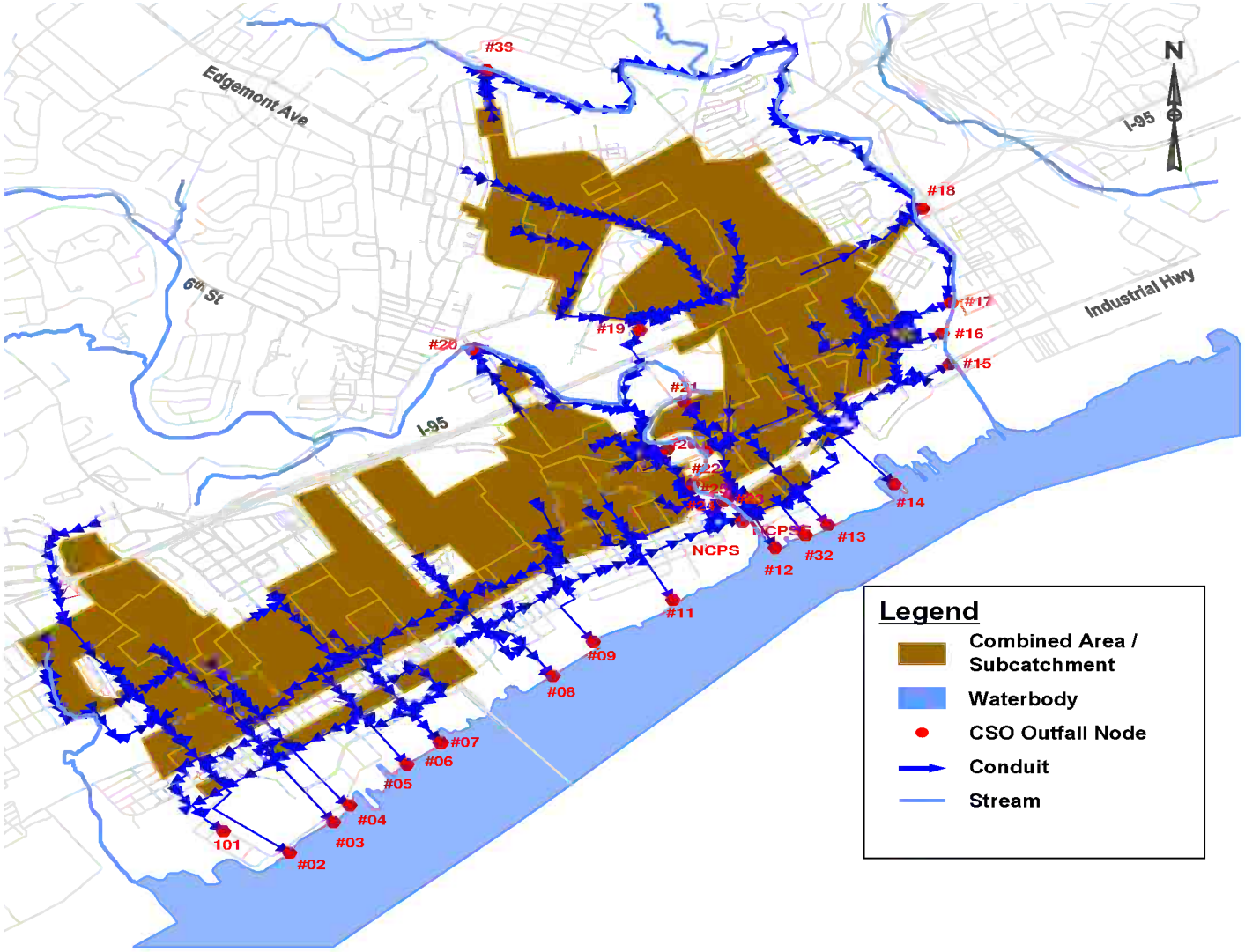
A number of hydraulic modeling software packages are available, including EPA SWMM, InfoSWMM, InfoWorks, Mike Urban and PCSWMM. For this H&H Model update, EPA SWMM, Version 5.1, and Innovyze InfoSWMM Version 14.6 were selected as the modeling software. EPA SWMM is a fully dynamic model and has been used extensively throughout the United States and abroad to assess CSO, flooding and water quality issues. It can be applied to simulate single events or long periods of time in a continuous mode. InfoSWMM uses the current EPA SWMM engine as its computational solution and is fully integrated with ArcGIS, which provides greater flexibility of importing the model network from the existing GIS database and preparing initial model inputs from existing datasheets. InfoSWMM was used during the model development and the calibration phase.

The model update is based on information obtained from a variety of sources including DELCORA's input, GIS, record drawings and field survey. Other documents pertaining to standard/actual operating procedures for CSO regulators, pump stations and the WRTP were also used to set up real time controls in the model. The model network consists of all major interceptors and force mains and extends to all active overflow points. The datum used for the model is NGVD 29.

4.4.2.1 Delineation of Model Area and Combined Area

DELCORA's latest GIS database, survey and record drawings were used to perform the desktop CSS delineation to verify the metershed boundaries. The total acreage of the model area is approximately 50,000 acres and the updated combined sewer area is approximately 1,486 acres as of July 2018.

Figure 4-1: CSS Area Delineation in the 2012 H&H Model



Metersheds were delineated for the purpose of dry weather flow allocation and model calibration. A metershed means the geographical area served by a system of sanitary drains, storm drains, private interceptor, main sewers, and public sewers that drain to a common monitoring point (flow meter location). Metershed delineation was performed based on the location of flow meter, sewer connectivity, and city contours. The listing of metersheds, their acreage and their associated subcatchments is presented **Table 4-2**.

Sewersheds (or "subcatchments") are delineated based on the drainage network, area characteristics, and flow monitor locations. Each sewershed has a dry weather and a wet weather flow input to the model network. The model network comprises 128 sewersheds (subcatchments), which includes 55 combined and 73 separated subcatchments.

Delineation of Model Area

The updated H&H model is used to evaluate the Model Area which is comprised of those areas hydraulically connected to the WRTP. As shown in **Figure 1-4**, the conveyance system is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Wastewater flows up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to (and thus is hydraulically connected to) DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows directly to the PWD-SWWPCP rather than to the WRTP. Therefore, municipalities connected to these two pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area. The updated delineation of the Model Area is presented in **Figure 4-2**.

Eastern Service Area

Within the Eastern Service Area, only the municipalities in the Central Delaware County Authority contribute flows to the WRTP and therefore, only these municipalities are included in the Model Area. These municipalities include Marple Township, Morton Borough, Nether Providence Township, Newtown Township, Prospect Park Borough, Ridley Park Borough, Rutledge Borough, Springfield Township, Swarthmore Borough, Ridley Township, and Upper Providence Township. In October 2012, DELCORA signed an agreement with Edgmont Township to provide sewer service to the eastern portion of the Township. The sanitary sewage of Edgmont Township is now collected and transported using the Crum Creek Sewer District System through the CDCA collection and conveyance facilities to the DELCORA System for treatment at the WRTP and ultimate disposal and discharge.

Figure 4-2: Model Area Delineation

Western Service Area

DELCORA's Western Service Area (shown in **Figure 4-1)** contributes all of its flow to the WRTP and is therefore considered part of the Model Area. DELCORA owns and operates the collection system in the following communities in the Western Service Area.

- Chester City
- Chester Township (parts of[5])
- Marcus Hook Borough
- Parkside Borough
- Rose Valley Borough[6]
- Upland Borough
- Trainer Borough

DELCORA does not own or operate the collection system in the following communities in the Western Service Area, however, these communities will be included as part of the service areas in the updated H&H model because they contribute flows to the WRTP.

- Brookhaven Borough
- Lower Chichester Township
- Nether Providence Township[7]
- Eddystone Borough
- Chester Heights Borough
- Upper Providence Township
- Aston Township
- Middletown Township
- Edgmont Township[5]
- Upper Chichester Township
- Bethel Township

Model Area Summary

In summary, the Model Area includes the municipalities in the Western Service Area plus those municipalities in the Eastern Service Area that are connected to the Central Delaware Pump Station, as shown in **Table 4-4**. The entire Model Area is illustrated in **Figure 1-4** and **Figure 4-2**

[5] DELCORA owns only a portion of Chester Township's collection system, but all flow comes to the WRTP as some goes through the CRC PS service area.
[6] Rose Valley Borough collection system used to discharge to its own treatment plant. This portion now discharges to the CRC PS service area.
[7] Parts of these communities are in the Eastern Service Area.

Table 4-4: Model Area

Municipality	Service Area
Aston Township	Western (CRCSA)
Bethel Township*	Western (SDCA)
Brookhaven Borough*	Western
Chester City	Western
Chester Township	Western (CRCSA)
Eddystone Borough	Western
Edgmont Township*	Eastern (CDCA)
Lower Chichester Township	Western (SDCA)
Marcus Hook Borough	Western (MHSA)
Marple Township*	Eastern (CDCA)
Middletown Township	Western (CRCSA)
Morton Borough	Eastern (CDCA)
Nether Providence Township	Eastern (CDCA) and Western
Newtown Township*	Eastern (CDCA)
Parkside Borough	Western
Prospect Park Borough	Eastern (CDCA)
Ridley Park Borough	Eastern (CDCA)
Ridley Township*	Eastern (CDCA)
Rose Valley Borough	Western
Rutledge Borough	Eastern
Springfield Township*	Eastern (CDCA)
Swarthmore Borough	Eastern (CDCA)
Trainer Borough	Western
Upland Borough	Western
Upper Chichester Township	Western (SDCA)
Upper Providence Township*	Eastern (CDCA) and Western
*Indicates that only a portion of the municipality contributes flow to WRTP CDCA: Central Delaware County Authority CRCSA: Chester Ridley Creek Service Area MHSA: Marcus Hook Service Area SDCA: Southern Delaware County Authority	

Delineation of the Combined Sewer System Area

The entire combined sewer system area of DELCORA's collection system is located in the City of Chester and consists of a drainage area of approximately 1,486 acres. It comprises approximately half of Chester City's serviced area. The location of the CSS area is shown in **Figure 1-4**. An enlarged view of the CSS area according to the 2012 H&H model is shown in **Figure 4-1**.

The CSS area delineation was updated with separation projects completed in recent years. The latest GIS database, survey, and record drawings were used to perform the desktop combined sewer area check. Some areas have separated systems with trunk sewers that subsequently connect to the CSS. For this situation, these particular separate sewer system areas were included within the delineation of the CSS. The revised CSS delineation in the updated H&H Model is illustrated in **Figure 4-3.**

Figure 4-3: CSS Area Delineation in the Revised Model

4.4.2.2 Model Network Extension

The collection system network in the original model has been updated with the following:

- Extended sewers to the updated delineation of the combined and separated areas
- Included all pump stations that control flows in the DELCORA collection system, and
- Reflect actual configuration of the CSO regulators.

Since the approval of the first LTCP in 1999, DELCORA has under-taken a program to replace and/or rehabilitate CSO regulators and tide gates in the City of Chester CSO system. In some cases, regulators have been eliminated. The updated model includes twenty-six (26) CSO regulators, which were modeled as weirs and orifices. The configuration of CSO regulators was obtained from both record drawings and field surveys.

Regulators

As indicated in **Subsection 1.5**, the majority of the City's CSO regulators are Brown & Brown type regulators. The operation of the CSO regulators has been changed from being controlled by the level in the trunk sewer entering the CSO regulator chamber to being controlled by the level in the downstream interceptor. This change is being implemented as part of the CSO regulator replacement program. This ensures that the flow sent to the WRTP for treatment is maximized.

During dry-weather operations, the sewage flow levels entering the CSO regulator chamber are below the top of the diversion weir and will pass through the CSO regulator gate. Once through the CSO regulator gate, the flow typically passes through an orifice plate and then will be sent to the WRTP via the interceptors. During wet-weather events, the level in the combined sewer (Type A regulator) or in the interceptor (Type B regulator) will begin to rise thus raising the float assembly that will close the CSO regulator gate. For cases where the regulator float and gate have been removed, dry weather flow and some portion of the wet weather flow will pass through the opening previously covered by the now removed gate. Flow through this opening will be modeled as an orifice. When wet weather flow exceeds the capacity of the orifice, the level in the sewer will continue to rise until it is high enough for a portion of the flow to pass over the weir to be discharged through the associated outfall.

Regulator gates, diversion weirs, and operating rules are simulated in the updated model.

Pump Stations

Major pump stations in the Western Service Area and the Central Delaware Pump Station in the Eastern Service Area were added to the updated model, as well as force mains connecting the pump stations to the interceptor/WRTP. **Figure 1-3** shows the pump stations included in the updated model. The list of the pump stations in the model includes:

- Chester PS
- Existing PS-1 WRTP
- Marcus Hook PS
- Naamans Creek PS
- Eddystone PS
- Central Delaware PS
- Chester Ridley Creek PS
- Sun Oil PS (Owned by Sunoco)
- Kimberly Clark PS (Owned by Kimberly Clark Corporation)

The following pump stations were excluded from the H&H Model:

- Price & Smith Street Trainer PS
- Stadium PS

Flow from the Price & Smith Street Trainer PS discharges to the downstream Existing Pump Station (EPS-1) where it is re-pumped. The updated H&H model assumes that all flow from subcatchments associated with the Price and Smith Street Trainer PS can be treated as an input to EPS-1.

Flow from the Stadium PS is sanitary sewage only with no stormwater flow. The Stadium PS discharges flow only during events held at the stadium. Due to the limited flow, its sporadic nature and the lack of wet weather flow, the Stadium PS is expected to have negligible effect on the wet weather capacity of the CSS. Therefore, the Stadium PS was not included in the H&H Model.

DELCORA owns or operates a number of lift stations in the Western Service Area and whose flows are handled by the above list of pumps stations. It was determined that the behavior of these lift stations would not require modeling and that inflow to the lift station can be assumed to equal outflow to the downstream conduit.

4.4.2.3 Model Input

The model inputs include the following-

- Subcatchments
  - Area
  - Percent of Directly Connected Impervious Area
  - Width
  - Slope
  - Manning's roughness coefficient (n)
  - Depression Storage
  - Soil and Soil Infiltration Parameters
- Manholes
- Sewer Mains
- CSO Outfalls
- Flow Diversion Structures
  - Regulator Gates
  - Orifices
  - Weirs
- Pump Stations
- Rainfall Derived Inflow and Infiltration (RDII) – Modeling Separated Areas

The above model input parameters are discussed in detail in **Appendix F**.

4.4.3 Summary

The 2012 H&H model was updated as described in this section. A summary of the key revisions to the H&H Model are presented in **Table 4-5**. The detailed layout of the updated model is shown in **Figure 4-4** and **Figure 4-5**.

Table 4-5: Summary of Revised H&H Model

Review Item	2012 Model Review Observation	Updated Model
Model Software	- EPA SWMM 5.0	Innovyze InfoSWMM version 14.6
Vertical Datum	- NAVD 88	- NGVD29
General Sub Models	- EPASWMM for the runoff model - Horton Equation for the infiltration model - Hydrodynamic wave for the flow routing model	
Rain Gauge	- One (1) rain gage, located at the Western Regional Treatment Plant (WRTP)	- Seven (7) rain gauges, as shown in Section 2 - Additional GARR analysis performed
Service Area	- 67 subcatchments, all for combined area - One set of Horton infiltration parameters are applied to most of the subcatchments (66 out of 67 subcatchments) - The infiltration parameters applied in the model is equivalent to infiltration parameters for soil type C/D	- 128 subcatchments, 55 for combined area and 73 for separated areas - Combined area was modified to include newly separated areas. - Horton infiltration parameters applied to 55 out of 128 subcatchments - Horton infiltration parameters varied based on identified soil types
Sewer Manhole	- 736 storage nodes. - All sewer manholes are simulated as storage units in the model. - The majority of the storage units (732 out of the 736) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - All storage units are set-up with a ponding area of 9,999 sf. to allow excess water to collect atop of the nodes and be re-introduced into the system as conditions permit.	- 918 common junction nodes. - The majority of the common junction nodes have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - There are 35 imaginary junctions created to receive flow from the subcatchments gravity network not included in the model network
CSO Outfall	- 29 outfall nodes - All CSO outfalls are free outfall	- 25 CSO outfall nodes - Tidal data is assigned to 25 outfalls using time series

Review Item	2012 Model Review Observation	Updated Model
Sewer Mains	- 735 conduit links. - Negative slopes at Nodes 73803 and 70709 not matching the GIS. - Pipe connectivity is not consistent with the GIS in Subcatchment EA1, 25A. - Pipe size and connectivity is not consistent with the GIS around Node: 5201242, 5201234. - Pipe size is not consistent with the GIS around Node: 52018-52015. - Pipe size is not consistent with the GIS around Node: 531-527, 522-517, 516-513, 510020301-5100202, 403-NCPS, 40801-40801A, 32405-32404, and 1110402-11103. - Pipe size and slope are not consistent with the GIS around Node: 422-4140. - NREG06 outfall pipe direction is opposite.	- 926 conduit links. - 30 imaginary conduit links created to receive flows from subcatchment gravity network not included in the model
CSO Regulators	- 34 orifice links. - All CSO regulators are simulated using orifices to intercept dry weather flows and partial wet weather flows to the collection system, and with elevated conduits to convey extra flows to the CSO outfalls. - Approximately 75% of the orifices (25 out of 34) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - None of the regulator diverting weir structures is simulated in the model.	- 44 orifice links. - CSO regulators are simulated using orifices and float-operated gates to intercept dry weather flows and partial wet weather flows to the collection system, and with conduits set a verified inverts to convey extra flows to the CSO outfalls. Exceptions occur at several regulators where orifices have been removed and at one regulator where the float and gate have been removed. - Approximately 55% of the orifices (24 out of 44) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - Regulator diverting weir structures added to the model. - All orifice opening dimensions were verified using record drawings
Pump Station	- No pump station is included in the model	- Pump stations added to model. - Related force mains added to model. - Pump Curves added to the model.

Review Item	2012 Model Review Observation	Updated Model
Dry Weather Flow	- 94 dry weather flow (DWF) inputs - Total DWF is 7.01 MGD - No diurnal curve - DWF does not include all the separated service areas that contribute to the DELCORA system	- 116 dry weather flow DWF inputs - Total DWF is 29.46 MGD - DWF analysis was performed on all flow meters in separated and combined areas as well as pump stations - Weekday and weekend diurnal curves were generated as well as overall, weekday, weekend and monthly DWF factors.
RDII	- No rainfall-derived infiltration/inflow (RDII) element was found in the model	- RDII was included in the model to estimate reasonable wet weather inflow from RDII

4.5 H&H Model Calibration and Validation

4.5.1 Model Calibration and Validation

Model credibility is developed through model calibration and validation. Model calibration involves application of the model to known external inputs (e.g., rainfall), evaluation of the model's ability to replicate monitored conditions (e.g., flow and volume), and adjustment of key model parameters as needed until an acceptable level of agreement is reached between the simulated and monitored conditions.

After the model is satisfactorily calibrated it must be validated by running known storms with known flow results and having the model replicate the known events. Storms used in model validation should be independent from the storms used in the model calibration.

4.5.1.1 Calibration/Validation Criteria

Dry Weather Flow Calibration Criteria

Dry weather flow analysis was based on the rainfall and flow monitoring results. DWF distribution in the collection system was based on land use data. Weekday, weekend and monthly diurnal factors from the DWF analysis were applied for each flow meter service area. Upstream meters in the system were calibrated first, then flows through the system to the pumps stations and to the WRTP were balanced. **Figure 4-6** presents a flowmeter schematic and shows the arrangement of the meters in the system and meter identification.

DWF calibration adheres to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be within 1 hour of the observed,
- The simulated peak flow will be within 10% of the observed flow, and
- The simulated flow volume over 24 hours will be within 10% of observed flow.

Figure 4-4: Updated H&H Model Layout

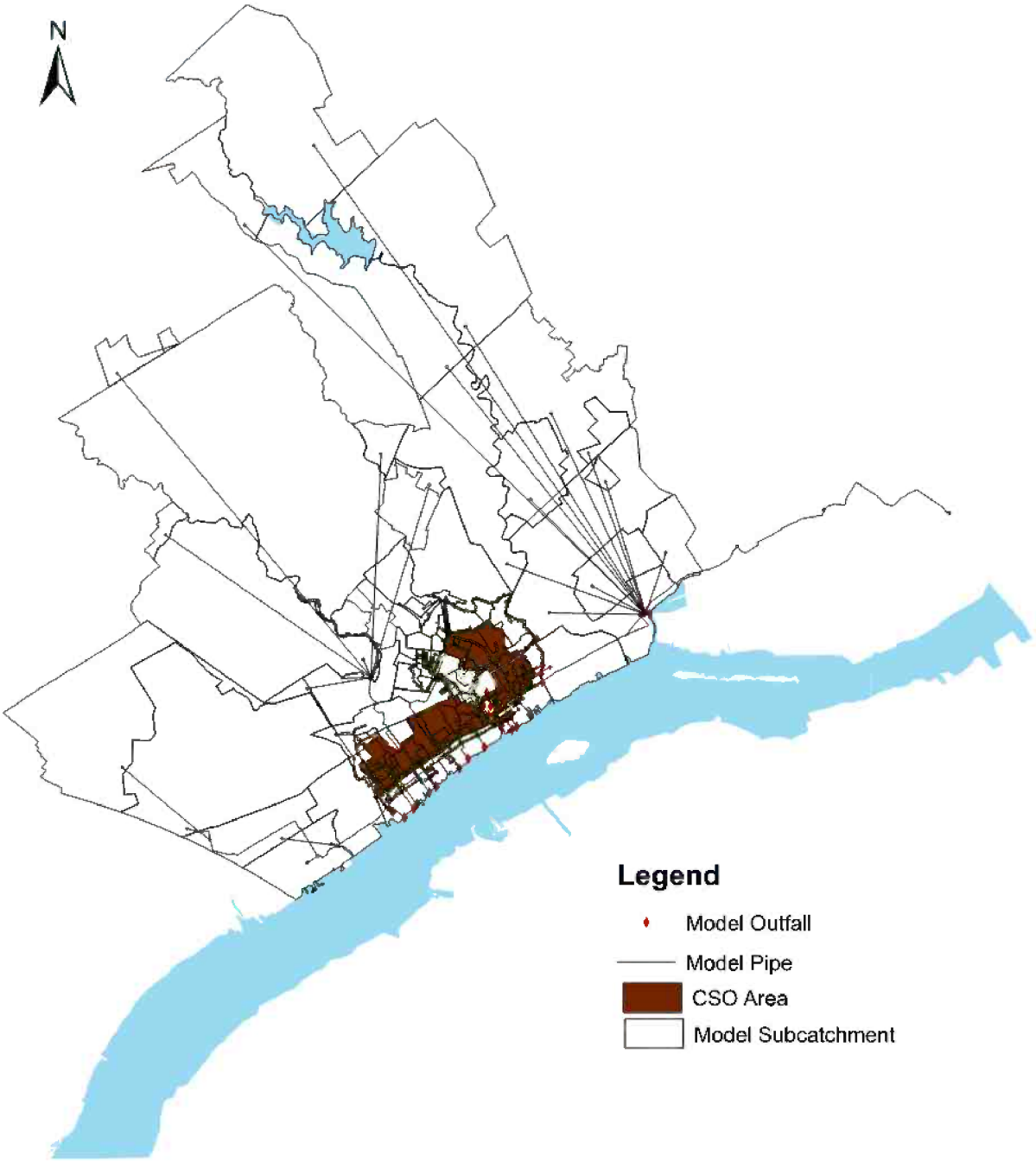
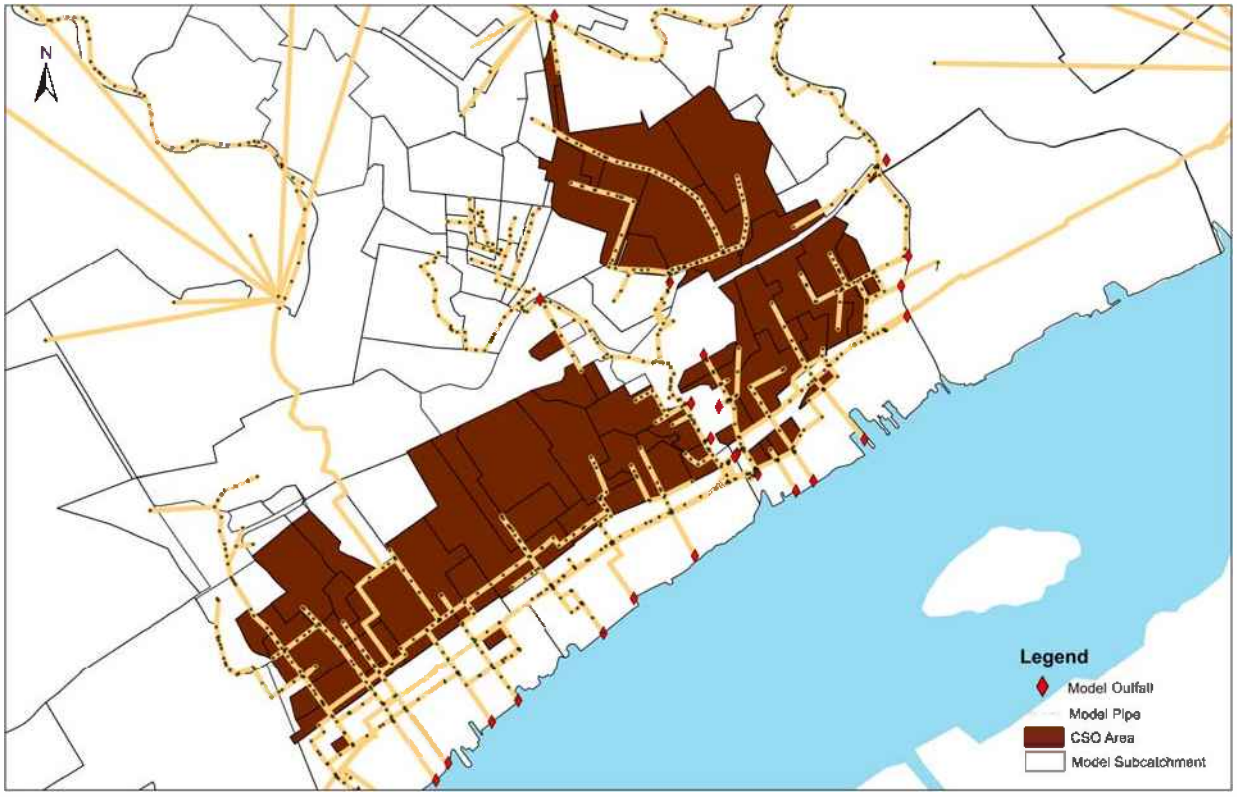


Figure 4-5: Updated H&H Model Layout – CSS Area



Wet Weather Flow Calibration Criteria

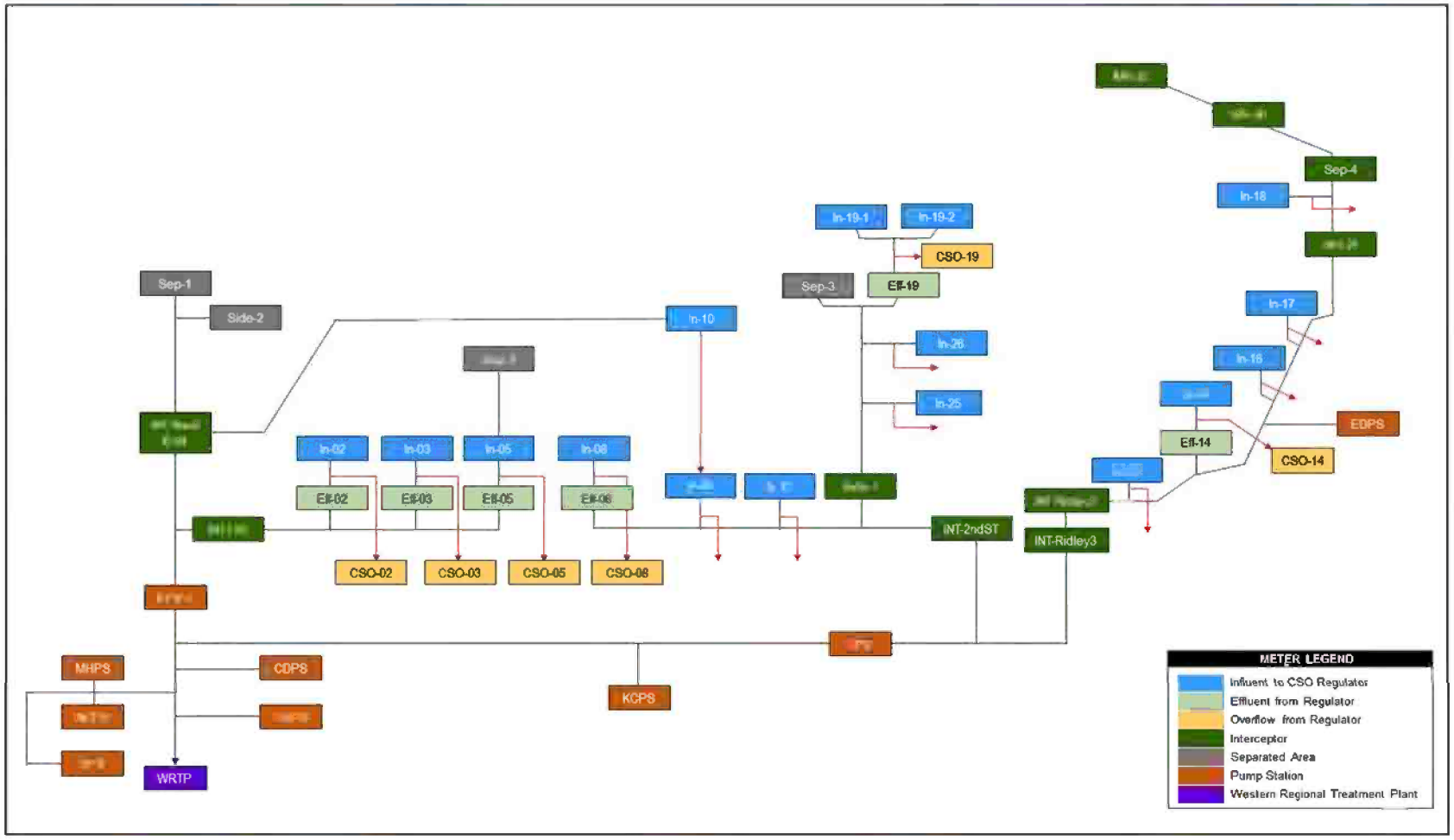
Wet weather flow (WWF) includes surface runoff from the combined area, RDII from the entire service area, and connected rooftops, if any, from the separated area. RDII parameters are developed based on the separated area, and surface runoff parameters are adjusted for the combined area to calibrate the system's response to the wet weather conditions.

Four (4) wet weather events were selected for wet weather calibration. Final selections include wet weather events with various rainfall intensities and volume.

WWF calibration adheres to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be similar having regard to the duration of the event,
- The simulated peak flow for significant peaks will be within the range of -15% to +25%,
- The simulated flow volume will be within the range of -10% to +20%,
- The depth of surcharge will be in the range of -0.1 m to +0.5 m, and
- At key points such as CSOs, the unsurcharged depth will be within ± 100 mm (± 0.33 ft.)

Figure 4-6: Flow Meter Schematic



4.5.1.2 Model Calibration Approach

The runoff calibration for the combined sewer area is achieved by primarily adjusting width and percent imperviousness. The RDII calibration for separated areas was achieved by adjusting RTK values. The calibration of hydraulic control structures (weirs and orifices) is achieved by adjustment the discharge coefficients. The conduit hydraulics calibration is achieved by adjusting Manning's "n" and head loss coefficients. Flow depth, as well as flow rate, is checked while calibrating the hydraulic model.

After calibration, a different set of flow monitoring data was used to validate the model calibration. Model calibration and validation is an iterative process.

The Model Calibration Approach has been discussed in detail in **Appendix F**.

4.5.1.3 Model Calibration Results

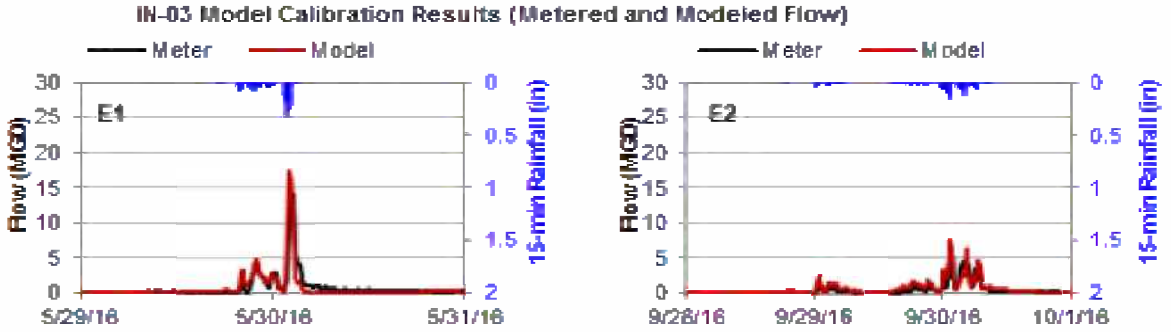
Successful calibration of the H&H Model is indicated by satisfying agreements between the model prediction and the flow monitoring data in terms of the shape of hydrograph, wet weather volume and peak flow. The calibration was performed and evaluated for various sizes of storms and different antecedent conditions so that the calibrated model can be reasonably applied for various hydrologic conditions. Wet weather events used for model calibration and validation are summarized in listed in **Table 4-6**. The larger storm events have more of a weighting factor in the calibration process because the large events are the ones that dominate the total overflow volume.

Table 4-6: Wet Weather Events Used for Model Calibration and Validation

Event ID	Start Time	Stop Time	Rainfall Depth* (inches)	Used in Calibration	Used in Validation
E1	5/29/16 19:00	5/30/16 5:00	1.82	C	
E2	9/28/16 12:00	9/30/16 10:00	2.36	C	
E3	11/29/16 7:00	11/29/16 20:00	1.08	C	
E4	3/30/17 21:00	4/1/17 3:00	1.83		V
E5	5/21/16 11:00	5/22/16 21:00	1.71		V
E6	7/28/16 15:00	7/29/16 9:00	1.26	C	
*At Chester PS rain gauge					

Examples of model calibration results are shown in
Figure 4-7. Additional figures for all meters installed at different locations, including meters installed at major trunk interceptor, overflow pipes, influent pipe to overflow control structure, intercepting pipes, previous CSO areas, separate sewer areas and boundaries can be found in **Appendix F** and **Appendix T**.

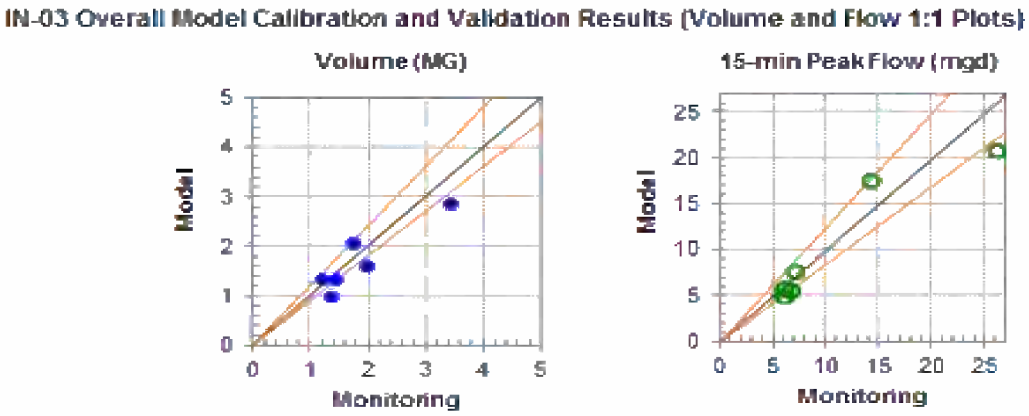
Figure 4-7: Model Calibration Hydrograph (Example Plot)



Comparisons of the predicted total volume against the monitoring total volume and predicted peak flow against monitoring peak flow were analyzed and shown in 1:1 ratio plots for all calibrated meters. This is to evaluate the overall calibration and validation from all the events. The event points in **Figure 4-8** are distributed close to the 1:1 ratio line, which means that the model predicted peak flow and wet weather event volumes are in good agreement with the metered data. Additional figures for all model calibration plots can be found in **Appendix F** and **Appendix T**.

The H&H model from the 2012 DELCORA LTCP Update was reviewed and updated as a part of the development of the LTCPU. Data from the rainfall and flow monitoring program was used to calibrate and validate the updated H&H model. The calibrated H&H model was used to assist DELCORA throughout the remaining steps in the CSO LTCP update process. The calibration and validation plots and a statistical evaluation of the model calibration are presented in **Appendix F** and **Appendix T**. The calibrated model was judged adequate for the purposes of the LTCPU and adheres to industry standards and criteria.

Figure 4-8: Model Calibration 1:1 Plots (Example Plot)



Section 5 Water Quality Monitoring and Modeling

5.1 Introduction

Water quality monitoring and modeling were conducted to support the development of the Long-Term Control Plan Update. The objective of the water quality modeling was to compute Pollutant of Concern concentrations in Chester Creek, Ridley Creek, and the Delaware River by accounting for all major POC sources within the Model Area. The objective of the water quality monitoring was to collect data that would allow for the characterization of the major POC sources, and to support calibration and validation of the receiving Water Quality Model under both dry and wet weather conditions. Another objective of the water quality model was to describe current water quality for the Typical Hydrologic Period, and predict future water quality for the proposed CSO control alternatives. The primary focus of the receiving water quality monitoring and modeling was on the local water conditions, including the tidal zones of Chester and Ridley Creeks, and the Delaware River from roughly river mile 80 near Marcus Hook to river mile 85 near Crum Creek.

5.1.1 Regulatory Requirements

Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within ninety (90) days after USEPA approval of the Alternatives Evaluation Approach, DELCORA shall submit to USEPA and PADEP a Water Quality Model Plan for review and approval. The Water Quality Modeling and Monitoring Work Plan was first submitted in January 11, 2017, a revision was submitted in July 31, 2017, and the Work Plan was approved by the USEPA on April 16, 2018.

The Consent Decree further specifies that within sixty (60) days after the approved Water Quality Model Plan is fully implemented according to the schedule included therein, DELCORA shall submit to USEPA and PADEP a Water Quality Model Report for review and approval pursuant to Section VI (Review and Approval of Submittals) to specifically address each item set forth in Paragraph 15(a)(i)-(vi). The Water Quality Model Report was submitted on February 27, 2018 and approved by the USEPA on April 17, 2018.

5.2 Water Quality Monitoring and Sampling

5.2.1 Water Quality Work Plan and Quality Assurance Project Plan Development

The Water Quality Modeling and Monitoring Work Plan was designed to support the development of the receiving water quality model (Water Quality Model) and described the collection of data that would be used to develop and calibrate the Watershed Model and the Water Quality Model. The water quality monitoring objectives were to 1) collect water quality data for the POCs during dry and wet weather event periods that were used to characterize the POC sources in the Delaware River, Chester Creek, and Ridley Creek, and in the vicinity of the City of Chester, and 2) to support calibration and validation of the Water Quality Model, consistent with the Consent Decree requirements in Paragraph V.A.15.a. Additional in situ parameters, such as salinity, temperature, and conductivity were also collected to inform the development of the Water Quality Model.

A Water Quality Monitoring and Modeling Quality Assurance Project Plan (QAPP) was also developed to meet the requirements of the DELCORA Consent Decree Paragraph Section V.A.15.a.(iv) which required detailed information regarding all additional data collection and water quality modeling

activities. The purpose of the QAPP was to document the necessary procedures required to ensure that the project was executed in a manner consistent with applicable USEPA guidance documents and with generally accepted and approved quality assurance objectives. The QAPP integrated quality control policies and project-specific work tasks to successfully conduct water quality monitoring and modeling to support the CSO Long -Term Control Plan Update. The overall intent of the QAPP was to provide professional guidelines for activities by all personnel on the project and to ensure that proper quality assurance/quality control (QA/QC) procedures were followed.

The Water Quality Monitoring and Modeling Work Plan and the Water Quality Monitoring and Modeling Quality Assurance Project Plan are included in **Appendix H** and **Appendix I**, respectively.

5.2.2 Sampling and Analysis Plan Overview

Water quality monitoring was undertaken at thirteen (13) in-stream locations (seven of which were Delaware River sampling locations), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) stormwater sewer locations in the City of Chester municipal separate storm sewer system, as shown in **Figure 5-1**. Water quality monitoring and sampling were conducted as follows:

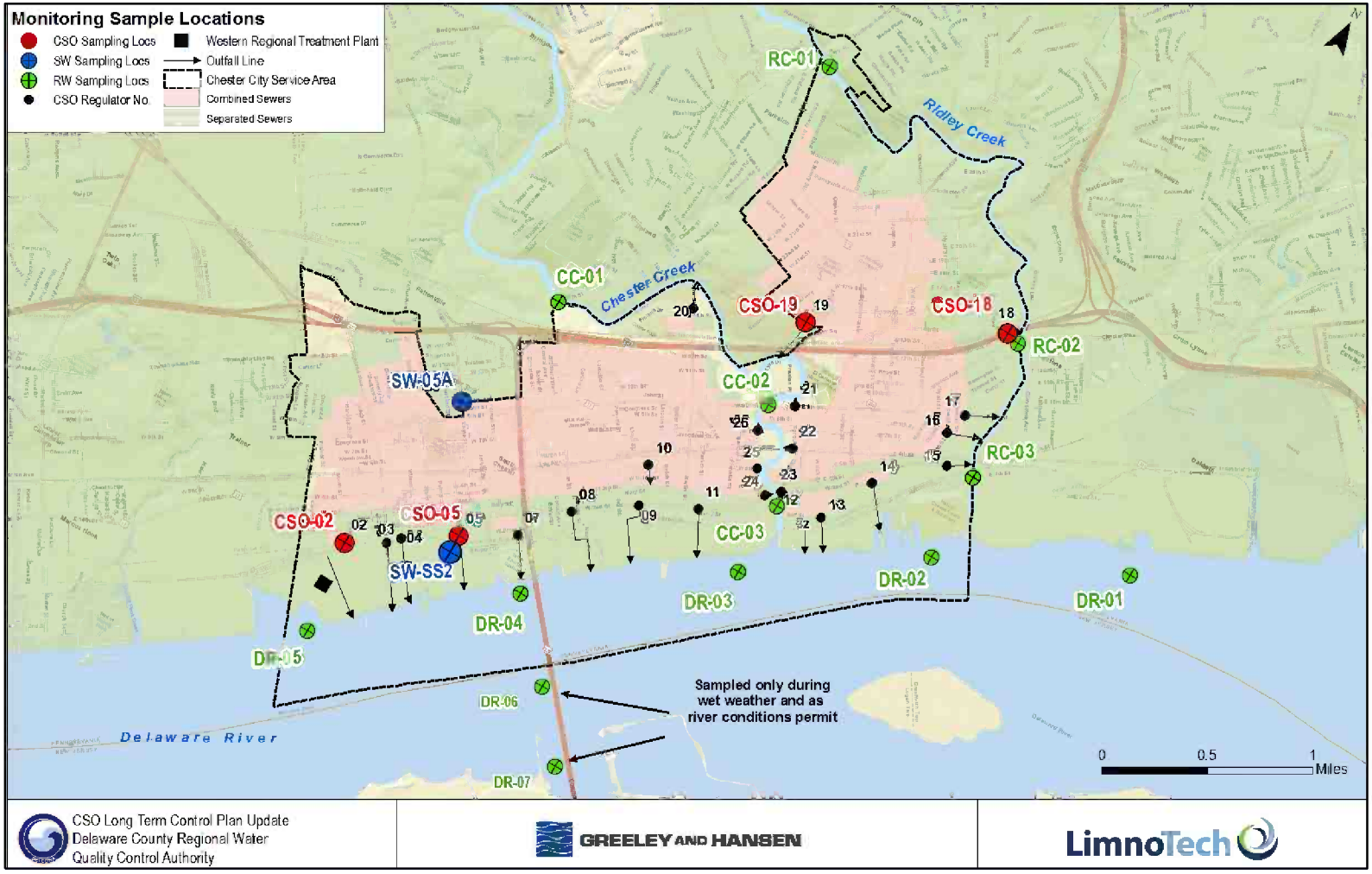
- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area were sampled for water quality for three (3) dry weather events; one of which was targeted for collection during a tributary low-flow period (less than 25th percentile flow). The mid-stream and far-shore Delaware River locations were not sampled during the dry weather surveys because the water quality in the river is found to be relatively uniform laterally due to the lack of active sources during dry weather. These dry weather events were distributed across the sampling season, which was from March through June of 2017. Grab samples and *in situ* measurements were collected at each location during each event.
- All thirteen in-stream locations were sampled for water quality using grab samples and *in situ* monitoring for three (3) discrete wet weather events, according to the surface water quality monitoring program protocols described in the Water Quality Monitoring and Modeling Work Plan;
- Up to four CSO and two stormwater outfall locations were sampled for water quality for the same three discrete wet weather events according to the outfall monitoring program protocols described in the Water Quality Monitoring and Modeling Work Plan. Samples for all outfalls were collected as grab samples.

The sampling events were distributed across the sampling season, which was from March through June 2017.

5.2.3 Sampling Locations

Monitoring locations were selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters were designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in **Figure 5-1**.

Figure 5-1: Receiving Water, Combined Sewer Overflow (CSO), and Stormwater (SW) Monitoring Locations



The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater, and DELCORA CSO pollutant loads. The Delaware River sampling locations characterized water quality entering the DELCORA CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples were collected across the transect corresponding to the DR-03 sampling location to characterize lateral variability in the Delaware River during storm events.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency and volume of overflow, and their accessibility. The stormwater sampling locations were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the Model Area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

5.2.4 Analytical Parameters

All of the in-stream dry and wet weather samples were analyzed for the parameters shown in **Table 5-1**. The outfall samples were analyzed for *E. coli*, *Enterococcus* and Fecal coliform bacteria.

Table 5-1: Analytical and Field Parameters

Parameter	Description	Sampling Program	Type of Measurement
E. coli	*Escherichia coli*	Dry, Wet	Grab
Enterococcus	*Enterococcus sp.*	Dry, Wet	Grab
Fecal coliform	Fecal coliform	Dry, Wet	Grab
Temp	Water temperature	Dry, Wet, Receiving Water Only	In-situ
Cond	Conductivity	Dry, Wet, Receiving Water Only	In-situ
Salinity	Salinity	Dry, Wet, Receiving Water Only	In-situ

5.2.5 Sampling Results

The DELCORA Sampling Program was designed to fill data gaps and characterize sources and surface waters during dry and wet weather events to support the development of water quality models for use in the development of the CSO Long-Term Control Plan Update. The data was sufficient to characterize DELCORA's CSO and stormwater source loads for the Water Quality Model. The data also spanned a range of environmental conditions and provided an extensive dataset for demonstrating the robustness of the Water Quality Model. The Sampling Program fully achieved the objectives of collecting comprehensive and complete datasets needed to characterize pollutant sources, produce an appropriately calibrated watershed and water quality model, and successfully meet the quality objectives of the QAPP.

The Water Quality Model Report (**Appendix J**) includes the Water Quality Sampling Report that presents a detailed overview of the dry and wet weather datasets by individual event. The following observations were presented with respect to the data:

- The presence of an incoming versus an outgoing tide did not significantly influence bacteria concentrations during dry weather;
- Dry weather bacteria concentrations in the Delaware River tended to be well below numeric thresholds used for water quality standard criteria;
- An increase in POC concentrations from upstream to downstream was observed in each of the tributaries, suggesting there may be significant non-CSO bacteria sources impacting these tributaries during dry weather;
- Downstream locations show more spread in the distribution of concentrations within each event as compared to the farthest upstream locations. This is likely the result of higher mixing with the Delaware River and the tidal influence on water quality at the more downstream locations;
- Short-term wet weather bacteria concentrations in all of the waterbodies were significantly higher than during dry weather;
- Bacteria concentrations in CSOs are highly variable and a consistent first flush concentration was not observed for the POCs.
- Lateral POC gradients in the Delaware River were present but not at a significant level (e.g. orders of magnitude); and,
- The time series profiles in the Chester Creek and Ridley Creek waterbodies indicated that upstream or other wet-weather sources also contribute to high bacteria concentrations during wet weather events in addition to DELCORA's CSOs and Chester's MS4 discharges.

Additional data results are presented below in **Subsection 5.3** in the Water Quality Model calibration discussion.

5.3 Water Quality Model

The objective of the water quality modeling was to compute POC concentrations in the tidal portions of Chester Creek and Ridley Creek, and in the Delaware River, by accounting for all major POC sources within the region of interest. To meet this objective, the Water Quality Model was developed and calibrated based on site-specific data representing local hydrodynamic and water quality conditions. Flow-weighted Event Mean Concentration (EMC) values were calculated from the sampling data as a starting point for determining EMCs to use in the Water Quality Model.

The full description of the model development, calibration, application, results, and analysis can be found in the Water Quality Monitoring Report, included in **Appendix J**. A summary of the report is provided in the following subsections.

5.3.1 Model Description and Development

Three types of models, which comprise the modeling framework, were jointly applied to compute POC concentrations in the Chester and Ridley Creeks and in the Delaware River:

- A watershed model (Watershed Model) which simulates flows and POC loads from the Chester and Ridley Creek watersheds;
- CSS models (H&H Models) that simulate flows and POC loads from the DELCORA and Philadelphia Water Department combined sewer systems; and,
- A receiving water quality model (the Water Quality Model) that computes POC concentrations in the Chester and Ridley Creeks and in the Delaware River resulting from the various sources of POCs to the water bodies (primarily Philadelphia's CSOs, watershed runoff, and DELCORA's CSOs).

The watershed and CSS models were developed using the EPA Stormwater Management Model (SWMM) and the receiving water quality model was developed using the EPA Environmental Fluid Dynamics Code (EFDC) model.

Figure 5-2 illustrates the extents of the watershed, CSS, and receiving water quality models.

The model development process for DELCORA's water quality modeling framework included definition of:

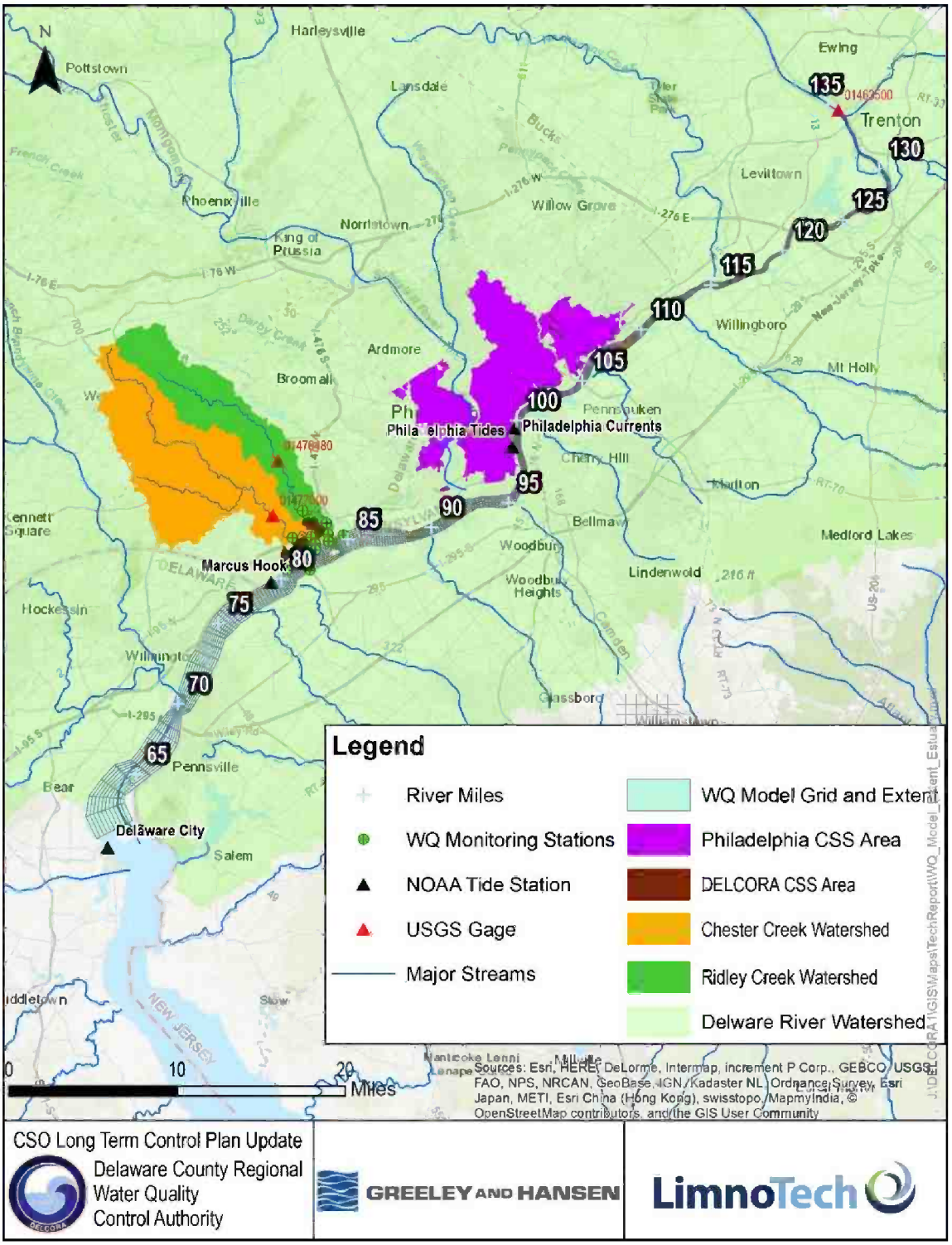
- Important physical and biological processes such as stormwater runoff and POC decay rates;
- Model inputs and assumptions influencing the modeled processes, such as water depths and stream flow rates;
- The spatial extent of model calculations; and,
- The time span of model calculations.

5.3.2 Model Calibration

Site specific data were used for calibrating the various models, including USGS flow data, NOAA tide data, wet and dry weather water quality data obtained by DELCORA, and ambient water quality data obtained from the Delaware River Basin Commission. The water quality data obtained by DELCORA proved particularly useful in calibration of the Water Quality Model, as it contained both wet and dry weather data at various locations within the study area, including both upstream and downstream of DELCORA's CSO discharges.

Calibration of the various models was evaluated using metrics such as total runoff volume, peak flow rates, timing of the flow response, frequency of discharge, water levels, water velocities, and in-stream water quality concentration. The calibration approach was to adjust model parameters and evaluate changes in model results against the entire calibration dataset, and identify the model input values that were most consistent with the central tendencies and distribution of the datasets by water body. Each model within the framework was developed and calibrated using the best available data. Calibration of the receiving water quality model served as a check on the reliability of the watershed and CSO models because the performance of the receiving water quality model was dependent on the quality of the other two models. Each model was found to be reasonably consistent with observed data and therefore reliable to be applied for the development of the Long-Term Control Plan Update.

Figure 5-2: Water Quality Model Extent and Related Features



5.3.3 Application of the WQ Model to support the LTCPU Development

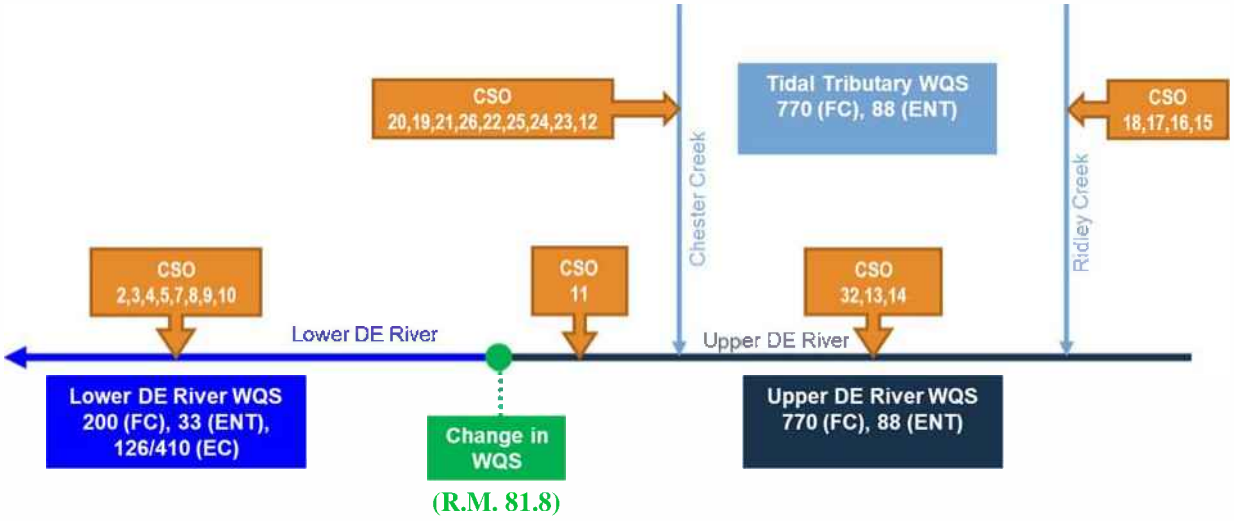
The Water Quality Model was applied for the typical year hydrologic period of 1994-1996, which includes one relatively dry year, a relatively wet year, and an average year (see **Section 3**). The modeled POC concentrations were compared to the currently applicable and potential future water quality standards, as shown in **Table 5-2**. The Upper Delaware River and the tidal zones of Chester and Ridley Creek currently have secondary contact water quality standards whereas the Lower Delaware River currently has primary contact water quality standards for fecal indicator bacteria. The boundary between the Upper and Lower Delaware River occurs at river mile 81.8, which is just downstream of Chester Creek and CSO-11 (see **Figure 5-3**).

Table 5-2: Water Quality Standards for Comparisons with Model Results

Segment	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E. coli*[1] (#/100 mL)
Upper Delaware River and Tidal Zones of Creeks	Monthly Geomean: 88 #/100 mL	Monthly Geomean: 770 #/100 mL	n/a
Lower Delaware River	Monthly Geomean: 33 #/100 mL	Monthly Geomean: 200 #/100 mL	Monthly Geomean: 126 #/100 mL Statistical Threshold Value: 410 #/100 mL

[1] It has been reported that *E. coli* (EC) standards are likely to be codified by PADEP in the near future and for this reason it was included as a parameter in the 2018 sampling. These criteria would apply to the non-tidal tributaries and to the Delaware River below R.M. 81.8, during recreational months only (May 1 - September 30).

Figure 5-3: Schematic of Applicable POC Water Quality Standards



5.3.4 Baseline Results

Model results were summarized over the stream reaches that receive CSO discharges, and that occur within Pennsylvania waters. Generally, the modeling indicated that the *Enterococcus* standards are the most stringent among the three POCs. Exceedances above the WQS are frequent in the two creeks and infrequent in the Delaware River. The exceedances are almost always due to background sources coming from upstream of the DELCORA CSO area. DELCORA's CSOs have a much smaller impact (less than 10%, on average) on the monthly geometric mean concentrations than do the upstream background sources.

Table 5-3 shows the number of months when water quality standards were exceeded for each of the three POCs in the Upper and Lower Delaware River and in the two creeks. Results are shown for all sources (background and CSOs) and for CSOs only. This table shows that DELCORA's CSOs by themselves do not cause water quality violations in the Upper or Lower Delaware River or in Chester and Ridley Creeks and are not precluding the attainment of WQS. DELCORA's CSOs have a relatively small impact (less than 10%, on average) on the monthly geometric mean concentrations than do the upstream background sources because they are intermittent discharges that are only active for short time periods within a monthly geometric mean evaluation period.

Table 5-3: Number of Months Exceeding the Monthly Geomean Water Quality Standard

	Enterococcus Monthly Geomean	Fecal Coliform Monthly Geomean	*E.coli*[1] Monthly Geomean	*E.coli*[1] STV
Ridley Creek				
All Sources	36/36	24/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Chester Creek				
All Sources	21/36	1/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Upper Delaware				
All Sources	1/36	0/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Lower Delaware				
All Sources	6/36	1/36	2/36	13/36
CSOs only	0/36	0/36	0/36	0/36

[1] No *E.coli* standard currently exists or has been officially proposed for the tidal portions of Ridley and Chester Creeks or for the Upper Delaware River, therefore results for these segments are marked as "n/a" in this table. Water Quality Modeling results indicate the contribution of CSOs only to these waterbodies do not result in *E. coli* counts above 126#/100mL for a monthly geomean.

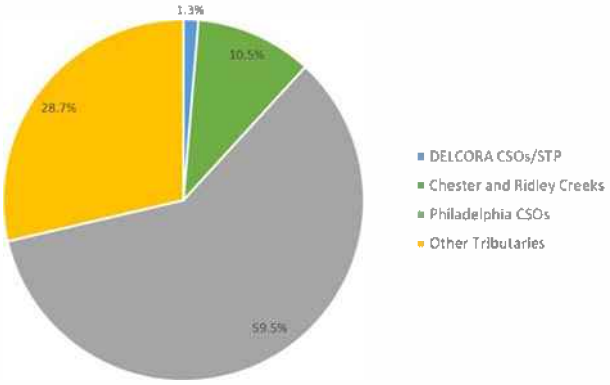
5.4 Water Quality Monitoring and Modeling Findings

The water quality sampling program and Water Quality Model were developed to compute POC concentrations in the Delaware River and in the tidal sections of Chester Creek and Ridley Creek. Major findings of the monitoring and modeling are as follows:

- The model is deemed adequate to assess the local water quality conditions in the DELCORA study area, including in the tidal portions of Chester and Ridley Creek and in the Delaware River from roughly river mile 80 near Marcus Hook Creek to river mile 85 near Crum Creek.
- Outputs of the Hydrologic and Hydraulic Model relative to volumes and loadings were adequate for utilization as inputs for the development of the Water Quality Model.
- The monitoring data shows that wet weather concentrations at the most upstream monitoring locations (located upstream of DELCORA's CSO influence) in Chester Creek and Ridley Creek often exceed the monthly geometric mean WQS concentration for the two POCs there. Wet weather exceedances are also observed in the most upstream monitoring location for the Delaware River, but less frequently as compared to the creeks. The *E.coli* statistical threshold value WQS[8] concentration (410 #/100 mL) was exceeded once under wet weather conditions during the sampling periods in the Delaware River.
- The modeling results show that when water quality standards are exceeded during wet weather events, upstream and background sources typically prevent the attainment of both the monthly geometric mean and statistical threshold value water quality standards.
- The modeling results show that CSOs by themselves do not cause water quality violations in any of the stream segments.
- Each model within the framework was developed and calibrated using the best available data, and found to be reasonably consistent with observed data and therefore reliable to be applied for the development of the LTCPU.

The DELCORA CSO loads are small compared to the upstream and background bacteria loads entering the DELCORA project area based off of the results of the Water Quality Model Report (see **Figure 5-4**, original source in **Appendix J**).

Figure 5-4: Percent of Bacteria Load by Source



[6] E.coli (EC) standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.M. 81.8, during recreational months only (May 1 - September 30).

Two major observations can be made from the water quality modeling application results. One is that background sources dominate the modeled POC concentrations (and by extension, DELCORA's CSO loads are small compared to background loads), and the second is that the DELCORA's CSOs by themselves do not cause non-attainment, or preclude the attainment, of WQS. Moreover, the modeling results show that regardless of additional CSO controls, even complete sewer separation, water quality standards would still be exceeded under current conditions because background sources of bacteria typically prevent compliance with the WQS. The modeling results are supported by the water quality data results from the wet weather sampling program, which shows that wet weather concentrations at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek (and to a lesser extent in the Delaware River) often exceed the monthly geometric mean and STV WQS concentration for the three POCs. These monitoring and modeling data taken together indicate the upstream bacteria loads result in a practical impossibility of meeting water quality standards in the tidal waters through CSO control alone.

The Water Quality Model is deemed adequate to evaluate compliance with the WQS and the degree to which DELCORA's CSOs contribute to the non-attainment of WQS. The intended use of the water quality modeling framework is to evaluate CSO control alternatives with respect to applicable water quality standards and demonstrate that the alternatives selected for the LTCPU program will meet the water quality-based requirements of the Clean Water Act and Consent Decree. The Water Quality Model is adequate to assess the Presumption approach levels of control to show that the CSOs will or will not preclude the attainment of water quality standards after CSO control measures are implemented.

The Water Quality Model was used to help assess the water quality benefits of potential infrastructure projects considered for the LTCPU (i.e. CSO alternative scenarios). The selected CSO alternatives were simulated in the DELCORA H & H Model (i.e. CSS model) and then evaluated with the receiving Water Quality Model. Resulting changes to in-stream POC concentrations were compared to the applicable water quality standards as well as to the concentrations observed under the baseline conditions. These model results are described in **Section 10 - Implementation of the CSO LTCP Update**.

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Section 6 Existing Service Area Characterization

6.1 Background

The *Existing Service Area Characterization Report* was prepared to fulfill the requirements of Paragraph V.A.16 of the Consent Decree, and of the federal CSO Control Policy Section II.C.1 – Characterization, Monitoring and Modeling of the Combined Sewer System and was approved by the USEPA on April 16, 2018. This Section of the LTCP Update summarizes the information presented in that report to characterize, monitor and model DELCORA's combined sewer system, and incorporates the conclusions about Sensitive Areas that were previously determined in **Section 2** of this LTCPU report. The full version of the approved *Existing Service Area Characterization Report* is included in **Appendix K**, with updates to the model calibration and validation results in **Appendix T**.

6.2 Regulatory Requirements for the Existing Service Area Characterization

6.2.1 Consent Decree Requirements for the Existing Service Area Characterization

The primary requirements for the Existing Service Area Characterization Report are established in the Consent Decree. Specifically, Paragraph V.A.16 of the Consent Decree, Existing Service Area Characterization, states that:

> *"Not later than two years (24) months after the Date of Lodging of the Consent Decree, DELCORA shall submit a characterization of the Model Area that includes all of the information required by CSO Control Policy Section II.C.1 and associated guidance to Plaintiffs for review and approval in accordance with the requirements of Section VI (Review and Approval of Submittals). The characterization shall include, but not be limited to, the following:*
>
> *DELCORA shall use the updated, calibrated, and validated H&H Model to characterize the expected volume, frequency, and duration of CSO discharge events from each CSO during the Typical Year, based on an inter-event period of twelve (12) hours;*
>
> *DELCORA shall incorporate the results of its investigation of Sensitive Areas;*
>
> *DELCORA shall provide a characterization of current water quality in its Receiving Waters, based upon all available sampling data, and its efforts to identify POCs.*
>
> *The characterization submitted pursuant to this paragraph shall include the entire Model Area, including the hydrology (i.e., runoff) from and within the entire Model Area."*

Additionally, the Consent Decree requires Rainfall and Flow Monitoring in Paragraph V.A.14.d.:

> *"Rainfall and flow monitoring that shall be carried out in accordance with current good industry practice for a period of at least twelve (12) months, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization*

of dry and wet weather flows for the entire Model Area, and the response of each CSO to wet weather flows."

6.2.2 Requirements from the USEPA's CSO Control Policy

Additional requirements for the *Existing Service Area Characterization Report* are established in the USEPA's CSO Control Policy. Section II.C.1 of the CSO Control Policy "Characterization, Monitoring and Modeling of the Combined Sewer System" states:

> *"In order to design a CSO control plan to adequately meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring, modelling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses."*

The CSO Control Policy states that the major elements of a sewer system characterization include the following:

> ***Rainfall Records***
>
> *"The permittee should examine the complete rainfall record for the geographic area of its existing CSS using sound statistical procedures and best available data. The permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water conditions."*
>
> ***Combined Sewer System Characterization***
>
> *"The permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities necessary to understand the number, location and frequency of overflows and their location relative to sensitive areas and to pollution sources in the collection system, such as indirect significant industrial users."*
>
> ***CSO Monitoring***
>
> *"The permittee should develop a comprehensive, representative monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters."*
>
> ***Modeling***
>
> *"Modeling of a sewer system is recognized as a valuable tool for predicting sewer system response to various wet weather events and assessing water quality impacts when evaluating different control strategies and alternatives. EPA supports the proper and effective use of models, where appropriate, in the evaluation of the nine minimum controls and the development of the long-term CSO control plan."*

6.3 Overview of DELCORA's Facilities

DELCORA owns and operates an extensive conveyance system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in **Figure 1-3**. An overview of DELCORA's facilities is presented in **Subsection 1.3** of this report.

6.4 Characteristics of the Model Area Sewer System

This subsection presents an investigation of the collection system to meet the requirements of Paragraph II.C.1.b, Combined Sewer System Characterization, of the USEPA's CSO Control Policy. Paragraph II.C.1.b requires DELCORA to evaluate the nature and extent of the sewer system through evaluation of available sewer records and inspections necessary to understand the number, location and frequency of overflows, and their locations relative to Sensitive Areas and to pollution sources in the collection system.

6.4.1 Sources of Collection System Data

The characteristics and attributes of DELCORA's collection system were determined through the collection, assessment, and evaluation of existing data and information, as part of the implementation of the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015).

Data and information on the collection system were obtained from several sources including DELCORA's input, DELCORA's Geographic Information System, as-built record drawings, design drawings and field surveys.

6.4.2 Overview of Sewer System Characteristics

The wastewater collection system within the Model Area consists of separated storm and sanitary sewer piping in some areas and combined sewer system piping in other areas. The Model Area covers approximately 50,000 acres, with approximately 48,500 acres served by separated storm and sanitary systems while only 1,486 acres are served by a combined sewer system. The combined sewer system is located entirely within the City of Chester. However, the City of Chester also has areas that are served by separated storm and sanitary piping or are direct drainage. The remaining areas of the Model Area outside of the City of Chester are all served by separated storm and sanitary sewer piping.

In separated areas, the sanitary sewers convey wastewater to the WRTP/PWD-SWWPCP for treatment and stormwater runoff is collected through storm sewers and discharged directly to the receiving waters.

Within the City of Chester's combined sewer areas, however, sanitary and storm sewers are combined into the same pipe. During dry weather, the sanitary wastewater is conveyed to the WRTP. During large storms, the stormwater runoff causes the carrying capacity of these combined sewers to be exceeded, and part of this combined flow may discharge directly to the receiving waters without undergoing any treatment.

Sewersheds (subcatchments) are delineated based on the drainage network and area characteristics. Each sewershed has a dry weather and a wet weather flow input to the model network. The model network comprises 128 sewersheds (subcatchments), including 55 combined and 73 separated subcatchments.

6.4.3 Characteristics of Separated Sewer Areas

Sanitary sewers within the separated areas deliver flow to the WRTP through connections to DELCORA's sewers and through connections to DELCORA's pump station. In many cases, DELCORA does not own or operate the sanitary sewers in separated areas. Consequently, detailed information regarding the characteristics of sanitary sewers from the separated areas is not included in this Report. Key characteristics necessary for developing flow inputs include the delineation of subcatchment boundaries as shown in **Figure 4-2** and in **Table 6-1**.

6.4.4 Characteristics of Combined Sewer System

As noted in **Subsection 1.3** of this report, the combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The CSS system in the City of Chester has several key components that all impact how the system operates. These key components are the local street sewers, combined collector sewers, CSO regulators, interceptors, and outfalls. The system starts with local street sewers that take flow from houses and businesses as well as the stormwater inlets that drain the streets. These local street sewers typically range in size from 12" to 24" in diameter. The local street sewers discharge to combined collector sewers, which flow to the CSO regulators. The combined collector sewers are larger pipes that typically range in size from 18" to 72" in diameter and connect directly to the CSO regulators.

Generally, in the CSO drainage areas, flows from the separate sanitary sewers flow into the combined sewers. Flows from the combined sewers in the collection system flow to the regulator structures where dry weather flow and a portion of wet weather flow are diverted into the interceptors. The remainder of the wet weather flow that exceeds the capacity of the interceptors is discharged directly to the closest receiving water (Delaware River, Chester Creek or Ridley Creek) through the CSO outfalls.

6.4.5 Overall Configuration

A schematic of the CSS was developed to facilitate the development, calibration, and validation of the H&H Model. The schematic illustrates the relationship between all major regulators, interceptors, outfalls, pump stations, force mains and other major appurtenances. The schematic also includes the location of the flow meters, and provides and good understanding of the relationship between the flow meters. The schematic of the collection system components is shown in **Figure 1-6**.

Figure 4-3 in **Section 4** depicts the locations of DELCORA's CSO regulators and outfalls and also depicts the various drainage subcatchments that flow to the CSO regulators. Information about the 26 CSO drainage areas including their subcatchments, total acreage and combined sewer acreage are shown depicted in **Table 6-1**.

Table 6-1: Subcatchments in the Model Area Sewer System

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
Regulator 2	02A	CSS	29	58	Chester City
	02B	CSS	29		Chester City
Regulator 3	03B	CSS	19	87	Chester City
	03C	CSS	43		Chester City
	03D	CSS	20		Chester City
Regulator 4	04A	CSS	12	31	Chester City
	04B	CSS	19		Chester City
Regulator 5	05C	CSS	49	233	Chester City
	05D	CSS	53		Chester City
	05E	Separate	27		Chester City
	CH_TWP_2	Separate	59		Chester Twp
	CH_CTY_9	Separate	7		Chester City
	CH_TWP_1	Separate	38		Chester Twp
Regulator 7	07A	CSS	21	26	Chester City
	07B	CSS	5		Chester City
Regulator 8	08A	CSS	89	237	Chester City
	08B	CSS	96		Chester City
	08C	CSS	52		Chester City
Regulator 9	09A	CSS	27	27	Chester City
Regulator 10	10A	CSS	60	60	Chester City
Regulator 11	11A	CSS	44	44	Chester City
Regulator 12	12A	CSS	5	5	Chester City
Regulator 13	13A	CSS	41	50	Chester City
	13C	CSS	9		Chester City
Regulator 14	14A	CSS	35	53	Chester City
	14B	CSS	13		Chester City
	14C	CSS	5		Chester City
Regulator 15	15A	CSS	10	10	Chester City
Regulator 16/17	16/17A	CSS	46	77	Chester City
	16/17B	CSS	31		Chester City
Regulator 16	16A	CSS	2	2	Chester City
Regulator 17	17A	CSS	12	12	Chester City
Regulator 18	18A	CSS	28	130	Chester City
	18B	CSS	2		Chester City
	18C	CSS	100		Chester City
Regulator 19	18C	Separate	100	421	Chester City
	19B	CSS	88		Chester City
	19D	CSS	94		Chester City
	19E	CSS	76		Chester City
	19G	CSS	18		Chester City
	PA_BORO_1	Separate	28		Parkside Boro
	CH_CTY_08	Separate	17		Chester City
Regulator 20	20A	CSS	18	18	Chester City
Regulator 21	21A	CSS	11	11	Chester City
Regulator 22	22A	CSS	27	27	Chester City
Regulator 23	23A	CSS	10	10	Chester City
Regulator 24	24A	CSS	6	6	Chester City
Regulator 25	25A	CSS	12	12	Chester City
Regulator 26	26A	CSS	33	37	Chester City

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
	26B	Separate	4		Chester City
Regulator 32	31A	CSS	3	3	Chester City
Chester Creek Interceptor East	CCE1	CSS	3	3	Chester City
Chester Creek Interceptor West	CCW1	CSS	7	552	Chester City
	CCW2	CSS	6		Chester City
	CCW3	Separate	5		
	CH_CTY_11	Separate	5		Chester City
	PA_BORO_3	Separate	27		Parkside Boro
	BR_TWP_1	Separate	27		Brookhaven Boro
	BR_TWP_2	Separate	49		Brookhaven Boro
	CH_CTY_13	Separate	2		Parkside Boro
	UPL_BORO_1	Separate	424		Upland Boro
2nd Street Interceptor	CH_CTY_02	Separate	238	238	Chester City
Penn Street Interceptor	PS1	CSS	3	13	Chester City
	PS3	CSS	10		Chester City
Ridley Creek Interceptor	RC1	CSS	3	2,327	Chester City
	CH_CTY_03	Separate	276		Chester City
	33A	Separate	9		Chester City
	CH_CTY_04	Separate	137		Chester City
	CH_CTY_05	Separate	124		Chester City
	CH_CTY_06	Separate	44		Chester City
	CH_CTY_07	Separate	44		Chester City
	BR_TWP_6	Separate	327		Brookhaven Boro
	NP_TWP_2	Separate	991		Nether Providence Twp
	PA_BORO_2	Separate	71		Parkside Boro
	BR_TWP_3	Separate	236		Brookhaven Boro
	BR_TWP_4	Separate	21		Brookhaven Boro
	BR_TWP_5	Separate	44		Brookhaven Boro
Stony Creek Interceptor	SC1	CSS	54	54	Chester City
West End Interceptor	DR1A	CSS	8	1,023	Chester City
	DR1C	CSS	7		Chester City
	CH_CTY_10	CSS	11		Chester City
	TR_BORO_1	Separate	669		Trainer Boro
	CH_TWP_3	Separate	245		Chester Twp
	UC_TWP_2	Separate	51		Upper Chichester Twp
	BS2	CSS	22		Chester City
	BS3	CSS	10		Chester City
Delaware River Interceptor	DR1B	CSS	3	332	Chester City
	CH_CTY_01	Separate	329		Chester City
Eddystone Pump Station	EDD_BORO_1	Separate	664	664	Eddystone Boro
Central Delaware Pump Station	RI_TWP_1	Separate	2,806	18,806	Ridley Twp
	RP_BORO_1	Separate	679		Ridley Park Boro
	RU_BORO_1	Separate	90		Rutledge Boro
	SP_TWP_1	Separate	2,208		Springfield Twp
	SW_BORO_1	Separate	898		Swarthmore Boro
	UPR_TWP_1	Separate	1,722		Upper Providence Twp
	PR_BORO_1	Separate	477		Prospect Park Boro
	MO_BORO_1	Separate	238		Morton Boro
	NE_TWP_1	Separate	3,422		Newtown Twp
	NP_TWP_1	Separate	1,927		Nether Providence Twp

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
	EDG_TWP_1	Separate	735		Edgmont Twp
	MA_TWP_1	Separate	3,604		Marple Twp
Chester Ridley Creek Pump Station	UC_TWP_3	Separate	192	14,513	Upper Chichester Twp
	UPR_TWP_2	Separate	248		Upper Providence Twp
	RV_BORO_1	Separate	471		Rose Valley Boro
	NP_TWP_3	Separate	110		Nether Providence Twp
	AS_TWP_1	Separate	3,732		Aston Twp
	CH_TWP_4	Separate	593		Chester Twp
	EDG_TWP_2	Separate	258		Edgmont Twp
	MI_TWP_1	Separate	8,612		Middletown Twp
	BR_TWP_7	Separate	156		Brookhaven Boro
	CH_BORO_1	Separate	141		Chester Heights Boro
Marcus Hook Pump Station	LC_TWP_1	Separate	700	1,401	Lower Chichester Twp
	MH_BORO_1	Separate	701		Marcus Hook Boro
Naamans Creek Pump Station	BE_TWP_1	Separate	2,500	6,528	Bethel Twp
	UC_TWP_1	Separate	4,028		Upper Chichester Twp

6.4.6 Sewer Mains

Sewer data was collected from DELCORA's GIS in support of the work to update and calibrate the H&H model. Most of the pipe input characteristics, including upstream and downstream nodes, dimension, shape, number of barrels, and flap gate information, were found or estimated from record drawings, design drawings and sewer gravity main GIS shapefiles. If sewer main information was not available, sewer length was estimated using GIS geometry measurement; sewer sizes were assumed based on upstream and downstream sewers; and sewer upstream and downstream offsets were estimated based on sewer connectivity assuming constant slope. Conduit ID was inherited from the 2012 H&H Model and new IDs were provided for the pipes not in the 2012 H&H Model.

Manhole information, including invert and rim elevations, were found or estimated from record drawings, design drawings, and the sewer manhole shape file. Manhole ID was inherited from the name of the manhole in the sewer GIS. Manhole input information was updated based on the latest available GIS information.

6.4.7 Flow Diversion Structures and CSO Regulators

The Chester CSO system contains 26 permitted CSO regulators as listed in **Table 6-2**. The CSO regulators and outfalls serve as combined sewer reliefs necessitated by stormwater entering the sewer system and exceeding the hydraulic capacity of the sewers and/or treatment plant. Wet weather flows in excess of the collection system's capacity are discharged to the Delaware River, Chester Creek or Ridley Creek. Although there are 26 regulators, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. **Table 6-2** shows that eleven of the outfalls, CSO Outfalls #002, 003, 004, 005, 007, 008, 009, 011, 013, 014, and 032, discharge excess wet weather flows into the Delaware River. Nine of the outfalls, CSO Outfalls #012, 019, 020, 021, 022, 023, 024, 025 and 026, discharge excess wet weather flows into the Chester Creek. The remaining five designated outfalls, Outfall #015, 016, 017, 018 and 033, discharge excess wet weather flows into the Ridley Creek.

Since the approval of the first LTCP in 1999, DELCORA has under-taken a program to replace and/or rehabilitate CSO regulators and tide gates in the City of Chester CSO system. In some cases, regulators have been eliminated. The modifications DELCORA committed to in the 1999 LTCP include a complete replacement of the mechanism, installation of a monitoring system to determine if flow is passing over the CSO regulator diversion weir to the outfall, and conversion of the CSO regulators to Type A. After installation of the first CSO regulator monitoring systems, DELCORA determined that the monitoring system improves system operation and significantly reduces dry-weather overflows by notifying operators at the WRTP that flow is passing over the diversion weir. (If it is not raining, this notification is indication of a dry-weather overflow and DELCORA dispatches a maintenance crew to correct the situation.) After this determination, DELCORA installed the monitoring system on all CSO regulators even though it was not required until the CSO regulator was replaced. DELCORA continues to use this system and it provides critical information to maintain proper operation of the CSO regulators.

Table 6-2: CSO Regulator Information

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	Latitude	Longitude	CSO Regulator Type	Regulator Replacement Status
002	Front & Booth	Delaware River	39°49'30"N	75°23'31"W	Brown & Brown	Replaced
003	Front & Highland	Delaware River	39°49'34"N	75°23'11"W	Brown & Brown	Replaced
004	Front & Hayes	Delaware River	39°50'36"N	75°23'07"W	Brown & Brown	Replaced
005	Front & Townsend	Delaware River	39°49'46"N	75°22'53"W	Brown & Brown	Replaced
007	Delaware & Reaney	Delaware River	39°49'51"N	75°22'45"W	Brown & Brown	Replaced
008	2nd & Tilghman	Delaware River	39°50'05"N	75°22'22"W	Brown & Brown	Replaced
009	2nd & Lloyd	Delaware River	39°50'14"N	75°22'10"W	Brown & Brown	Replaced
010*	5th & Pusey	Delaware River	39°50'26"N	75°22'19"W	Brown & Brown	Replaced
011	2nd & Parker	Delaware River	39°50'26"N	75°21'54"W	Brown & Brown	Replaced
012	2nd & Edgmont	Chester Creek	39°50'42"N	75°21'38"W	Brown & Brown	Replaced
013	2nd & Welsh	Delaware River	39°50'37"N	75°21'17"W	Brown & Brown	Replaced
014	3rd & Upland	Delaware River	39°50'50"N	75°21'05"W	Brown & Brown	Replaced
015	4th & Melrose	Ridley Creek	39°51'03"N	75°20'48"W	Brown & Brown	2022
016	8th & McDowell	Ridley Creek	39°51'15"N	75°20'53"W	Brown & Brown	Replaced
017	9th & Campbell	Ridley Creek	39°51'16"N	75°20'51"W	Brown & Brown	Replaced
018	Sun Dr. & Hancock	Ridley Creek	39°51'47"N	75°20'57"W	Brown & Brown	Replaced
019	14th & Crozer Hospital	Chester Creek	39°51'24"N	75°21'54"W	Brown & Brown	Replaced
020	Kerlin & Finland	Chester Creek	39°51'24"N	75°22'27"W	Brown & Brown	Replaced
021	9th & Sproul	Chester Creek	39°51'08"N	75°21'49"W	Brown & Brown	Replaced
022	6th & Sproul	Chester Creek	39°50'56"N	75°21'47"W	Brown & Brown	Replaced
023	3rd & Edgmont	Chester Creek	39°50'45"N	75°21'42"W	Brown & Brown	Replaced
024	3rd & Dock	Chester Creek	39°50'44"N	75°21'43"W	Brown & Brown	Replaced
025	5th & Penn	Chester Creek	39°50'49"N	75°21'50"W	Brown & Brown	Replaced
026	7th & Penn	Chester Creek	39°50'58"N	75°21'55"W	Brown & Brown	Replaced

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	Latitude	Longitude	CSO Regulator Type	Regulator Replacement Status
032	2nd & Avenue of the States	Delaware River	39°50'34"N	75°21'25"W	Weir Structure	Removed Mechanisms
033	Elkington Blvd. and Ridley Creek	Ridley Creek	39°52'22"N	75°22'29"W	Weir Structure	See Notes
Notes: - CSO Regulator 010 discharges at Outfall 009. - CSO Regulators 006 ad 007 have been disconnected from CSS and removed from NPDES permit - CSO Regulator 033 has been disconnected from the CSS but had not been removed from NPDES permit at the date of this Report						

As indicated in **Table 6-2**, the majority of the City's CSO regulators are Brown & Brown type regulators. The original CSO regulators were Type B regulators in which the regulator gate position is controlled by the level in the trunk sewer entering the CSO regulator chamber. As part of its regulator replacement program DELCORA is replacing the regulators with Type A regulators in which the gate position is controlled by the level in the interceptor. This allows for the interceptor to operate at full capacity thus maximizing the amount of flow being sent to the WRTP for treatment. Flow that cannot enter the interceptor because it is at capacity, passes over the CSO regulator diversion weir and into the outfall for release to the receiving water.

The updated H&H model includes twenty-six (26) CSO regulators, which were modeled as weirs and orifices. The configuration of CSO regulators was obtained from both record drawings and field surveys.

6.4.7.1 Flow Diversion Structure Components

The key components required for modeling these structures include float-operated gates, orifice plates and diversion weirs. **Table 6-2** lists basic information for each of DELCORA's 26 CSO regulators.

Regulator Gates

Characteristics of the regulator gates were obtained from as-built drawings and field surveys and are discussed in detail in **Appendix K**.

Orifices

Most of the regulators include an orifice between the regulator gate and the downstream interceptor. All orifices in the collection system are side orifice type, rectangular in shape and were assigned a discharge coefficient of 0.65. The dimensions are based on record drawings. The orifices in the updated H&H Model are discussed in Section 4 of this report.

Weirs

Characteristics for the diversion weirs were obtained from record drawings and were field verified as necessary. The characteristics of the weirs is discussed in Section 4 of this LTCPU Report.

6.4.8 Interceptors

The interceptors convey flow from the CSO regulators to the WRTP or to the Chester Pump Station, which discharges directly to the WRTP. The interceptors shown on **Figure 1-4** vary in size from 24" to 72" in diameter. Any flow entering the interceptor system will eventually reach the WRTP for treatment.

Figure 1-6 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO. Specifically, as diagrammed in **Figure 1-6**, the relationship between DELCORA's interceptors and outfalls are as follows:

- The Delaware River Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 002, 003, 004, 005 and 007 into the Booth Street Interceptor that then leads to the WRTP.
- The Second Street Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 008, 009, 011 and 024 to the Chester Pump Station, which is then pumped to the WRTP.
- The West End Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Area 010 into the Booth Street Interceptor and then to the WRTP.
- The Ridley Creek Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 012, 013, 014, 015, 016, 017, 018, 032 and 033 to the Chester Pump Station, which pumps the flow to the WRTP.
- The Edgmont Avenue Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 021, 022 and 023 into the Ridley Creek Interceptor and from there to the Chester Pump Station and then to the WRTP.
- The Chester Creek East Interceptor and the Chester Creek West Interceptor respectively convey the dry weather flow and a portion of the wet weather flow from CSO Service Areas 019 and 020. These two interceptors then both flow into the Penn Street Interceptor that also conveys the dry weather flow and a portion of wet weather flow from CSO Service Areas 025 and 026 to the Chester Pump Station, which pumps the flow to the WRTP.

6.4.9 CSO Outfalls

Outfalls are the discharge points at the receiving streams. The outfalls can either be free outfalls without any boundary conditions or the outfalls can have a boundary condition that the head needs to overcome for outflow to occur. The outfalls in DELCORA's collection system are mostly in the tidal river reach. Therefore, appropriate tidal stages from NOAA data were used to set boundary conditions. Outfalls can have a flap gate or other backflow device at the end to prevent backflow. The CSO Outfalls are discussed in detail in **Section 4** of this report.

6.4.10 Drainage Areas and Subcatchments

Each of the 26 CSO regulators has a unique drainage area associated with it. A CSO drainage area is defined as the entire surface area contributing overland wet weather flow to a specific CSO. Subcatchments are smaller drainage basins located within the overall CSO drainage area. Subcatchments are more useful when developing a model, because the area is smaller and it becomes more site-specific. Subcatchment boundaries were determined from sewer system maps and local topography. GIS software was then used to estimate the acreage within a subcatchment boundary.

The subcatchment parameters - percent imperviousness, depression storage, and soil infiltration parameters are discussed in **Section 4** of this report.

6.5 Collection System Pump Stations

Major pump stations in the Western Service Area and the Central Delaware Pump Station in the Eastern Service Area were added to the updated model, as well as force mains connecting the pump stations to the WRTP. The pump stations included in the updated H&H Model are as follows:

- Chester PS (CPS)
- Existing PS-1 (EPS-1)
- Marcus Hook PS (MHPS)
- Naamans Creek PS (NCPS)
- Eddystone PS (EDPS)
- Central Delaware PS (CDPS)
- Chester Ridley Creek PS (CRPS)
- Sun Oil PS (Owned by Sunoco) (SPS)
- Kimberly Clark PS (Owned by KC) (KCPS)

The Pump Stations that were excluded from the H&H Model are discussed in **Section 4** of this report.

6.6 Force Mains

DELCORA's Model Area includes the numerous force mains that convey flow from the various pump stations to the WRTP.

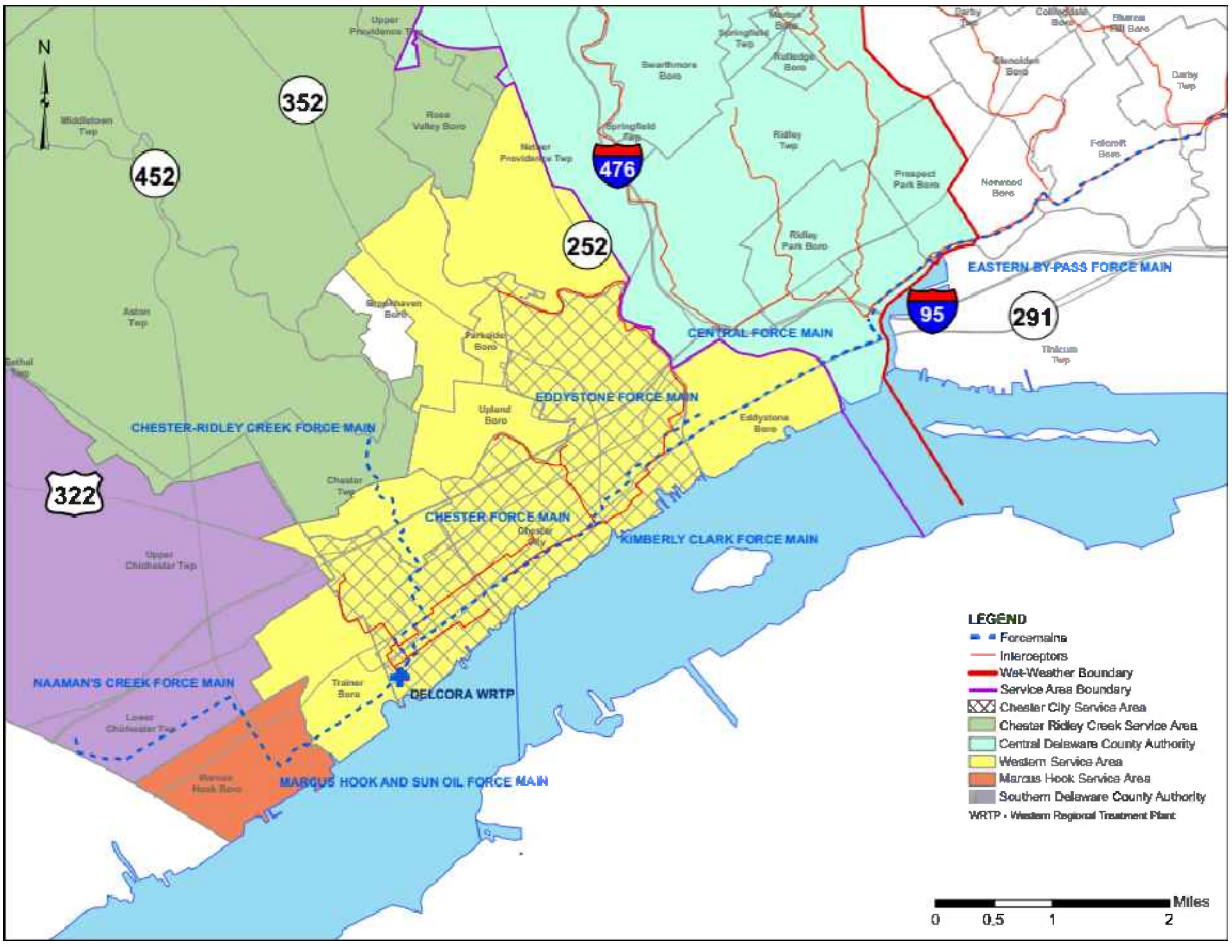
- Chester Force Main
- Central Force Main
- Chester-Ridley Creek Force Main
- Naaman's Creek Force Main
- Marcus Hook/Sun Oil Force Main
- Eddystone Force Main
- Kimberly Clark Force Main
- Existing Pump Station Force Main

The 40-MGD Chester Pump Station discharges to the Chester Force Main which then runs to the WRTP as a 54-inch diameter ductile iron force main.

The Central Delaware Pump Station discharges through two force mains, one of which connects to the Model Area and the WRTP while the other delivers flow to the PWD-SWWPCP. The force main to the Model Area is referred to as the Central Force Main and is a 3.4-mile, 24-inch ductile iron force main which subsequently connects to the Chester Force Main. This connection allows DELCORA to send up to 27 MGD of flow from the CDPS to the WRTP, however, DELCORA's operating policy limits this flow to 20 MGD, with flows above this point to be directed to PWD-SWWPCP. Only the force main connecting to the Model Area is included in the updated H&H model.

A schematic representation showing the force mains can be found in **Figure 1-6**. A map showing the location of the force mains is depicted in **Figure 6-1**.

Figure 6-1: Force Mains



6.7 Flow Monitoring Data Summary

Rainfall Monitoring and Analysis, Dry Weather Flow Analysis, and Wet Weather Flow Analysis can all be found in the Existing Service Area Characterization Report in **Appendix K** and **Appendix T**.

The majority of the flow meters measured flow, level and velocity data for each flow monitoring site at 5-minute interval; other flow meters measured the same parameters in 15 minute intervals. Metering data was analyzed for dry weather flows and wet weather flows for each monitoring site.

The DWF was ultimately used as inputs into the H&H model. Overall annual average DWFs, average monthly DWFs, and weekday and weekend diurnal patterns were input into the model for each flow meter in the combined area. The WWF were used to calibrate the model output. Model data was compared side by side with metered data for each wet weather event for each flow meter.

6.8 Collection of WRTP Operational Data

In addition to flow data collected from the flow meters located in the collection system, flow data from DELCORA's WRTP influent flow meter was obtained for the same time period. A summary of the plant flow data is shown in **Figure 6-2**, **Figure 6-3**, **Figure 6-4**, and **Figure 6-5**.

6.9 Characteristics of the Receiving Waters

6.9.1 Physical Characteristics

The CSS discharges to portions of the Delaware River and two of its tributaries, Chester Creek and Ridley Creek. These receiving waters are located in the tidal portion of the Delaware River Basin, which stretches from the mouth of the Delaware Bay (River Mile 0) to Trenton (River Mile 133.4). The segment of the Delaware River directly impacted by DELCORA's CSO discharges is Zone 4, which extends from River Mile 78.8 to River Mile 95.0 (see **Figure 6-6**). Chester Creek is located at River Mile 82.93 and Ridley Creek at River Mile 83.8. These creeks are tidally influenced tributaries to the Delaware River. For Chester Creek, the tidal portion extends from the mouth of the tributary at Delaware River upstream to Kerlin Street in Chester City while for Ridley Creek, the tidal portion extends from the mouth of the tributary at the Delaware River upstream to MacDade Boulevard in Chester City (Summary Book - 2017 Pennsylvania Fishing Laws & Regulations, http://www.pfbc.pa.gov/fishpub/summaryad/delaware.html) (PFBC, 2017).

Figure 6-2: DELCORA WRTP Influent Flow (3/16 – 6/16)

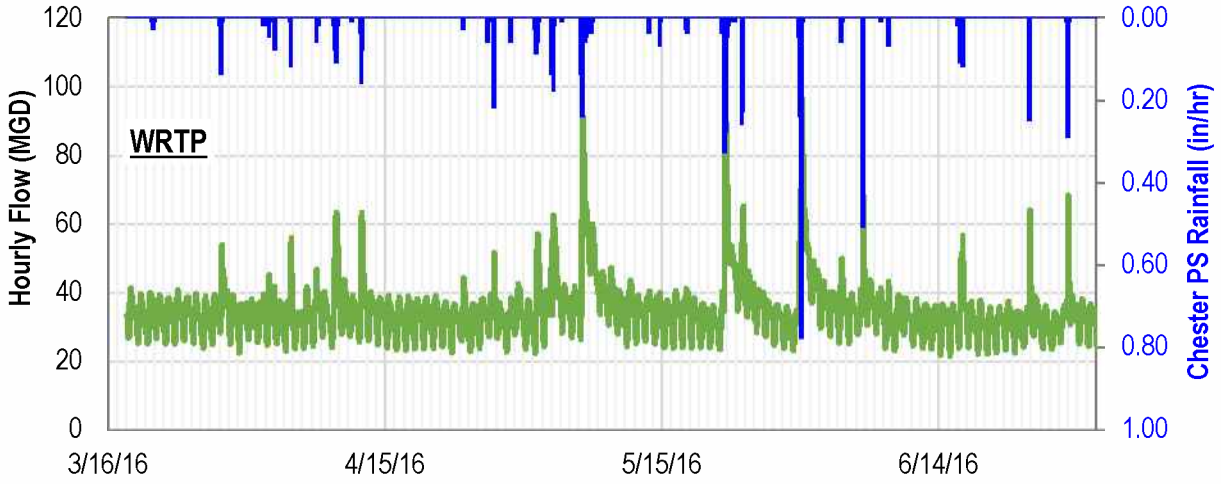


Figure 6-3: DELCORA WRTP Influent Flow (7/16 – 9/16)

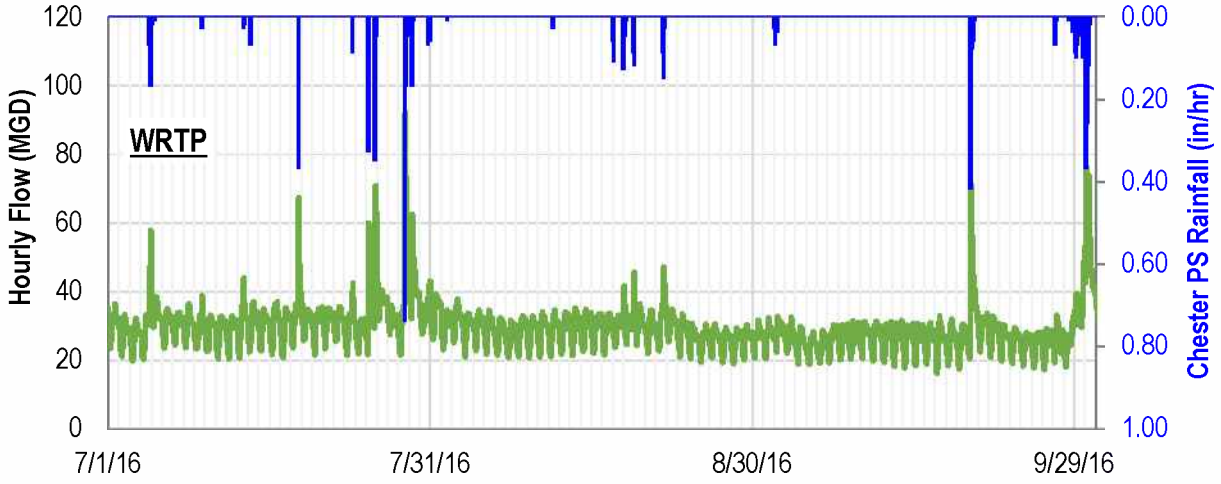


Figure 6-4: DELCORA WRTP Influent Flow (10/16 – 12/16)

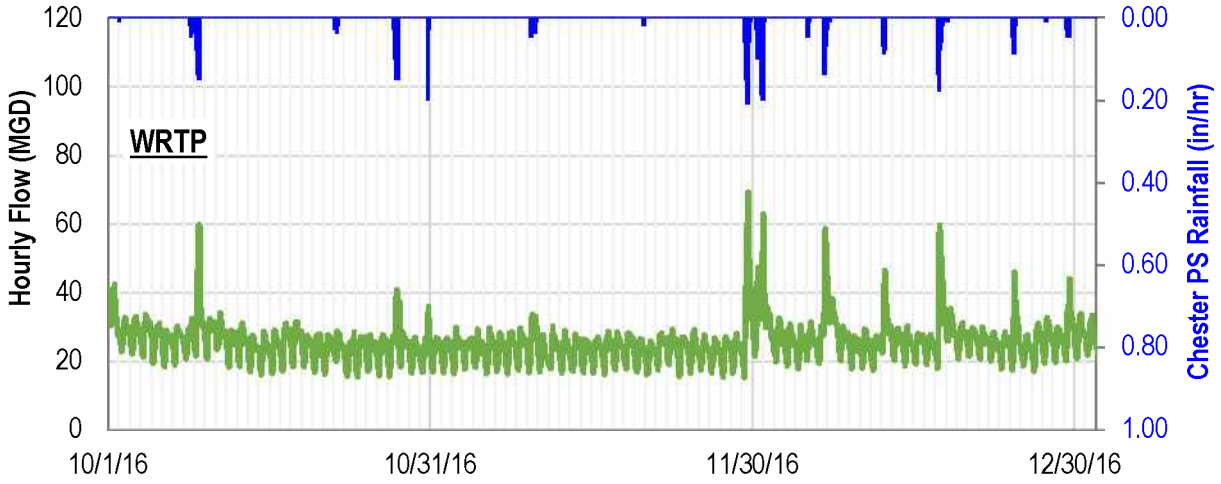


Figure 6-5: DELCORA WRTP Influent Flow (1/17 – 4/17)

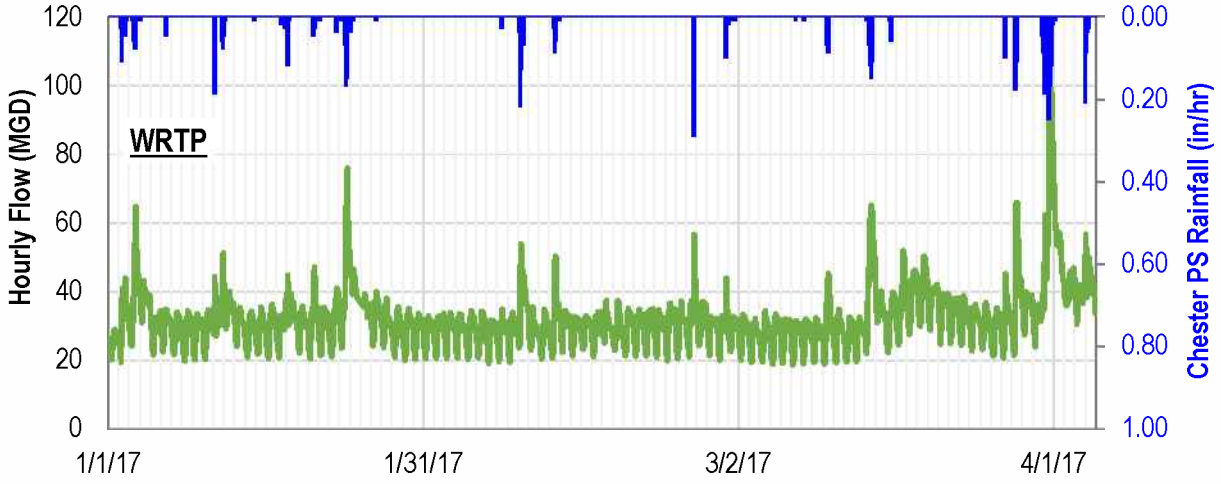


Figure 6-6: Zones of the Delaware River and Bay

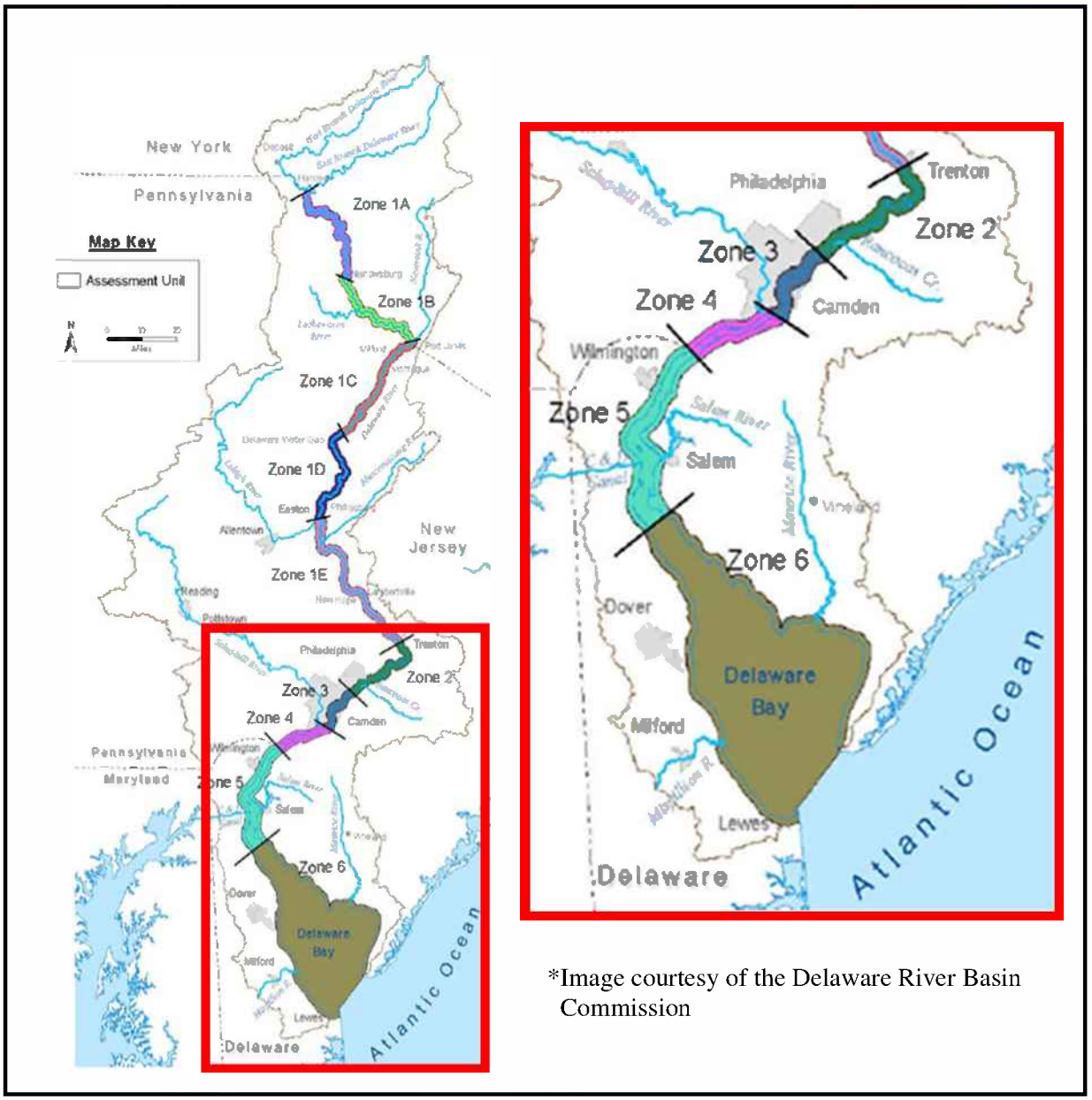


*Image courtesy of the Delaware River Basin Commission

In March 2017, an elevation (bathymetric) survey was conducted by LimnoTech for the lower portions of the Chester and Ridley Creeks. **Figure 6-7** shows the transect locations where elevation measurements were collected. Reaches surveyed included the lower 2.75 miles of Chester Creek and 3.25 miles of Ridley Creek to their discharge into the Delaware River. Transects were collected on ¼-mile interval spacing. Access to the creeks on the upper portions, generally greater than 1 mile upstream, was by wading where the bottom was shallow and firm. The portions below 1 mile were too deep and soft to be accessed on foot and a john boat with tagline was utilized.

Each creek cross section was surveyed at approximately five locations across the bed, water surface, bank toe, and bank top. Access to the entire upland bank at transect locations was not always possible; so the closest points safely accessed to the bank toe were surveyed. Elevation measurements from this survey were compared with similar elevation data from a 1977 Federal Emergency Management Agency Flood Insurance Study of the creeks (FEMA, 2015). To serve as a useful check on the accuracy and sufficiency of the bathymetric survey data.

6.9.2 Watershed Drainage Basins

The Chester Creek and Ridley Creek watersheds extend from the mouth of the tributaries upstream through Delaware County and into Chester County, well beyond the boundaries of DELCORA's Model Area. The extent of the watersheds within Delaware County is illustrated in **Figure 1-1**, along with the boundaries of DELCORA's Model Area.

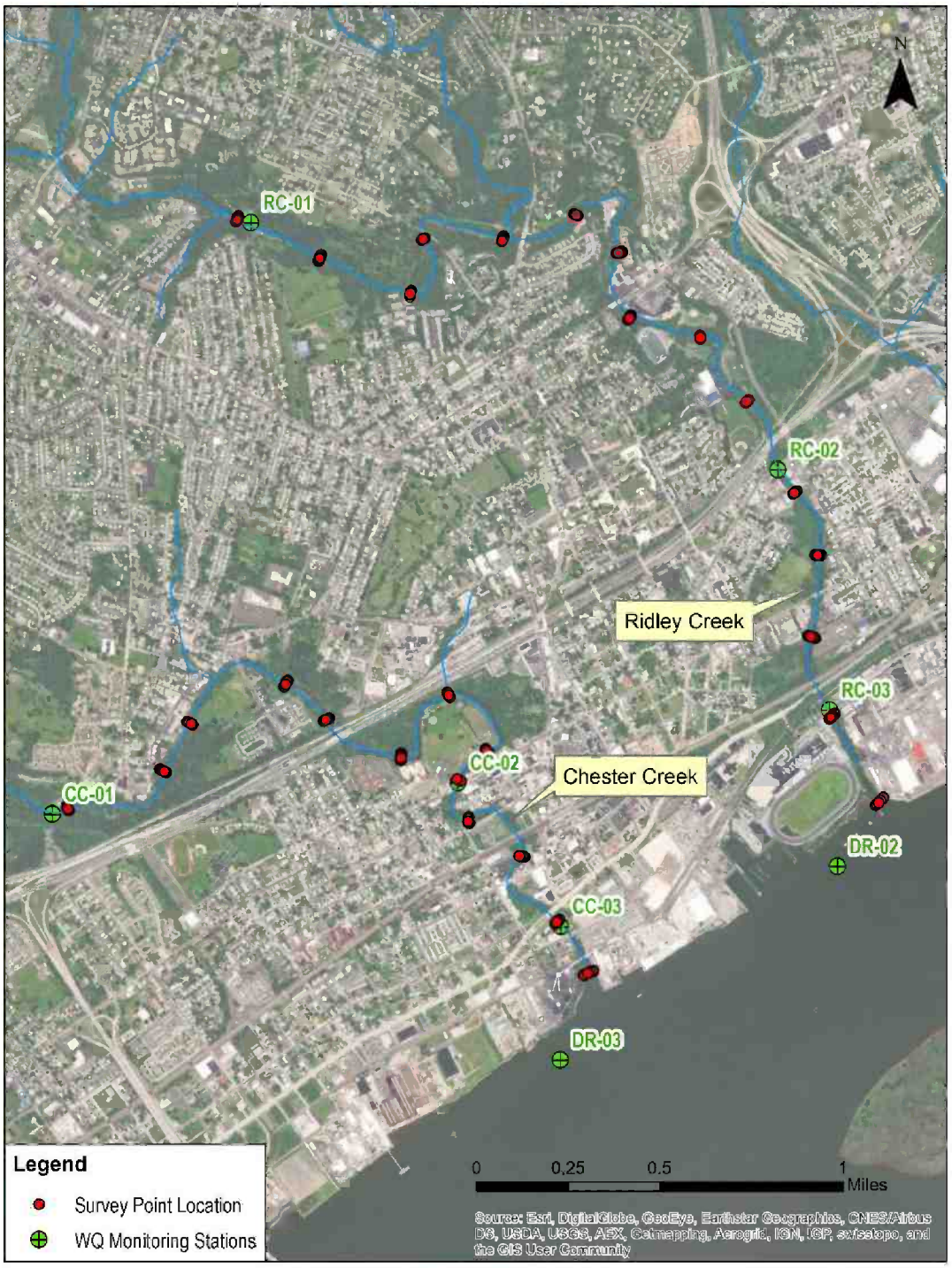
6.9.3 Receiving Water Use Designations and Applicable Water Quality Standards

Information about the water quality standards, the designated uses and the impairment status for the three receiving water bodies impacted by DELCORA's CSOs was obtained from the PADEP's 2014 Integrated Water Quality Monitoring and Assessment Report (or "303(d) list"), the Pennsylvania Code, the Delaware River Basin Commission's (DRBC's) Water Quality Regulations (WQRs) and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment (DRBC, 2014). This information is presented in **Section 2** of this LTCPU.

6.10 Summary of the Identified POCs for each Receiving Water

The determination of the Pollutants of Concern for each of DELCORA's three receiving water bodies occurred as part of the development of the *Identification of Sensitive Areas and Pollutants of Concern Report* and this information was also summarized as part of the *Existing Service Area Characterization Report*. The methodology used for determining the POCs and the POCs that were identified are detailed in **Subsection 2.5** of this LTCPU.

Figure 6-7: Locations of Elevation Measurements in Chester and Ridley Creeks



6.11 Summary of Sensitive and Priority Areas

The determination of the Sensitive Areas for DELCORA's receiving water bodies occurred in the development of the *Identification of Sensitive Areas and Pollutants of Concern Report,* and this information was also summarized as part of the *Existing Service Area Characterization Report*. The methodology used and the identified Sensitive Areas are detailed in **Subsection 2.3** of this LTCPU report.

6.12 Collection of Water Quality Data

The *Existing Service Area Characterization Report* included information about DELCORA's Water Quality Monitoring Program and included water quality data collected from DELCORA's CSO discharges, storm water discharges, and from the three receiving waters. This information is presented within this LTCPU report within **Section 5 - Water Quality Monitoring and Modeling**.

6.13 Typical Hydrologic Period

The *Existing Service Area Characterization Report* included information describing DELCORA's statistical evaluation of long-term local rainfall patterns and the identification of an appropriate Typical Hydrologic Period for LTCPU development purposes. This information had been summarized from the previously submitted *Typical Hydrologic Period Report* (Greeley and Hansen, 2016a), which was approved by PADEP and USEPA on May 23, 2016. The details of the determination of the Typical Hydrologic Period (1994 through 1996) are presented within this report in **Section 3 - Typical Hydrologic Period**.

6.14 Hydrologic and Hydraulic Modeling

The *Existing Service Area Characterization Report* also included information describing the development and application of the Hydrologic and Hydraulic Model for DELCORA's combined sewer system, which was used to help identify and evaluate the range of potential water pollution/control alternatives. Information regarding the development and application of the H&H Model is presented within this report in **Section 4 - Sewer System Hydrologic and Hydraulic Model Update and Calibration**.

The Sewer System Hydrologic and Hydraulic (H&H) Model Report was submitted to USEPA and PADEP on June 30, 2017, as was approved on April 17, 2018 after DELCORA responded to comments received on January 2, 2018. The approved report is included in **Appendix F**. It is to be noted that the H&H model was updated and recalibrated after the June 2017 submission as a result of receiving additional monitoring data, pump station operation data, and sewer system characteristics data. The H&H Model Calibration and Validation Results (updated July 2018) are provided in **Appendix T**. The baseline number of overflows by regulator and regulator overflow volumes predicted by the final version of the H&H model used for this LTCPU are summarized in **Table 9-3** and **Table 9-4**, respectively.

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Section 7 Public Participation

DELCORA's Public Participation Plan (PPP) was developed to employ an on-going public participation process that actively involves the public by informing and soliciting input from stakeholders, including the public, customer communities and regulatory agencies as the LTCPU is developed and implemented and to meet the requirements of the USEPA's CSO Policy and DELCORA's Consent Decree.

7.1 Expectations of the CSO Policy

The goals of the PPP during the development of the CSO LTCPU included addressing the specific requirements of the United States Environmental Protection Agency Combined Sewer Overflow Control Policy (dated April 19, 1994) by:

> *"employing a process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons."*

Additionally, in accordance with Section V.A.17 of the Consent Decree between the United States of America, the Commonwealth of Pennsylvania, Department of Environmental Protection, and DELCORA, (lodged on August 17, 2015) the PPP "*shall describe in detail how DELCORA will inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The plan shall specifically describe how the LTCP update process will:*

> *(i) address the impact of DELCORA's CSOs and LTCP on environmental justice populations,*
> *(ii) seek input from communities that may have historically borne a disproportionate share of the negative environmental consequences resulting from DELCORA's CSOs, and*
> *(iii) ensure that the LTCP and selected CSO Control Measures will not impose a disproportionate share of negative environmental consequences on such communities in the future.*
>
> *The plan shall also include a schedule for DELCORA's implementation of the plan."*

The USEPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan* indicates that public participation and Agency interactions should occur at the following steps of the LTCP development process:

1. System Characterization
2. Development and Evaluation of Alternatives for CSO Controls
3. Selection and Implementation of the Long-Term Plan

The PPP has been developed to actively involve the affected public in each of the above steps via Public Participation Meetings and other methods as further described in the herein and in the PPP. In addition to these minimum requirements, one additional Public Participation Meeting will be considered prior to the required meetings (listed above) to inform the public early in the planning process about the scope and goals of the program.

The PPP was implemented to address the above requirements of the CSO Control Policy, Section V.A.17 of the Consent Decree, and the USEPA's CSO Guidance for LTCP Document. DELCORA submitted the PPP to the USEPA and PADEP on October 21, 2015, within three months of the lodging of the Consent Decree meeting the first step of the Consent Decree Public Participation requirements. The final PPP was approved by the USEPA and PADEP on April 28, 2016 and is included in **Appendix L** of this report.

7.2 Public Meetings and Engagement Tools

The main objective of the public meetings and the engagement tools that were implemented under the PPP was to foster public awareness and actively facilitate public involvement by taking into consideration public input during the decision making process and selection of the final long term CSO controls. Public engagement was encouraged and accomplished during each public meeting by incorporating a Questions and Answer session at the end of every meeting.

7.3 Meeting Schedule

Public meetings were held over the course of the LTCPU development effort to inform and actively solicit input to its LTCPU from stakeholders, including the public, customer communities, and the regulatory agencies. The LTCPU meeting subject and actual meeting dates are noted in **Table 7-1**.

7.3.1 Inputs During the Public Participation Process

Four public meetings were planned and implemented at different steps in the development of the DELCORA CSO LTCPU as recommended by the CSO Guidance Document. In summary, the Public Participation Meetings that were held are as noted in **Table 7-1** below including the meeting dates, topic and location:

Table 7-1: Public Meetings, Locations and Meeting Dates

Meeting No	Meeting Topic	Location	Meeting Dates
Meeting No. 1	Scope and Purpose of the Study	Chester City Hall	March 15, 2016
Meeting No. 2	System Characterization	Ridley Township Municipal Building	June 27, 2017
Meeting No. 3	Development and Evaluation of Alternatives for CSO Controls	Chester City Hall	December 5, 2017
Meeting No. 4	Selection and Implementation of the Long-Term Plan	Aston Township Administration Building	September 26, 2018

The location of the each meeting was different to provide opportunities throughout the DELCORA Service area for residents to attend.

7.3.2 Facilities Description and Location

The public meetings were held at different locations in order to maximize the likelihood of attendance and participation from the residents and stakeholders with in the service area. The facilities were checked ahead of time and had ample meeting space. These locations serve a vital role in Delaware County as

central meeting places and serve as gathering places for the local community as well as for the hosting of numerous public events, including public information meetings.

7.3.3 Responsiveness Summary

Each public meeting provided an opportunity for the public to be activity involved in the decision – making process to select the LTCPU CSO controls. By informing the public early in the planning process about the scope and goals of the program and continuing public involvement conflicts could be identified and address more expeditiously. Each Public Meeting included a presentation of status of the LTCPU and an update from the previous meeting. Questions from the public were taken during the presentation and at the end of the presentation for each meeting. Responses to each comment or question was provided during the meetings. A 30-day period after each meeting was allowed for questions and comments to be mailed to DELCORA.

At the beginning of each meeting a Public Comment Form was handed out to attendees allowing them to submit questions or comments in writing. Comment Forms could be handed in at the end of the meeting or mailed to DELCORA. After each Public Meeting a Responsiveness Summary was prepared to memorialize all comments; statements and questions raised by the public during the meeting.

A final copy of the Meeting presentation and responsiveness summary was placed on DELCORA's CSO LTCPU website. In addition, the responsiveness summary was also made available at each offline repository location.

7.3.4 Public Engagement Tools

The public engagement program was developed in collaboration with DELCORA and the Engineering and Program Management Consultant. This program included multiple tools nested in primarily the two following strategies:

1. Direct Engagement Strategy: This strategy was implemented at the Public Meetings, as well as the Stakeholder Meetings, and addressed the complex issues of the LTCPU program by providing an opportunity for public participation that is active, interactive, and encourages people to provide ideas and comments and continue to learn about DELCORA's CSO LTCPU program and its objectives. Poster boards were displayed at each meeting to encourage discussion during the presentation for a better understanding of the DELCORA system.

2. Digital Engagement Strategy: This strategy actively engaged the public in providing feedback and comments through the use of digital technology on the DELCORA CSO Website.

The two strategies listed above are detailed further in the approved PPP.

7.3.5 Public Meeting Descriptions

Four public engagement meetings were held over the duration of 42 months of the development of the updated Long-Term Control Plan Update. Meetings were developed to sync with the needs on the development of the LTCPU and informing those that are affected by the strategies implemented for the selection of CSO control alternatives. Each public meeting consisted of a presentation to the public that

included elements of the following topics suggested by the USEPA's *Combined Sewer Overflows Guidance for Long-Term Control Plan*:

1. System Characterization
2. Development and Evaluation of Alternatives for CSO Controls
3. Selection and Implementation of the Long-Term Control Plan

At each public meeting copies of the meeting presentation were made available as a handout to the public in attendance. The public meeting presentations were provided as requested to other listed stakeholders (as discussed in Section 3) and posted on the website. Meeting notes were drafted after each public meeting memorializing the proceedings and public questions. See **Appendix M** for Public Meeting Nos. 1, 2, 3 and 4 meeting notes, sign-in sheet, presentation and list of public comments with responses.

The first public meeting was used to brief the public on the history, scope and purpose of the study and to obtain their general views on the study. At this meeting a general presentation with information on DELCORA and its CSO LTCPU program was given to the public.

The second public meeting focused on updating the public on the scope of activities that make up the system characterization, the analysis of existing data and development of the monitoring and modeling programs, the identification and status of implementation of the Nine Minimum Controls, and the process for evaluating alternative CSO controls. **Figure 7-1** provides a photograph of the 2nd Public Meeting. DELCORA and the Engineering and Program Management Consultant provided a Powerpoint presentation with hand-outs to the public for the following information:

- Scope of monitoring and assessment programs for system characterization
- The watershed approach to CSO control planning
- Identification of watersheds in the CSO area
- Identification and quantification of non-CSO sources
- Existing sewer system conditions and problems (e.g., flooding, basement backups)
- Quantification of CSO flows and loads and impacts of CSOs on receiving waters
- Results of CSS and receiving water monitoring programs
- Development and calibration of the CSS and receiving water models
- Identification and implementation status of the NMC
- Process for evaluating CSO control alternatives

There were approximately 7 individuals from the public in attendance for the 2nd Public Meeting. During the second public meeting a question was asked relating to CSOs near the Flower Street Boat Ramp located in Chester near the new Soccer Stadium. DELCORA considered and has addressed this concern through a selection of alternatives that will provide significate CSOs reduction at each regulator upstream and downstream of the boat ramp area.

Figure 7-1: Photographs of Public Meeting Nos. 2 and 3

The goals of the third public meeting was to actively involve the public in the development of the alternative solutions to protect the receiving streams, as well as to consider the financial impacts to the community as a whole. Any suggestions, comments and financial impacts to the community were considered. **Figure 7-1** provides a photograph of the 3rd Public Meeting. The following key information was presented to the public during this meeting:

- Water quality goals for each receiving water segment
- CSO control goals for each receiving water segment as developed under the Presumption and/or Demonstration approach options
- Types of control alternatives available to meet CSO control goals
- CSO control alternatives identified to meet the control goals
- Process of evaluating and comparing various alternatives for CSO control

During the CSO control measures evaluation stage, alternative measures to reduce the impact of CSO discharges typically fall into one of the following four categories:

1. Source Control Technologies/Alternatives - eliminating or preventing pollution before it is created.
2. Collection System Control Reducing Technologies/Alternatives – reducing the discharge volume, concentration, or frequency.
3. Storage Technologies/Alternatives - capturing all or some of the discharge and then releasing it for treatment.
4. Treatment Technologies/Alternatives - treating as much as possible.

As part of the 3rd public meeting participation process, various CSO control measures investigated through engineering analysis were presented by the LTCPU Engineering Consultant and DELCORA. Some of the major CSO mitigation measures that were considered are listed below:

- Capacity Recovery in the existing CSS
- CSO Regulator Improvement Program
- Sewer System Cleaning/Flushing to avoid backups

- Sewer/ CSO Regulator replacement
- Tide Gate Maintenance or replacement
- Reduction of fats, oil and grease (FOG) in the sewers
- Outfall Maintenance Program;
- Private Property Inflow and Infiltration Elimination
- Outfall Combined Wastewater Diversion and Separation
- Outfall Consolidation, Relocation, or Elimination
- Additional Conveyance Systems
- Inlet Replacement Program
- Downspout Disconnect Program

There were approximately 35 individuals from the public in attendance for the 3rd Public Meeting. A major focus of the public concern, questions and discussion for the third public meeting revolved around the Chester Stormwater Authority. Many individuals at the meeting were concerned that a new Chester Stormwater Authority was formed imposing a separate stormwater fee on the resident of Chester. However they saw this authority as a duplication of effort of DELCORA responsibility. The City of Chester was present and the city engineer clarified the responsibility of the City of Chester relating to the Municipality MS4 area of Chester.

The fourth public meeting was held to discuss and present progress on the development and selection of the alternatives for implementation of the Long-Term Plan Update. The alternatives were evaluated in detail and prior to selection of specific CSO controls. The fourth meeting was held to inform the public of each CSO control alternative and ranking based on Knee-of-the-Curve (KOC) analysis. **Figure 7-2** provides photographs of the 4th Public Meeting. The fourth Public was originally advertised as starting at 6:00 however the start time had to be adjusted to 5:00 PM. The following key informational items were presented to the public during the 4th Public Meeting:

- LTCPU Completed Early Action Items and System Improvements to Date
- Review of National CSO Policy Requirements for the Alternative Analysis
- LTCPU Alternative Analysis
- "Knee-of-the-Curve" Analysis and the Recommended Plan for the Selected Alternative
- LTCPU Implementation Schedule and Milestones

There were no individuals from the public in attendance for the 4th Public Meeting. However there were two consultants that arrived after meeting adjournment. They indicated that the LTCPU website showed that the meeting started at 6:00 PM. DELCORA met separately with the two consultants on November 1, 2018 and provided a hardcopy of the Public Meeting No. 4 presentation and handout materials and reviewed the materials with them. They had no questions or feedback that would influence the LTCPU. They signed the meeting sign-in sheet, see Appendix M.

A Public Briefing Document was posted on the website and delivered to the repositories 2 weeks before the 4th Public Meeting. The Public Briefing Document summarized the DELCORA Recommended Long-Term Control Plan to address Combined Sewer Overflows in Chester, Pennsylvania where necessary. Also covered in the summary were the following key issues: (1) an overview of the DELCORA System and Wet Weather Issues, (2) a summary of progress to date, (3) response to public comments to date, (4)

review of sensitive areas, (5) the range of alternatives considered, (6) DELCORA's recommended overflow control plan, (7) the implementation schedule and, (8) post construction monitoring of the overflow control program.

Figure 7-2: Photographs of Public Meeting No. 4

7.3.6 Meeting Advertisements

To meet the requirements of Pennsylvania's Sunshine Act (see the PPP in **Appendix L**), DELCORA provided public notice of its meetings not less than three days in advance of the meeting and gave the schedule for each of the remaining meetings during the first meeting presentation.

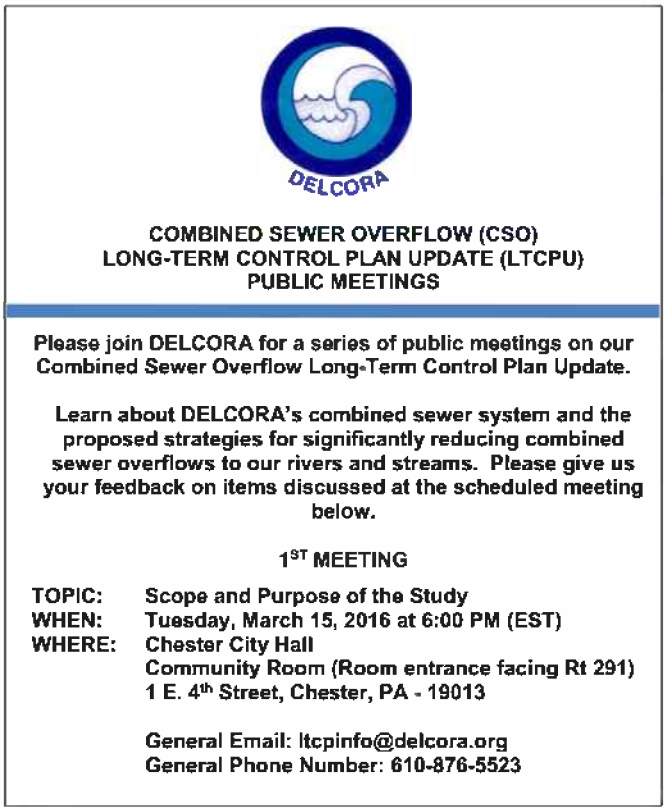
In accordance with the Sunshine Act, DELCORA invited the public to participate in the LTCPU meetings by placing an advertisement indicating place, date and time in the following four local newspapers or circulations and by also posting the notice on DELCORA's CSO LTCPU website in advance.

1. Chester Spirit
2. Delaware County Daily Times
3. Philadelphia Inquirer
4. Press Newspaper

Figure 7-3 presents an example of the LTCPU public meeting advertisement. This notice was for the first LTCPU Public Meeting. The other public meeting advertisements were similar.

DELCORA also provided public notice of any special meeting or rescheduled meeting at least 24 hours in advance of the time of the convening of the meeting specified in the notice.

Figure 7-3: Advertisement for the First Public Meeting



7.4 Stakeholder Members and Meetings

In addition to the Public Meetings and Engagement Tools described in **Subsection 7.2**, a group comprising of stakeholder members were formed for this PPP.

7.4.1 Selection of Members

To reflect a balance of perspectives, stakeholder members consisted of representatives from the public, customer communities, regulatory agencies, and special interest groups. The list of stakeholders considered by DELCORA is provided below.

1. Darby Creek Joint Authority
2. Central Delaware County Authority
3. Muckinipates Authority
4. Delaware River Basin Commission
5. Radnor, Haverford, Marple Authority
6. Southern Delaware County Authority
7. Southwest Delaware County Municipal Authority
8. Middletown Township Sewer Authority
9. Chester Environmental Partnership

10. Department of Environmental Protection - Southeast Regional Office
11. Delaware County Planning Department
12. State Elected Officials
13. Local Municipal Officials
14. National Association for the Advancement of Colored People (NAACP)
15. Chester City Council
16. Pennsylvania Resource Council
17. Chester, Ridley & Crum Creek Watershed Association
18. Chester Water Authority (CWA)
19. Delaware County Public Relations Department
20. Delaware Riverkeeper
21. PA Sea Grant
22. Delaware County Council
23. Delaware County Chamber of Commerce
24. Industrial Contributors
25. Chester Business Association
26. Chester Economic Development Authority
27. Stormwater Authority of Chester
28. Chester Stormwater Authority

7.4.2 Meeting Site Format and Time

Stakeholder Meetings convened in a meeting room at a predetermined and mutually agreed upon location. The location of the meetings were coordinated with the Stakeholder members. Some of these meetings were held at DELCORA's Western Regional Treatment Plant and at the DELCORA Municipal Building. DELCORA chaired each meeting and provided an update on the progress and status of current issues regarding the development of the LTCPU. Regular stakeholder meetings were held on an as-needed basis throughout the course of the LTCPU program. Some of the Stakeholders meetings that were held during 2015 and 2016 are listed in **Table 7-2** below:

Table 7-2: Stakeholders Meetings and Meeting Dates

Meeting Dates	Meeting Topic	Goal
September 24, 2015	Combined Sewer Overflow – Long Term Control Plan Update	Review requirements of new Consent Decree
March 8, 2016	Combined Sewer Overflow – Long Term Control Plan Update	Review of progress of the LTCPU

DELCORA has provided the stakeholders an active role and opportunity to provide comments at each meeting by encouraging questions and comments during each meeting and a questions and answer session at the end of each meeting. The stakeholders were able to receive updates of the LTCPU project by reviewing the DELCORA Website which posted project updates, USEPA / PADEP approved project reports and information. The CSO Website was noted at the end of each presentation. Educational material was also provided at meetings and reviewed during the meetings.

7.5 Public Information Plan

7.5.1 Notices and Advertisements

To encourage public awareness of, and involvement in the public meetings, notifications and background information was be made available to the public at least three days prior to each meeting as required by Pennsylvania's Sunshine Act. Access to public information will be provided as required by the Pennsylvania Right-to-Know Law Act 3 of 2008 (provided in the PPP).

Announcements were communicated to the public through the following media devices:

- Local Newspapers
- Internet Websites
- Notice by Mail

7.5.2 Public Education and Involvement

A concerted effort was made to make the public aware of the CSO LTCPU development process and to actively involve and educate them about CSO issues through the following media:

1. DELCORA Provided Updates and Educational Material in Sewer Bills

2. CSO Website: DELCORA created a special section of its Internet website devoted exclusively to CSO issues. This section of the website is called "Combined Sewer System". The website includes information on the nature of CSOs, maps showing the location of outfalls, descriptions of the LTCPU development process, CSO monitoring results, information on pollution prevention, ways in which the public can get involved, previous meeting responsiveness summaries, and an option to post comments or questions on the program. Notices for public meetings were also posted on the website. The website provided a means to sign up to receive any newsletters. A downloadable copy of the newsletter was uploaded to the CSO website as well.

3. CSO Newsletters Project updates have been sent out to the mailing list created through the first public meeting, as well as subsequent requests from the public and interested stakeholders.

4. Handouts

5. Literature and Documentation: Literature and documentation were also made available by DELCORA at the repository locations listed below. Documents on display for the public and included in the repositories included presentations, public meeting notes, billing insert newsletters, DELCORA's educational materials and documents that were distributed at the public meeting and reports that had received final approval from the USEPA and the PADEP. These can be found in **Appendix M.** Each repository included a Chain of Custody Form with a description of articles which were delivered to each repository.

Figure 7-4 shows an example of a chain of custody sheet for the J. Lewis Crozer Library. This custody sheet indicates the name, title and address of the authorized person from whom the documents could be received and the authorized person to receive. Each binder delivered had a unique binder number to be able to track and account for all documents delivered. Each binder also included a sign-in sheet which allows all those reviewing the DELCORA LTCPU documents to sign up for additional information. All of the documents which were posted in the repository binders were also made available on the DELCORA Web site.

DELCORA Administration Building
100 East Fifth Street
Chester, PA 19013

J. Lewis Crozer Library
620 Engle Street
Chester, PA 19013

Marcus Hook Municipal Building
1015 Green Street
Marcus Hook, PA 19061

Ridley Township Building
100 MacDade Blvd.
Folsom, PA 19033

Upland Borough Office
224 Castle Avenue
Brookhaven, PA 19015

Chester Township
1150 Engle Street
Chester, PA 19013

6. Presentations to Stakeholder Members

7.6 Public Participation Program Other Meetings

In addition to the above stated Public Participation Meetings, DELCORA has maintained a working relationship with the municipalities and authorities in its service area, and has made efforts to coordinate any improvements to the LTCPU with them. Most notably is the City of Chester, where the Combined Sewer System CSO outfalls are located. Chester City wanted to do more regarding stormwater runoff, and developed the Stormwater Authority of Chester (also known as SAC) to coordinate these efforts with DELCORA, especially in the combined sewer areas. Chester City also hired a sub consultant, Corvias, to develop green infrastructure in the areas of the city where DELCORA could use the technology most. These entities have also held public meetings to gather public feedback and are able to communicate effectively with DELCORA in any areas of mutual concern. The support of these entities is instrumental to incorporating the LTCPU effectively.

Figure 7-4: Chain-of-Custody Form

DELAWARE COUNTY REGIONAL
WATER QUALITY CONTROL AUTHORITY
Long-Term Control Plan Update

Public Participation Off-Line Repository
Chain-of-Custody Form
(Revised 2/14/17)

EVIDENCE/PROPERTY CUSTODY	BINDER NUMBERS	
Evidence of Public Input Solicitation	DEL-05, VOLUMES 1, 2 OF 2	
NAME OF RECIPIENT FACILITY J. Lewis Crozer Library	**LOCATION** 620 Engle Street; Chester, PA 19013	
NAME, TITLE AND CONTACT NUMBER OF PERSON FROM WHOM RECEIVED Lindsey Isler, Controller Assistant	**ADDRESS** 100 E. Fifth Street Chester PA 19013	
LOCATION FROM WHERE OBTAINED DELCORA	**REASON OBTAINED** Public Participation	**DATE/TIME OBTAINED**

ITEM NO	DESCRIPTION OF ARTICLES – VOLUME 1	
1	Signed Chain-of-Custody Form	June 21, 2016
2	List of Offline Repository Documents	June 2, 2016
3	DELCORA Contact Information	June 2, 2016
4	Long Term Control Plan Update (LTCPU) Glossy of Terms	June 2, 2016
5	Public Meeting No. 1 – LTCPU Scope and Purpose - Notes - Presentation - Responses to Public Comments	March 15, 2016
6	DELCORA Newsletter	January 2016
7	DELCORA Education Materials - DELCORA CSO Long-Term Control Plan – Plan Update - Stop Sewer Back-Ups - Sanitary Sewer Overflows - Fat-Free Sewers - Drug-Free Drains - Disconnecting & Redirecting Your Sump Pump & Downspouts	 2011 2004 2006 1999 June 2008
8	LTCPU Project Schedule	June 1, 2016
9	Typical Hydrologic Period Report (Final)	November 2015 (Updated April 2016)
10	Hydrologic and Hydraulic Model Report	October 2015
11	Public Participation Plan Report	October 2015 (Updated April 2016)
12	USEPA Semi-Annual Report	December 2015
13	**USEPA Semi-Annual Report No. 2 (January 1, 2016-June 30, 2016)**	**June 30, 2016**
14	**Rainfall and Flow Monitoring Quarterly Report No. 1**	**July 2016**
15	**Alternatives Evaluation Approach Report (Final)**	**April 2016**
16	**Identification of Sensitive Areas and Pollutants of Concern Report (Final)**	**February 2016 (May 2016)**
ITEM NO	**DESCRIPTION OF ARTICLES – VOLUME 2**	
17	**Rainfall and Flow Monitoring Quarterly Report No. 2**	**October 2016**
18	**USEPA Semi-Annual Report No. 3 (July 1, 2016-December 30, 2016)**	**December 2016**
19	**Newsletter**	**January 2017**

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Section 8 Preliminary Screening of CSO Control Technologies

8.1 Introduction

This section describes how DELCORA assessed the technical feasibility of the use of a wide range of demonstrated CSO Control Technologies to address the requirements of the Consent Decree, which states the following according to Paragraph V.A.19.a (Screening of Available CSO Control Technologies):

> *"DELCORA shall assess the technical feasibility of the use of a wide range of demonstrated CSO control technologies. DELCORA shall provide descriptions of the following types of CSO control technology – Source Controls, Collection System Controls, Storage Technologies and Treatment Technologies – and an assessment of the feasibility of applying each technology type for long-term CSO control in the Model Area, based on existing and anticipated future conditions affecting the Model Area. This evaluation is not intended to consider cost or cost effectiveness, but rather to exclude control technologies that are not technically or physically applicable to the Model Area. Partial and complete separation of sewers in each CSO Outfall tributary area, and deep tunnel storage, shall be considered feasible technologies for this purpose and be carried forward for further evaluation. Expansion of the primary and secondary capacity of the WRTP shall also be considered feasible technologies for this purpose and be forward for further evaluation, as required by Section II.C.4 of the CSO Control Policy".*

A range of CSO Control Technologies has been identified and categorized into four categories: Source Controls, Collection System Controls, Storage Technologies, and Treatment Technologies. The Technologies were then assessed for their impact on reducing bacterial and volume loading from CSO outfalls. Any technology thought to be a significant contributor to either of these requirements was recommended for further evaluation. The Consent Decree lists required Technologies for evaluation, and includes sewer separation, tunnels, plant expansion, and green infrastructure. Appropriate combinations of these technologies have been determined in the Alternatives Evaluation to meet the requirements of the Consent Decree, which states the following (Paragraph V.A.19):

> *"DELCORA shall carry out and include in the LTCP an Alternatives Evaluation that complies with the requirements of the CSO Control Policy Section II.C.4, and that is consistent with EPA's "Guidance for Long-Term Control Plan," EPA 832-B-95-002,September 1995. The Alternatives Evaluation shall consist of: (1) a technology screening process, (2) a detailed evaluation of specific CSO control alternatives, and (3) selection of an appropriate range of proposed CSO controls to achieve compliance with the Clean Water Act. DELCORA shall specifically evaluate the feasibility of eliminating or relocating all CSO Outfalls that discharge to Sensitive Areas. DELCORA shall give a high priority to the control of those CSO Outfalls that discharge to Priority Areas, and those that have the highest frequency or greatest volume of discharge of wastewater."*

8.2 Long Term Control Plan Approach

USEPA CSO control guidance calls for the identification of alternatives through brainstorming, preliminary screening of alternatives, and the selection of alternatives for further evaluation. As discussed above, the Consent Decree also requires the evaluation of specific technologies. In addition to the specific technologies called for in the Consent Decree, alternative technologies are developed and screened and brainstormed alternatives are developed and evaluated as called for in Subsection 3.3.1.3 of the CSO Guidance Document (Creative Thinking):

> *"The initial identification of alternatives should involve some degree of brainstorming and free thinking. CSO control can be a challenging problem, where lack of available sites, potential impacts on sensitive receptors, and stringent water quality goals are common issues. The CSO Control Policy encourages 'Permittees and permitting authorities...to consider innovative and alternative approaches and technologies that achieve the objectives of this policy and the CWA.'"*

Subsection 1.1.3 (Regulatory Requirements) of this report describes that the Presumption approach will be used for the development of the LTCPU. The criteria being used in this analysis is achieving the 85% capture by volume. This will be met by looking at two different approaches: the Consent Decree requirements and a more targeted CSO specific approach.

With regard to the Consent Decree requirements, as previously stated, Paragraph V.A.19.a (Screening of Available CSO Control Technologies) describes the overall Control Technologies to be analyzed, which consist of partial and complete separation of sewers in each CSO Outfall tributary area, deep tunnel storage, green infrastructure, and expansion of the primary and secondary capacity of the WRTP. This essentially is a more global approach to analyzing Alternatives as opposed to a more targeted approach, which looks at specific CSOs based on number of overflows and pollutant loading. The targeted CSO specific approach is designed to get to 85% overall capture by volume, whereas the global approach may obtain a higher percent volume capture and overshoot the targeted 85%, thereby making it less cost effective. These two approaches will be looked at further in **Subsection 9.3.1** and **9.3.2**. For the purposes of the preliminary siting of Control Alternatives being discussed in this Section, the specific approach being utilized going forward in the Analysis does not impact this exercise.

8.3 Water Quality and CSO Control Goals

With respect to water quality, control technologies are screened for their effectiveness on addressing the pollutants of concern and CSO control goals to achieve compliance with the CWA, including:

- Reducing the count of fecal coliform colonies
- Reducing the count of Enterococcus colonies
- Reducing the count of Escherichia coli colonies
- CSO discharge volume reduction.

The bacteria above have been identified as POCS and .exceeding the maximum water quality standards and **Table** 8-1 contains the concentrations approved by the USEPA in the *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016).

Table 8-1: Water Quality Standards in the Receiving Streams

Pollutant of Concern	Protected Water Use	Primary Contact	Secondary Contact
Fecal Coliform	200/400/200 #/100 mL[1]	200 #/100 mL	770 #/100 mL
Enterococcus	---	33 #/100 mL	88 #/100 mL
E. Coli	126/410 #/100 mL[2]	126/410 #/100 mL[2]	---

[1] First value is a geometric mean standard, second is a statistical threshold value standard (no more than 10% of concentrations can be above this value), third value is a non-recreational season standard (Oct 1- Apr 31).
[2] E. coli standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.H. 81.8., during recreational months only (May 1 - Sep 30). First value is a geometric mean standard, second is a statistical threshold value standard (no more than 10% of concentrations can be above this value).

For addressing the CSO discharge volume reduction, **Table 8-2** presents the baseline existing percent system wide capture during wet weather events by the receiving waterbody, based on EPA-SWMM modeling of regulator overflows.

Table 8-2: Existing Conditions Percent Capture

Percent Capture by Segment			Total Percent Capture
Delaware River	Ridley Creek	Chester Creek	
81.7%	74.5%	89.5%	82.3%

An arbitrary example of the discharge volumes necessary to achieve 85% overall capture was generated from the EPA-SWMM baseline model. These values are presented in **Table 8-3** below. These volume capture amounts can be adjusted by segment to get an end calculation of 85% overall volume capture. The sum if these values is the average amount of overflow that must be captured during wet weather events per year to meet 85% system wide capture. A more in-depth analysis with regard to these capture goals is presented in Section 9 of this LTCPU.

Table 8-3: Capture Goals for LTCPU Compliance – Percent Capture

Target Capture Volume by Segment (MG)			Total Percent Capture
Delaware River	Ridley Creek	Chester Creek	
21.23	7.79	6.51	85.0%

The goals above serve as an initial roadmap to look at how to narrow down to the best Control Technologies for utilization during the Alternatives Analysis. The following subsection describes the process by which the preliminary screening of CSO Control Technologies was completed.

8.4 Development of CSO Control Technologies

To determine the appropriate CSO Control Technologies, a preliminary comprehensive review of combined sewer overflow technologies was completed in order to determine those that have the greatest potential to help DELCORA meet the requirements of the USEPA Consent Decree. Per the DELCORA Consent Decree, DELCORA shall carry out and include in the LTCPU an Alternative Evaluation that complies with the requirements of the CSO Control Policy Section II.C.4 and that is consistent with the USEPA's "Guidance for Long-Term Control Plan." The Alternatives Evaluation will consist of:

- Technology screening process
- Evaluation of specific CSO Control Alternatives
- Selection of a range of CSO controls to achieve CWA compliance

The evaluation does not consider cost or cost effectiveness and is only meant to exclude CSO Control Technologies that are not technically or physically applicable to the Model Area. The results of this screening have brought several CSO Control Technologies forward for more detailed consideration in the final Evaluation and Selection of CSO Control Alternatives.

8.4.1 Evaluation Methodology Used for This Study

The CSO Control Technologies evaluated have been assigned a value based on their effectiveness at reaching primary and secondary CSO control goals. Descriptions of the goal effectiveness categories are detailed below:

- High: The CSO Control Technology will have a significant impact on this CSO control goal and is among the best technologies available to achieve that goal. These technologies may be considered for further evaluation for this reason.
- Medium: This technology is effective at achieving the CSO control goal but is not considered among the most effective technologies to achieve that goal.
- Low: This technology will have a minor impact on this CSO control goal. These technologies will need other positive attributes to be considered for further evaluation.
- None: The CSO Control Technology will have zero or negative effect on the CSO control goals.

CSO Control Technologies are recommended for further evaluation based on multiple factors. The first factor is the goal-effectiveness value that generally quantifies the impact a technology will have towards achieving a water quality goal. The second factor is whether or not the DELCORA Consent Decree requires further investigation of a Technology. The third and final factor in determining whether a technology was evaluated further are current or future implementation and operation. If the technology is already currently in place, will be in place, or is mandated to be in place by the Nine Minimum Controls, then an evaluation was unnecessary. The tables at the end of the section contain a brief description of the implementation and operation factors for each technology, and those highlighted in green are recommended for further evaluation. A CSO technology that is considered to have a "high" effectiveness in one or all evaluation factors will likely be recommended for further evaluation. A CSO technology that does not reach at least a "medium" effectiveness rating for bacteria or volume reduction will not be recommended.

8.4.2 Identification of Potential Control Technologies

In order to develop the most effective solution to help DELCORA meet EPA requirements, a wide variety of CSO control technologies were identified from past projects and research into emerging technologies. Potential CSO control technologies generally fall into the following broad categories:

- Source Controls (Green Infrastructure): Public and private Infiltration and Inflow (I/I) reduction and removal; sewer separation; best management practices (BMPs)/Nine Minimum Controls including floatables control.
- Collection System Controls: Gravity sewers; pump stations; hydraulic relief structures; in-line storage; outfall relocation/consolidation; and regulator/diversion structure modification
- Storage Technologies: Above and below ground tanks; and tunnels
- Treatment Technologies: Screening and disinfection; vortex separation; retention/treatment basins; high rate clarification; and satellite sewage treatment

In order to develop the most effective solution to help DELCORA meet EPA requirements, a wide variety of CSO Control Technologies were identified from past projects and research into emerging technologies. The following subsections give a more detailed breakdown of each of these technologies that were chosen out of the preliminary screening that was completed. Summary tables containing the control technologies discussed are located near the end of each subsection, with the recommended technologies highlighted in green in the tables. All recommended CSO Control Technologies are listed in **Table 8-7** at the end of this section.

8.5 Source Controls

EPA defines source controls as those that impact the quality or quantity of runoff entering the combined sewer system. Source control measures can reduce volumes, peak flows, or pollutant discharges that may decrease the need for more capital-intensive technologies downstream in the CSS. However, source controls typically require a high level of effort to implement on a scale that can achieve a measureable impact. A summary of select Source Control Technologies can be found described in the following subsections along with a full list presented in **Table 8-4**.

8.5.1 Green Infrastructure

Green infrastructure (GI) is a source control that reduces runoff volumes, peak flows, and/or pollutant loads. According to the Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow Control, GI utilizes the processes of infiltration, evapotranspiration, and capture for re-use to reduce the amount of runoff volume (USEPA, 2014). It is effective at increasing the time of concentration of remaining runoff and reducing pollutant loads through sedimentation and filtration. This technology can be used alone in a scalable manner, or it can be used in conjunction with gray infrastructure using traditional materials like concrete and steel, to reduce its size and cost.

GI's benefits extend beyond reducing the flow of water into CSSs during wet weather events. Through mimicking a more naturalized system, GI can deliver a broad range of ecosystem services or benefits to people, some of which include: improved community livability (aesthetics and property values), human health, air quality, water quality, groundwater recharge, wildlife habitats and connectivity, reduced heat island effects, reduced energy use, green jobs, and recreational opportunities (USEPA, 2014). It can also help reduce flooding and is flexible for addressing Climate Change (droughts or increased precipitation).

As described in *Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control* (USEPA, 2014), the USEPA requires that any incorporation of GI into a LTCP include analysis in two areas:

1. Community and political support for GI
2. Realistic potential for GI implementation

DELCORA assessed the public support from stakeholders in the community and government for the GI alternatives through the implementation of the LTCPU Public Participation Plan. The practical potential implementation for these technologies was evaluated by in Green Storm Water Infrastructure Evaluation in **Appendix N**.

There are a wide range of potential GI technologies currently in use throughout the country, and many of these include numerous design variations incorporated into a variety of documents and design manuals. Corvias Group, LLC has joined DELCORA to help assess GI and feasible locations for their implementation. The intent of this section is to summarize important aspects of the relevant practices, rather than to provide a comprehensive catalog or detailed design documents.

In addition, there are watershed-scale GI options that are not appropriate for DELCORA due to the relatively small size and highly urbanized nature of the CSS area. These include land conservation efforts and creation, preservation, or restoration of riparian buffers, floodplains, wetlands, open space, and forests. These GI options should be encouraged when land use can easily be converted for this intention, but this report will not consider these technologies to reduce runoff volume and bacterial loading.
With the above considerations in mind, feasible and appropriate GI technologies were evaluated for implementation in the following areas for publicly owned property:

- Buildings
- Impervious Areas
- Pervious Areas

8.5.2 Green Roofs

Green roofs have bioretention media that collect runoff to promote evapotranspiration and achieve water quality standards through soil media filtration. They are typically shallow in depth (4-8") based on the ability of the building to support the weight of the media, plantings, and captured rainfall. Green roofs may be built in layers on a roof or installed as cells in crates. An example green roof section can be found in **Figure 8-1**.

Figure 8-1: Example Green Roof Section

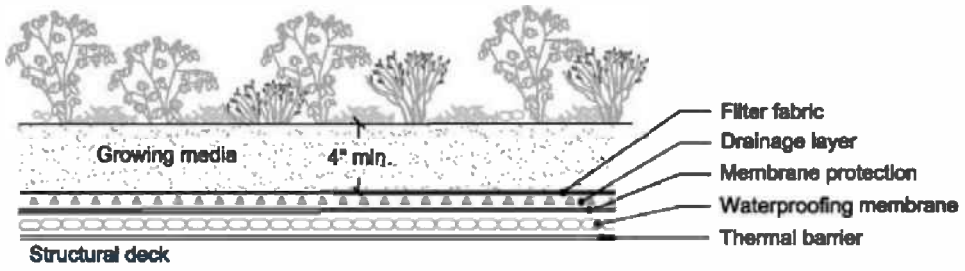


Table 8-4: Source Control Alternatives

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
Stormwater Management	Street/Parking Lot Storage (Catch Basin Control)	Low	Low	Flow restrictions to the CSS can cause flooding in lots, yards and buildings; potential for freezing in lots; low operational cost. Effective at reducing peak flows during wet weather events but can cause dangerous conditions for the public if pedestrian areas freeze during flooding.	No	No	No
	Catch Basin Modification (for Floatables Control)	Low	None	Requires periodic catch basin cleaning; requires suitable catch basin configuration; potential for street flooding and increased maintenance efforts. Reduces debris and floatables that can cause operational problems with the mechanical regulators.	No	No	No
	Catch Basin Modification (Leaching)	Low	Low	Can be installed in new developments or used as replacements for existing catch basins. Require similar maintenance as traditional catch basins. Leaching catch basins have minor effects on the primary CSO control goals.	No	No	No
Public Education and Outreach	Water Conservation	None	Low	Chester Water Authority is responsible for the water system and all related programs in the City of Chester. However, water conservation is a common topic for public education programs. Water conservation can reduce CSO discharge volume but would have little impact on peak flows.	No	Yes	No
	Catch Basin Stenciling	None	None	Inexpensive; easy to implement; public education. Is only as effective as the public's acceptance and understanding of the message. Public outreach programs would have a more effective result.	No	Yes	No
	Community Cleanup Programs	None	None	Inexpensive; sense of community ownership; educational BMP; aesthetic enhancement. Community cleanups are inexpensive and build ownership in the city.	No	Yes	No
	Public Outreach Programs	Low	None	DELCORA has an ongoing public education program. DELCORA should continue its public education program as control measures demonstrate implementation of the NMC.	Yes	Yes	No
	FOG Program	Low	None	Requires communication with business owners; City of Chester has no enforcement authority. Reduces buildup and maintains flow capacity. Only as effective as business owner cooperation	No	Yes	No
	Garbage Disposal Restriction	Low	None	The City of Chester is responsible for Garbage Disposal. This requires an increased allocation of resources for enforcement while providing very little reduction to wet weather CSO events.	No	Yes	No
	Pet Waste Management	Medium	None	Low cost of implementation and little to no maintenance. This is a low cost technology that can significantly reduce bacteria loading in wet weather CSO's.	No	Yes	No

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
	Lawn and Garden Maintenance	Low	Low	Requires communication with business and homeowners. Guidelines are already established per USEPA. Educating the public on proper lawn and garden treatment protocols developed by USEPA will reduce waterway contamination. Since this information is already available to the public it is unlikely to have a significant effect on improving water quality.	No	Yes	No
	Hazardous Waste Collection	Low	None	Ongoing Industrial Users (IUs) program prohibits the discharge of hazardous waste to the collection system; Delaware County sponsors four household hazardous waste events annually.	Yes	Yes	No
	Construction Site Erosion & Sediment Control	None	None	In building code; Reduces silt loads to waterways; DELCORA has no enforcement authority. Contractor or owner pays for erosion control; reduces clogging of catch basins; reduces sediment and silt loads to stream; little O&M for City of Chester; DELCORA has no enforcement authority.	Yes	Yes	No
	Illegal Dumping Control	Low	None	Enforcement of current law requires large number of code enforcement personnel; recycling sites maintained. Local ordinances already in place can be used as needed to address illegal dumping complaints.	Yes	Yes	No
Ordinance Enforcement	Pet Waste Control	Medium	None	Requires resources to enforce pet waste ordinances. Public education and outreach is a more efficient use of resources, but this may also provide an alternative to reducing bacterial loads.	No	Yes	No
	Litter Control	None	None	Aesthetic enhancement; labor intensive; City function. Litter control provides an aesthetic and water quality enhancement. It will require city resources to enforce. Public education and outreach is a more efficient use of resources.	No	Yes	No
	Illicit Connection Control	Low	Low	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The primary goal of the LTCPU is to meet the USEPA CD requirements limiting CSO's, Total Suspended Solids (TSS) and Biochemical Oxygen Demand (BOD). Illicit connection control is not particularly effective at any of these goals and is not recommended for further evaluation unless separate sewers are in place.	No	Yes	No
Good Housekeeping	Street Sweeping/Flushing	Low	None	Labor intensive; specialized equipment; doesn't address flow or bacteria; City function. Street sweeping and flushing primarily addresses floatables entering the CSS while offering an aesthetic improvement.	No	Yes	No
	Leaf Collection	Low	None	Requires additional seasonal labor. Leaf collection maximizes flow capacity and removes nutrients from the collection system.	No	Yes	No
	Recycling Programs	None	None	The City of Chester has an ongoing recycling program.	Yes	Yes	No

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
	Storage/Loading/Unloading Areas	None	None	Requires Industrial & commercial facilities designate and use specific areas for loading/unloading operations. There are few major commercial or industrial users upstream of CSO regulators.	No	Yes	No
	Industrial Spill Control	Low	None	Pretreatment program regulated by PADEP. There are two commercial or industrial users upstream of CSO regulators.	No	Yes	No
Green Infrastructure – Buildings	Green Roofs	None	Medium	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the City of Chester or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof vegetation. Portions of the City of Chester have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	No	Yes	Yes
	Blue Roofs	None	Medium	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the City of Chester or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof debris. Portions of the City of Chester have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	No	Yes	Yes
	Rainwater Harvesting	None	Medium	Simple to install and operate; low operational resource demand; will require the City of Chester or private owners to implement; requires regular cleaning of gutters & pipes. Portions of the City of Chester have densely populated areas, but this technology is limited to capturing rooftop drainage. Capture is limited to available storage, which can vary on rainwater use. Can be difficult to require on private properties.	No	Yes	Yes
Green Infrastructure – Impervious Areas	Permeable Pavements	Low	Medium	Not durable and clogs in winter; oil and grease will clog; significant O&M requirements with vacuuming and replacing deteriorated surfaces; can be very effective in parking lots, lanes and sidewalks. Maintenance requirements could be reduced if located in low-traffic areas, and can utilize underground infiltration beds or detention tanks to increase storage.	No	Yes	Yes
	Planter Boxes	Low	Medium	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evapotranspirating runoff in developed areas. Flexible and can be implemented even on a small-scale to any high-priority drainage areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	No	Yes	Yes
Green Infrastructure – Pervious Areas	Bioswales	Low	Low	Site specific; good BMP; minimal vegetation & mulch O&M requirements; not as flexible or infiltrate as much stormwater as planter boxes. Technology requires open space and is primarily a surface conveyance technology with additional storage & infiltration benefits. Can be modified with check dams to slow water flow. Limited open space in the City of Chester means land can be utilized in more effective ways with the existing infrastructure.	No	Yes	Yes
	Free-Form Rain Gardens	Low	Medium	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evapotranspirating diverted runoff. Rain Gardens are flexible and can be modified to fit into the previous areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	No	Yes	Yes

Green roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media, plantings, and water. Structural improvements to an existing building to support the additional weight associated with a green roof are not typically recommended; therefore this technology is more feasible on new construction. Green roofs can be installed in a section or across an entire roof. An overflow system is typically installed. The vegetation may require irrigation during the first 1-2 years to establish growth. Recommended maintenance for green roofs includes semi-annual maintenance of vegetation.

Many rooftop retrofits are required for this GI technology to have measureable impact. Most of the buildings in the CSS are privately owned. Implementing this technology on a scale that would have a measureable impact would require retrofits on private property, which would be very difficult for DELCORA to require.

8.5.3 Blue Roofs

Blue roofs collect runoff to promote evaporation (they do not have plantings) through detention. They are typically shallow in depth (4-8") based on the ability of the building to support the weight of the media and captured rainfall. Blue roofs may be built in layers on a roof or installed as cells in crates. Unlike green roofs, a blue roof may not provide any water quality benefits, unless filters or storage media are used specifically for this purpose. The water detained from blue roofs may be used on-site instead of being released with the appropriate modifications.

As with green roofs, blue roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media and water. Structural improvements to an existing building to support the additional weight associated with a blue roof are not typically recommended; therefore, this option is more feasible on new construction. Blue roofs can be installed in a section or across an entire roof. An overflow system is typically installed to direct the detained water off of the roof. Recommended maintenance for blue roofs includes semi-annual maintenance for clearing of debris.

Similar to green roofs, blue roofs would require implementation on private property to have a measureable impact. It is unlikely that DELCORA would be able to require roof retrofits on private property.

8.5.4 Rainwater Harvesting

Rainwater harvesting is the collection and storage of rainfall from buildings to delay or eliminate runoff. The reduction in runoff volume varies based on the size of the rain barrel or cistern storage unit, and the reuse of the stored rainfall. Typical reuse options are irrigation and vehicle washing. Indoor reuse options, such as toilet flushing and heating and cooling, may be possible if coordinated with building policies.

Rainwater harvesting is applicable to all types of buildings with gutters and downspouts but may be reserved for buildings where green or blue roofs are not appropriate (roof slopes greater than 2%). Storage units may be sized and installed for each downspout or for the building as a whole. Rain barrels, such as those in **Figure 8-2**, are typically used for residential installations and larger cisterns are typically used for non-residential applications. They are typically placed at grade but can be buried below grade if a pumping system for water reuse is provided. An overflow system is typically installed. Recommended

maintenance for rainwater harvesting includes semi-annual maintenance for clearing of debris in the piping or storage unit.

Figure 8-2: Rain Barrels

Similar to green and blue roofs, this technology is limited by the number of available roofs, most of which are private. Private residential uses of cisterns are much less common than on private commercial properties, but are encouraged to help reduce combined sewer overflows. Previous "*Free Rain Barrel Workshops*" held within the City of Chester by the Pennsylvania Resources Council offered attendees the basics of how to construct, install, and maintain a rain barrel, as well as a recycled barrel and fittings for installation.

8.5.5 Permeable Pavements

Permeable pavements promote runoff infiltration and rely on a permeable substrate (engineered soils) to store runoff and remove pollutants. There are different types of permeable pavements, most commonly constructed with asphalt, concrete, or prefabricated pavers. Permeable asphalt and concrete are similar to traditional mixes except that the amount of fine aggregates is reduced or eliminated. Permeable pavers are individual paver units laid together to create a paved surface. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation.

Permeable pavements are recommended for low traffic and low speed traffic areas such as sidewalks, parking lanes, parking lots, driveways, and alleys. **Figure 8-3**, **Figure 8-4** and **Figure 8-5** show slightly different permeable pavement details for each of these surfaces. Recommended maintenance for permeable pavement includes semi-annual inspection and vacuuming. Preventative maintenance is also necessary to minimize the introduction of soil and other fine particles that could clog the pavement pores.

Figure 8-3: Example Permeable Sidewalk Section

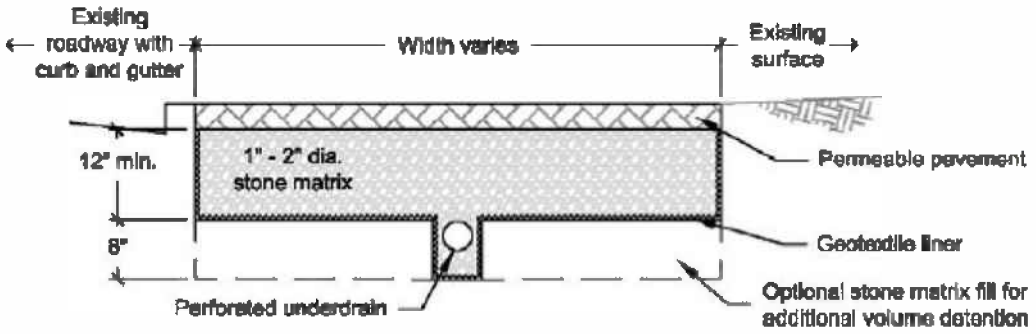


Figure 8-4: Example Permeable Alley Section

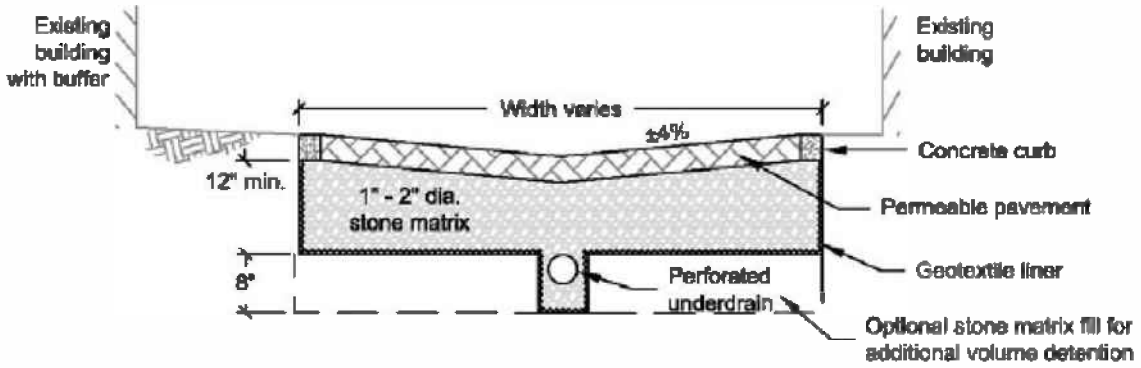
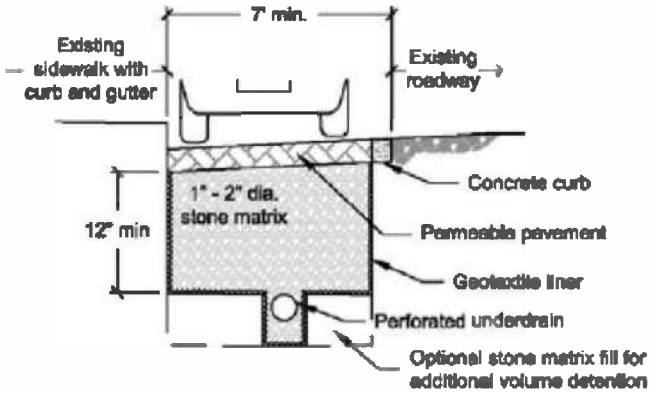


Figure 8-5: Example Permeable Parking Lane Section



Notes:
1. Depth of stone matrix will be determined by structural requirements, storage desired, and permeable pavement type.
2. Top of existing sewer and other utilities shall be a minimum of 1' below the invert of the stone matrix.
3. All underdrains will connect to the existing storm sewer system via solid pipe.

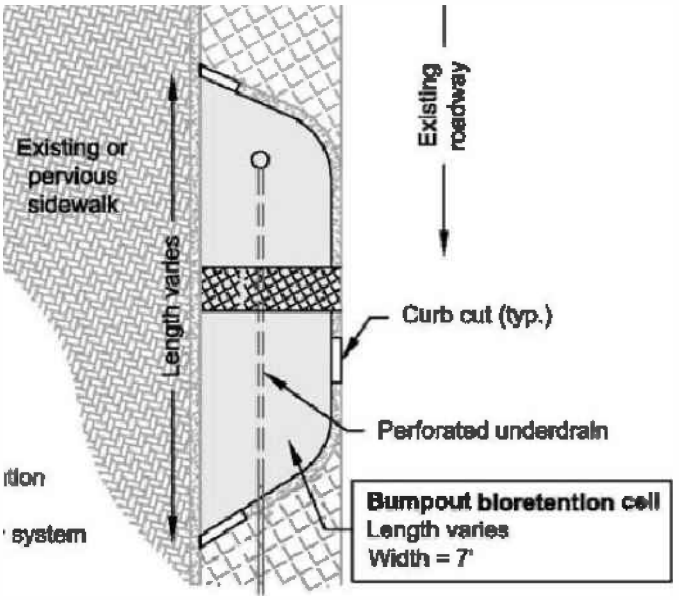
This GI technology can be very effective when implemented in parking lots, parking lanes, and narrow sidewalks where planter boxes cannot be implemented.

8.5.6 Planter Boxes

Planter boxes are bioretention cells that collect runoff and promote runoff infiltration. These walled units are similar to free-form rain gardens as vegetated depressions (12-24 in) that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Properly designed planter boxes limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff.

There are two primary sizes of planter boxes used based on the drainage pattern in developed areas: sidewalk planter boxes and bumpout planter boxes. Sidewalk planter boxes may also be more specifically referred to as a Tree Well Best Management Practice (BMP), a Tree Well with Soil Panels, a Continuous Planting Strip, Mid-Sidewalk BMP, or a Back of Sidewalk BMP. Sidewalk planter boxes are depressed below the elevation of the existing sidewalk. Bumpout planter boxes are larger units that extend from the sidewalk curb into an area of a parking lane. An example of this design can be found in **Figure 8-6**. Curb cuts into planter boxes allow roadway runoff to enter the cells and overflow to street inlets once the maximum ponding depth has been reached. Planter boxes are recommended for use in regularly spaced intervals in the downstream drainage path in areas of impervious cover.

Figure 8-6: Example Planter Bumpout Section



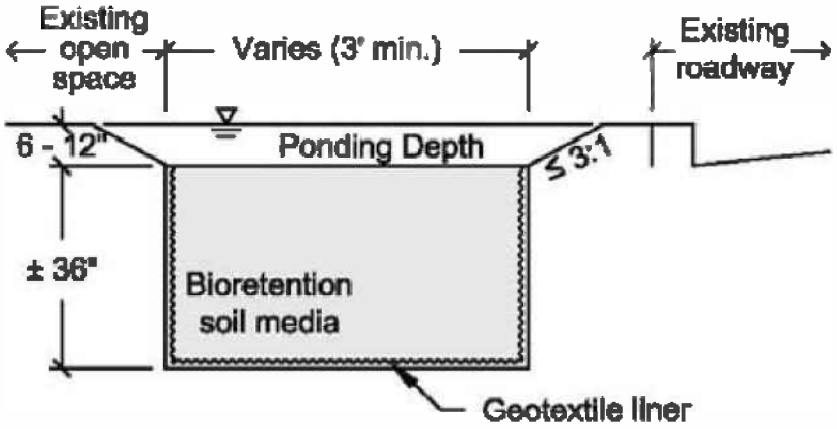
Recommended maintenance for planter boxes includes semi-annual inspections and improvements to vegetation and mulch and annual inspection of overflow pipes and underdrains, if applicable. Inspection after a large storm is also recommended. If there is evidence of ponding after 48 hours, mulch replacement or overflow pipe cleaning may be necessary.

Planter boxes are well suited for highly developed areas where space allows. They can be installed block by-block to contain, infiltrate, and evapotranspirate stormwater runoff.

8.5.7 Bioswales

Bioswales are vegetated channels that reduce runoff velocity and promote runoff infiltration. These are linear channels with shallow depressions (6-12") that incorporate vegetation and a permeable substrate (engineered soils). As a channel, runoff not infiltrated does not pond, but flows through the swale and is conveyed elsewhere. The channels, especially those with slopes greater than 6%, may incorporate check dams to assist in reducing runoff velocity and promote infiltration and pollutant removal. A design example for a bioswale is found in **Figure 8-7**.

Figure 8-7: Example Bioswale Detail



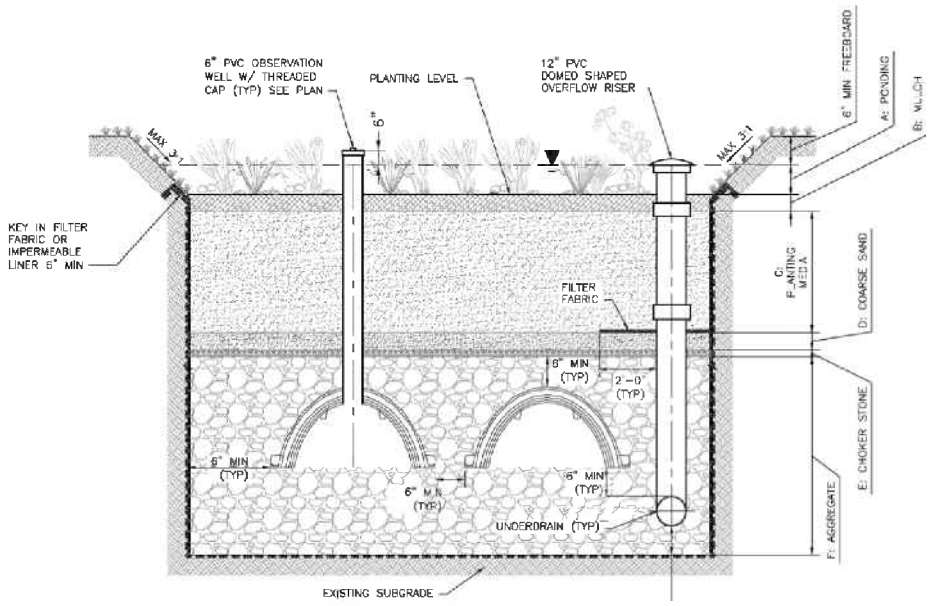
Bioswales are recommended for use in parks and areas of natural cover since they primarily reduce runoff velocity and have a low volume reduction per square foot. Due to their linear nature, bioswales may also be effective in the buffer between open space areas and impervious areas with high volumes of runoff such as roads and parking lots. Recommended maintenance for bioswales includes semi-annual inspections and improvements to vegetation and mulch.

This technology incorporates both stormwater treatment and stormwater conveyance. While not as flexible as planter boxes, there may be locations in the DELCORA CSS where a bioswale could be effective.

8.5.8 Free-Form Rain Gardens

Rain gardens are bioretention basins that collect runoff and promote runoff infiltration. These are vegetated depressions (12-24") that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The size and shape of rain gardens can be tailored to site-specific needs, but the depth of the permeable substrate (anywhere from 3-10 feet) will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Properly designed rain gardens limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff, and infiltration helps improve water quality. An example of a rain garden design is found in **Figure 8-8**

Figure 8-8: Example Rain Garden Section



Rain gardens are recommended for use in low points in parks and areas of natural cover so they can blend in seamlessly with a grassed buffer and enhance the vegetation without appearing to be a stormwater control mechanism. Locations near the transition from pervious to impervious cover can provide runoff reduction for nearby impervious areas.

Recommended maintenance for rain gardens includes semi-annual inspections and improvements to vegetation and mulch and annual inspection of overflow pipes and underdrains, if applicable. Annual inspection after a large storm is also recommended; if there is evidence of ponding after 48 hours, mulch and/or soil replacement or overflow pipe cleaning may be necessary.

Rain gardens are very effective at capturing and treating stormwater and have versatile footprints that make them advantageous for use in highly developed urban environments, such as the City's CSS area.

8.6 Collection System Control

The USEPA defines collection system controls as measures that can reduce CSO volume and frequency by removing or diverting stormwater runoff to maximize the capacity of the collection system. Collection system controls have no impact on water quality, but do have the potential to reduce the volume of CSO events. A summary of select collection system control technologies can be found below along with a full list in **Table 8-5**.

8.6.1 Infiltration/Inflow Reduction

I/I can significantly limit the hydraulic capacity of a collection system, if not held in check. Inflow comes from sources such as roof drains, manhole covers, cross connections from storm sewers, catch basins, and surface runoff. Infiltration comes from groundwater that seeps in through leaking pipe joints, cracked pipes, manholes, and other similar sources. Identifying I/I sources is labor intensive and requires specialized equipment. Additionally, significant I/I reductions can be difficult and expensive to achieve. However the benefit of a good I/I control program is that it can save money by extending the life of the system, reducing the need for expansion, and lowering treatment costs. I/I reduction for combined sewers provides limited gains, since water tends to find another way into the system. However, I/I reductions in sanitary sewers can have significant impacts on increasing the available capacity in the downstream CSS.

8.6.2 Combined Sewer Separation

Sewer separation is the conversion of a CSS into a system of separate storm sewers and sanitary sewers. This can be accomplished by installing a new sanitary sewer and using the existing combined sewer as a storm sewer or vice versa. This practice can be very expensive, disruptive to the public, and difficult to implement, especially in downtown areas or other densely developed urban environments. It typically requires closure of public streets for construction while the new pipes are installed and the sewer is separated. Combined sewer separation shall be considered a feasible technology and be carried forward for further evaluation as required by Section 5.A.19.a of the DELCORA Consent Decree.

8.6.3 Additional Conveyance

Conveyance is a technology that transports the combined sewage out of a particular area to a location where the flow can be stored, treated, or discharged where direct public contact with the water is less likely. Conveyance is accomplished by providing additional conveyance pipes or upsizing the existing conveyance pipe to a greater capacity. This practice can effectively reduce overflow volume and frequency in the affected areas. Large conveyance projects can be expensive and may require a lengthy permitting process.

Table 8-5: Collection System Alternatives

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
Operation and Maintenance	I/I Reduction	Low	Medium	Requires labor intensive work; changes to the conveyance system require temporary pumping measures; repairs on private property required by homeowners. Reduces the volume of flow and frequency; Provides additional capacity for future growth; House laterals account for 1/2 the sewer system length and significant sources of I/I in the sanitary sewer.	No	Yes	Yes
	Advanced System Inspection & Maintenance	Low	Low	Requires additional resources towards regular inspection and maintenance work. Inspection and maintenance programs can provide detailed information about the condition and future performance of infrastructure. Offers relatively small advances towards goals of the LTCPU.	Yes	Yes	No
	Combined Sewer Flushing	Low	Low	Requires inspection after every flush; no changes to the existing conveyance system needed; requires flushing water source. Ongoing: CSO Operational Plan; maximizes existing collection system; reduces first flush effect.	Yes	Yes	No
	Catch Basin Cleaning	Low	None	Labor intensive; requires specialized equipment. Catch Basin Cleaning reduces litter and floatables but will have no effect on flow and little effect on bacteria and BOD levels.	Yes	Yes	No
Combined Sewer Separation	Roof Leader Disconnection	Low	Low	Site specific; Includes area drains and roof leaders; new storm sewers may be required; requires home and business owner participation. The City of Chester is densely populated and disconnected roof leaders have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	No	Yes	No
	Sump Pump Disconnection	Low	Low	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The City of Chester is densely populated and disconnected sump pumps have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	No	Yes	No
	Combined Sewer Separation	High	High	Very disruptive to affected areas; requires homeowner participation; sewer asset renewal achieved at the same time; labor intensive.	No	No	Yes
Combined Sewer Optimization	Additional Conveyance	High	High	Additional conveyance can be costly and would require additional maintenance to keep new structures and pipelines operating. Reduces a bottleneck in the interceptor system to reduce backup in the Delaware River Interceptor.	No	No	Yes

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
	Regulator Modifications	Medium	Medium	Relatively easy to implement with existing regulators; mechanical controls requires O&M. May increase risk of upstream flooding. DELCORA has an ongoing O&M program and system wide replacement program for CSO regulators and tide gates completed by 2022.	Yes	Yes	Yes
	Outfall Consolidation/Relocation	High	High	Lower operational requirements; may reduce permitting/monitoring; can be used in conjunction with storage & treatment technologies. Combining and relocating outfalls may lower operating costs and CSO flows. It can also direct flow away from specific sensitive areas.	No	Yes	Yes
	Real Time Control	High	High	Requires periodic inspection of flow elements; highly automated system; increased potential for sewer backups. RTC is only effective if additional storage capacity is present in the system.	No	Yes	Yes

8.6.4 Outfall Consolidation/Relocation

Consolidation of one or multiple outfalls can help eliminate CSO discharges in sensitive areas. Outfall consolidation may require modification or relocation of an outfall, the installation of additional conveyance to accommodate new flow configurations, and may also require additional permitting with government agencies. This practice typically lowers O&M requirements for the CSS by limiting the number of outfall structures that need to be monitored. Outfall consolidation works best in areas where outfalls are located in close proximity to each other and require limited additional conveyance. Similar to regulator modifications, outfall consolidation is especially effective at reducing high frequency, low volume CSOs. This practice typically doesn't add a significant amount of extra capacity to the CSS (depending on the amount of conveyance pipe associated with the consolidation project), so its impact on infrequent, large volume CSO events can be limited. The H&H Model can determine the level of impact that outfall consolidation will have in terms of reducing the number of CSO events.

8.6.5 Regulator Modifications

A CSO regulator can be uniquely configured to control combined sewer overflow frequency and volume. The existing overflow control structures may be modified based on site-specific conditions - for example, by increasing the overflow weir height and length or raising the overflow pipe elevation. This technology is especially effective for CSO outfalls with high overflow frequency and low overflow volume, because the additional volume held back in the system is small and less likely to have negative impacts on upstream conditions.

8.6.6 Real Time Control

Real Time Control (RTC) is a highly automated system in which sewer level and flow data are measured at key points in the sewer system and used to operate system controls to maximize the storage capacity of the CSS and limit overflows. The collected data is typically transferred to a control device where program logic is used to operate gates, pump stations, inflatable dams and other control components. Local dynamic controls are used to control regulators to prevent flooding and system-wide dynamic controls are used to implement control objectives such as maximizing flow to the treatment plant or transferring flows from one portion of the CSS to another to fully utilize the system. Predicative control, which incorporates use of weather forecast data is an optional feature, but is complex and requires sophisticated operational capabilities. It should be noted that RTC can only reduce CSO volumes where in-system storage capacity is available. Additionally this measure involves the installation of numerous mechanical controls which require upkeep and maintenance. Due to these limitations and complexities, this measure has been identified as a complementary technology.

8.7 Storage

The objective of storage is to reduce overflows by capturing and storing wet weather flows in excess of the CSS conveyance/treatment plant capacity for controlled release back into the system once the treatment and conveyance capacity have been restored. A storage facility can attenuate peak flows in the CSS and provide a relatively constant flow into the treatment plant after peak events. Storage technologies do not prevent water from entering the CSS or treat bacterial loads in CSO discharge, but are very effective at reducing or eliminating CSO events. Storage technologies typically have fairly high construction and O&M costs compared to other CSO control technologies, but are a very reliable means

of achieving CSO control goals. A summary of the various storage technologies is listed below and in **Table 8-6**.

8.7.1 Pipeline Storage

Large diameter parallel pipelines or conduits can provide significant storage in addition to the ability to convey flow. Pipelines are typically constructed between an overflow point and a pump station or treatment facility. The pipelines include discharge controls to allow flow to be stored within the pipeline during wet weather events, and slowly released by gravity following the event. Pipelines have the advantage of requiring less area for construction compared to point storage technologies. If trenchless technologies can be utilized, such as horizontal directional drilling (HDD), land requirements can be reduced even further.

One disadvantage of pipelines is that a larger volume is typically required to accommodate combined sewer storage needs. The installation of large diameter pipelines is typically less cost-effective than tunneling, and the installation of smaller diameter pipes typically requires a significant length in order to provide adequate storage. Additionally, the installation of pipelines is very disruptive, typically requiring open trenches and the temporary closure of public streets.

8.7.2 Tunnel Storage

Tunnels provide more storage volume than pipelines, while maintaining the ability to convey flow. Tunnel excavation is accomplished completely underground, and therefore results in minimal surface disruption and requires little right-of-way. Costs for tunnel storage is fairly reasonable compared to other storage technologies, depending on local geology. Tunnels are typically used in congested urban areas where available land is scarce. Tunnels shall be considered a feasible technology and be carried forward for further evaluation as required by section 5.A.19.a of the DELCORA Consent Decree.

8.7.3 Tank Storage

This technology reduces overflow quantity and frequency by storing all or a portion of diverted wet weather combined flows in off-line storage tanks. Stored flows are returned to the interceptor for conveyance to the treatment plant once system capacity becomes available. Storage tanks are generally fed by gravity and the stored flow is typically pumped back to the interceptor after the storm. The benefit of off-line storage tanks is that they are well suited for early action projects at critical CSO outfalls. Storage tanks capture the most concentrated first flush portion wet weather peak flow and help to reduce the downstream capacity needs for conveyance and treatment.

A disadvantage of off-line storage tanks is that they typically require large land area for installation, which may not be available in congested urban areas. Off-line storage tanks typically have higher costs per volume captured compared to other technologies. Additionally, if the existing sewers are deep, then the storage tank must also be deep, which results in additional construction costs. Operation and maintenance costs can also be high, especially if the application includes provisions for partial treatment and discharge, rather than simple storage and bleed-back to the sewer. Depending on the application, odor problems may also be an issue. However, storage tanks can be a very effective means of CSO control.

Table 8-6: Storage and Treatment Alternatives

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
Linear Storage	Pipeline	High	High	Can only be implemented if in-line storage potential exists in the system; increased potential for basement flooding if not properly designed; maximizes use of existing facilities. Pipe storage for a CSS typically requires large diameter pipes to have a significant effect on reducing CSOs. This typically requires large open trenches and temporary closure of streets to install.	No	No	Yes
	Tunnel	High	High	Requires small area at ground level relative to storage basins; disruptive at shaft locations; increased O&M burden.	No	No	Yes
Point Storage	Tank	High	High	Storage tanks typically require pumps to return wet weather flow to the system which will require additional O&M; disruptive to affected areas during construction. Several CSO outfalls have space available for tank storage. There may be existing tanks in abandoned commercial and industrial areas to be converted to hold stormwater. Tanks are an effective technology to reduce wet weather CSO's.	No	No	Yes
	Industrial Discharge Detention	Low	Low	Requires cooperation with industrial users; more resources devoted to enforcement; depends on IUs to maintain storage basins. IUs hold stormwater or combined sewage until wet weather flows subside; few commercial or industrial users upstream of CSO regulators.	No	Yes	No
Treatment-CSO Facility	Vortex Separators	None	None	Space required; challenging controls for intermittent and highly variable wet weather flows. Vortex separators would remove floatables and suspended solids when installed. It does not address volume, bacteria or BOD.	No	Yes	No
	Screens and Trash Racks	None	None	Prone to clogging; requires manual maintenance; requires suitable physical configuration; increased O&M burden. Screens and trash racks will only address floatables.	No	Yes	No
	Netting	None	None	Easy to implement; labor intensive; potential negative aesthetic impact; requires additional resources for inspection and maintenance. Netting will only address floatables.	No	Yes	No
	Contaminant Booms	None	None	Difficult to maintain requiring additional resources. Contaminant booms will only address floatables.	No	Yes	No
	Baffles	None	None	Very low maintenance; easy to install; requires proper hydraulic configuration; long lifespan. Baffles will only address floatables.	No	Yes	No
	Disinfection & Satellite Treatment	High	None	Requires additional flow stabilizing measures; requires additional resources for maintenance; requires additional system analysis. Disinfection is an effective control to reduce bacteria and BOD in CSO's.	No	Yes	Yes
	High Rate Physical/Chemical Treatment (ActiFlo)	None	None	Challenging controls for intermittent and highly variable wet weather flows; smaller footprint than conventional methods. This technology primarily focuses on TSS & BOD removal, but does not help reduce the bacteria or CSO discharge volume.	No	Yes	No

Technology Group	Practice	Primary Goals		Implementation & Operation Factors	Being Implemented	Consider Combining w/ Other Technologies	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction				
	High Rate Physical (Fuzzy Filters)	None	None	Relatively low O&M requirements; smaller footprint than traditional filtration methods. This technology primarily focuses on TSS removal, but does not help reduce the bacteria or CSO discharge volume.	No	Yes	No
Treatment-WRTP	Additional Treatment Capacity	High	High	May require additional space; increased O&M burden.	No	No	Yes
	Wet Weather Blending	Low	Low	Requires upgrading the capacity of influent pumping, primary treatment and disinfection processes; increased O&M burden. Wet weather blending does not address bacteria and overflow volume reduction, as it is a secondary treatment bypass for the POTW. Permittee must demonstrate there are no feasible alternatives to the diversion for this to be implemented.	No	Yes	No
Treatment-Industrial	Industrial Pretreatment Program	Low	Low	Requires cooperation with Industrial User's; more resources devoted to enforcement; depends on IU's to maintain treatment standards. DELCORA has an ongoing Industrial Pretreatment program that includes 3 IU's and requires a permit be renewed every 4 years.	Yes	Yes	No

8.8 Treatment Technologies

Treatment technologies are intended to reduce the pollutant loads to receiving waters by treating wet weather flows prior to discharging to the environment. Specific technologies can address different pollutant constituents, such as settleable solids, floatables, or bacteria. Where treatment facilities are to be considered, the LTCPU should contain provisions for the handling, treatment, and ultimate disposal of sludge and other treatment residuals. A summary of various treatment technologies are listed in **Table 8-6**.

8.8.1 Disinfection & Satellite Treatment

This technology consists of disinfecting & treating sewer overflows at a local facility near the CSO outfall. Disinfection is very effective at reducing bacteria through inactivation, but provides only limited opportunities for volume reduction. Disinfection alone cannot provide reductions in TSS, floatables, and nutrient loads unless other processes (e.g. screening, high-rate clarification, etc.) are provided upstream of the disinfection facility. The combination of these other processes with disinfection can provide a satellite treatment facility that helps reduce Pollutants of Concern.

Disinfection of wet weather flow is more challenging to design and control than traditional disinfection at a treatment plant, because of the complex characteristics of the flow. Intermittent occurrence and highly variable flowrate make it more challenging to regulate the addition of disinfectant. One way to address the variable flow issue is to provide flow retention facilities that provide for disinfectant contact time and capture through storage of the first flush of TSS, floatables and nutrients.

Wet weather flows can vary widely in temperature, suspended solids concentrations, and bacterial composition. Therefore, pilot studies are usually needed to characterize the range of conditions that exist for a particular area and the design criteria that need to be considered. Experience has shown that the long contact time required for conventional wastewater treatment is not appropriate for the treatment of wet weather flows. Disinfection can be achieved by providing an increased disinfection dosage and intense mixing to ensure disinfectant contact with the maximum number of microorganisms.

Various disinfection technologies are available, both with and without chlorine compounds. In addition to disinfection effectiveness, many factors should be considered when selecting a disinfectant, including potential toxic effects to the environment, regulations for residuals, safety precautions, and ease of operation and maintenance. Ultraviolet (UV) light and peracetic acid (PAA) are two alternatives to chlorine compounds for wet weather disinfection.

- The main advantages of UV light include its ability to quickly respond to flow variation and the absence of a disinfectant residual, among others. The size of the UV system mainly depends on the UV transmittance (i.e. the ability of wastewater to transmit UV light) and the TSS concentrations in the wastewater. One of the challenges for UV disinfection is determining how to manage the disinfection of effluent during a power outage. In addition, UV typically has higher capital cost compared to chlorine disinfection systems.

The main advantage of peracetic acid over sodium hypochlorite is its long "shelf life" without product deterioration. Due to the intermittent nature of CSO flows, stored sodium hypochlorite may degrade over time if not used; however, PAA systems generally have higher operating costs than chlorine systems.

8.8.2 Additional Treatment Capacity - WRTP

CSOs can potentially be reduced by increasing the treatment capacity of the WRTP. Plans are currently being evaluated to increase the capacity of the WRTP from the currently permitted effluent limits of 44 MGD to 50 MGD. The plant is also being evaluated for necessary improvements to handle up to 60 MGD average flow capacity loading. In combination with increased plant capacity, additional conveyance would be needed to accommodate flow to the WRTP for treatment. Additional treatment plant capacity shall be considered a feasible technology and be carried forward for further evaluation as required by section 5.A.19.a of the DELCORA Consent Decree

8.8.3 Recommended Control Technologies for Evaluation

Based on the evaluation criteria, the following CSO Control Technologies are recommended for further evaluation. They have been selected based on their rating of bacteria and volume reduction. Should any CSO control technology rank as "medium" or "high" in either category, it will be retained for further evaluation. Technologies will also be further evaluated if they have been identified as a feasible technology by the Consent Decree. See **Table 8-7** for the Selected Alternative Technologies Summary.

Table 8-7: Selected Alternative Technologies Summary

Technology Group	Practice	Primary Goals		Consider Combining w/ Other Technologies
		Bacteria Reduction	Volume Reduction	
Source Controls (Green Infrastructure)	Green Roofs	None	Medium	Yes
	Blue Roofs	None	Medium	Yes
	Rainwater Harvesting	None	Medium	Yes
	Permeable Pavements	Low	Medium	Yes
	Planter Boxes	Low	Medium	Yes
	Bioswales	Low	Low	Yes
	Free-Form Rain Gardens	Low	Medium	Yes
Collection System Controls	I/I Reduction	Low	Medium	Yes

Technology Group	Practice	Primary Goals		Consider Combining w/ Other Technologies
		Bacteria Reduction	Volume Reduction	
	Combined Sewer Separation	High	High	Yes
	Additional Conveyance	High	High	Yes
	Regulator Modifications	Medium	Medium	Yes
	Outfall Consolidation/Relocation	High	High	Yes
	Real Time Control	High	High	Yes
Storage Technologies	Pipeline	High	High	No
	Tunnel	High	High	No
	Tank	High	High	No
Treatment Technologies	Disinfection & Satellite Treatment	High	None	Yes
	Additional Treatment Capacity	High	High	No

8.9 Preliminary Siting of CSO Control Technologies

Following the determination of appropriate Alternative Technologies to utilize in the final analysis, Control Alternatives were sited for the various CSO areas based on a variety of factors such as suitability for placement at a particular CSO, the type of land use, the CSO's location in relation to the WRTP, available land for Control Technology placement, and the ultimate feasibility of the Control Technology installation. For the preliminary siting of green infrastructure, an evaluation was completed in November 2017 by Corvias. The entire DELCORA CSO area was analyzed for green infrastructure Control Technology placement with specific siting recommended based on several factors such as the "life-cycle costs, the ability to develop effective green infrastructure, availability of land, and combined sewer overflow control levels achieved". This analysis was incorporated into the preliminary siting. The completed preliminary siting matrix can be viewed in **Table 8-8**.

Table 8-8: Preliminary Siting of CSO Alternative Control Technologies

Practice		Bacteria Reduction	Volume Reduction	DELAWARE RIVER												CHESTER CREEK									RIDLEY CREEK				
				REG 01	REG 02	REG 03	REG 04	REG 05	REG07	REG08	REG09	REG11	REG13	REG14	REG32	REG12	REG19	REG20	REG21	REG22	REG23	REG24	REG25	REG26	REG15	REG16	REG17	REG18	REG33
Annual OF (Freq)					56	52	21	70	45	61	43	62	55	32	0	1	47	37	1	46	12	43	57	20	64	27	77	90	
Annual OF (Vol, MG)					11.8	8.4	3.4	42.3	2.1	33.1	7.1	25.1	23.6	6.3	0.0	0.008	43.9	2.9	0.031	2.2	0.2	1.3	9.0	2.0	1.9	7.6	38.7	32.1	
Source Controls	Green Roof	None	Medium										x		x						x		x						
	Blue Roof	None	Medium										x		x						x		x						
	Rainwater Harvesting	None	Medium										x						x	x	x		x	x					
	Permeable Pavements	Low	Medium						x		x			x	x	x	x		x		x	x	x	x				x	
	Planter Boxes	Low	Medium							x	x	x		x		x	x	x	x	x	x	x	x	x	x		x		x	
	Bioswales	Low	Low						x	x						x		x				x			x	x	x			
	Free-Form Rain Gardens	Low	Medium		x		x	x	x	x	x					x		x		x	x	x			x	x	x	x	
Collection System Controls	I/I Reduction	Low	Medium		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Combined Sewer Separation	High	High					x						x	x	x			x	x								x	x
	Additional Conveyance	High	High		x	x	x	x	x																				
	Outfall Consolidation/Relocation	High	High		x	x	x			x	x	x	x	x	x	x			x	x			x				x	x	
	Regulator Modification								x											x		x			x				
	Real Time Control	High	High		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Storage Technologies	Pipeline Storage	High	High		x	x	x		x	x	x	x	x	x		x	x		x	x	x	x	x		x			x	
	Tunnel Storage	High	High		x	x	x	x	x	x	x	x	x	x	x	x					x	x	x		x	x			
	Tank Storage	High	High			x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x	x	x	
Treatment Technologies	Disinfection & Satellite Treatment	High	None												x	x		x				x				x	x	x	
	Additional Treatment Capacity	High	High	x																									
Early Action Items	Pump Station	High	High		x	x	x	x	x																				
	CSO Regulator Closure	High	High																										x

Notes:
= Corvias's Recommendation
-Source controls are incorporated from Corvias along with GH separate analysis.
-Table is specific to siting at each specific outfall/CSO.
-This table does not qualify whether these locations impact other CSOs downstream.

Section 9 Evaluation and Selection of CSO Control Alternatives

9.1 Introduction

This Section is intended to evaluate the CSO Control Technologies presented in Section 8. As described previously in Section 8, preliminary Control Technologies that have a rating of "medium" or "high" with regard to bacteria and volume reduction were retained for consideration for inclusion in the Evaluation and Selection of CSO Control Alternatives. The remaining Technologies were then utilized throughout the process of developing the Alternative Analysis methodology. The chosen Alternatives, whether it is the Consent Decree requirement approach or the Targeted approach, both to be discussed in subsequent subsections, rely mainly on the following: tunnel storage, green infrastructure, storage tanks, WRTP expansion, sewer separation, regulator modifications, parallel interceptors, and most importantly, the utilization of existing infrastructure. The storage volume and location of these Technologies were completed after an exhaustive analysis process to look at volume capture and the unique characteristics of each CSO area for ultimate placement of the Technologies. Following this investigation of appropriate technologies within each sewer shed, further modeling was completed along with developing opinions of probable construction cost. Knee-of-the-Curve graphs to compare each alternative developed from a suite of viable technologies in each sewer shed were developed to graphically see where the cost benefit per million gallon of CSO captured is maximized. Subsequent subsections provide additional details into the overall processes to develop cost effective alternatives to achieve various levels of CSO control in the DELCORA combined sewer area.

9.2 CSO Control Policy Alternatives Analysis Requirements

As previously stated, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania on August 17, 2015 that requires DELCORA to complete and submit a revised and updated LTCP to the USEPA and/or PADEP for review and approval. With regard to the Alternatives Analysis, Consent Decree Paragraph V.A.19 (Alternatives Evaluation) states:

> *"DELCORA shall carry out and include in the LTCP an Alternatives Evaluation that complies with the requirements of the CSO Control Policy Section II.C.4, and that is consistent with EPA's "Guidance for Long-Term Control Plan," EPA 832-B-95-002,September 1995. The Alternatives Evaluation shall consist of: (1) a technology screening process, (2) a detailed evaluation of specific CSO control alternatives, and (3) selection of an appropriate range of proposed CSO controls to achieve compliance with the Clean Water Act. DELCORA shall specifically evaluate the feasibility of eliminating or relocating all CSO Outfalls that discharge to Sensitive Areas. DELCORA shall give a high priority to the control of those CSO Outfalls that discharge to Priority Areas, and those that have the highest frequency or greatest volume of discharge of wastewater."*

Described in Section 8, the first step in the Alternatives Evaluation is the screening of available CSO Control Technologies as outlined in Consent Decree Paragraph V.A.19.a (Screening of Available CSO Control Technologies):

> *"DELCORA shall assess the technical feasibility of the use of a wide range of demonstrated CSO control technologies. DELCORA shall provide descriptions of the following types of CSO control technology – Source Controls, Collection System Controls, Storage Technologies and Treatment*

Technologies – and an assessment of the feasibility of applying each technology type for long-term CSO control in the Model Area, based on existing and anticipated future conditions affecting the Model Area. This evaluation is not intended to consider cost or cost effectiveness, but rather to exclude control technologies that are not technically or physically applicable to the Model Area."

The Consent Decree specifically states as part of the Alternative Evaluation preliminary screening process certain alternatives shall be carried forward for final consideration:

*"**Partial and complete separation of sewers** in each CSO Outfall tributary area, and **deep tunnel storage**, shall be considered feasible technologies for this purpose and be carried forward for further evaluation. **Expansion of the primary and secondary capacity of the WRTP** shall also be considered feasible technologies for this purpose and be forward for further evaluation, as required by Section II.C.4 of the CSO Control Policy."*

Additional Control Technologies to be considered include green infrastructure as well, as stated in Consent Decree Paragraph V.A.19.c (Green Infrastructure):

"DELCORA shall consider Green Infrastructure ("GI") alternatives as part of the combined sewer system control alternatives under the LTCP. The LTCP shall contain the following minimum considerations for proposing a GI alternative to traditional controls:

(i) Identification of potential locations for GI. DELCORA shall specifically identify potential areas within the service area that would be suitable for development of a GI control measure. Each potential area shall be prioritized using considerations such as lifecycle cost (including cost of long-term operation and maintenance),the ability to develop effective GI control measures, availability of land, CSO control levels achieved, environmental and socioeconomic benefits and impacts, and benefits and impacts to minority and low income neighborhoods.

(ii) Applicability and Performance Assessment. Any GI control measure proposed shall include an applicability and performance assessment that includes consideration of unique sewer shed-specific features such as diversion structures/outfalls, Receiving Waters, and land uses. Information and data gathered from other existing GI control measure studies and/or projects can inform, to the extent appropriate, applicability and performance assessments required under this Paragraph.

(iii) For any GI controls to be sited on private property, or operated by an entity other than DELCORA, DELCORA shall describe how DELCORA will ensure the continual operation and maintenance of such controls."

In terms of early action CSO Control Technologies, Consent Decree V.B.26 (Early Action CSO Control Measure) states:

"DELCORA shall Place in Operation a new EPS-1 Pump Station to reduce discharges from CSO Outfalls #2, #3, #4, #5 and #7, by December 31, 2018. DELCORA shall update its NMC Plan to reflect this Early Action CSO Control Measure within 60 days of its Placement in Operation, as required by Section V.B.26 of the Consent Decree."

This Early Action Item, construction of new Pump Station PS-6 (reconstructed EPS-1) will be included as part of the baseline for each CSO Control Alternative. Further description of requirements of the Alternatives Analysis in the Consent Decree it the following with regard to evaluating controls to achieve a certain number of overflows events per year (CSO Control Policy Section II.C.4 (Evaluation of Alternatives):

> *"EPA expects the long-term CSO control plan to consider a reasonable Range of alternatives. The plan should, for example, evaluate controls that would be necessary to achieve zero overflow events per year, an average of one to three, four to seven, and eight to twelve overflow events per year. Alternatively, the long-term plan could evaluate controls that achieve 100% capture, 90% capture, 85% capture, 80% capture, and 75% capture for treatment. The long-term control plan should also consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. The analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance as described in Section Q.C.5. Because the final long-term CSO control plan will become the basis for NPDES permit limits and requirements the selected controls should be sufficient to meet CWA requirements."*

These relevant regulatory requirements have been extracted from the Consent Decree and the USEPA's CSO Guidance for LTCP. The Consent Decree contains the regulatory requirements related to Alternatives Evaluation, Screening of Available CSO Control Technologies and Green Infrastructure. The USEPA's CSO Guidance for LTCP contains the regulatory requirements related to Creative Thinking, Definition of Water Quality and CSO Control Goals and the Identification of Control Alternatives. The following subsections address the overall process used to develop the Alternatives to be utilized.

9.3 Alternatives Analysis Approach

9.3.1 Consent Decree Requirement Approach

The Consent Decree requirement approach consists of a system wide method to addressing water quality and overflows. As stated earlier, the Consent Decree specifically states as part of the Alternative Evaluation preliminary screening process certain alternatives shall be carried forward for final consideration:

> *"**Partial and complete separation of sewers** in each CSO Outfall tributary area, and **deep tunnel storage**, shall be considered feasible technologies for this purpose and be carried forward for further evaluation. **Expansion of the primary and secondary capacity of the WRTP** shall also be considered feasible technologies for this purpose and be forward for further evaluation, as required by Section II.C.4 of the CSO Control Policy."*

Green infrastructure must also be considered as well as part of the Consent Decree and is included as part of the analysis.

For items that are considered "early action", DELCORA was required to construct a new pump station to replace existing pump station EPS-1. This new pump station, designated as PS-6 and placed in operation on September 5, 2018, is included as part of the modeling scenarios for each CSO Control Alternative and

will help in reducing discharges from Outfalls #2-5 and #7 along the Delaware River Interceptor and the West End Interceptor.

The Consent Decree approach consists of analyzing tunnel storage, sewer separation, WRTP expansion, and storage tanks separately coupled with adding in recommended green infrastructure practices from Corvias. For example, Alternative 1 consists of storage tanks throughout the CSS area as the LTCPU solution, Alternative 2 provides tunnel storage as the principal technology. These single technology practices are sized along with costs being developed to reduce the number of untreated CSOs in a Typical Year to frequencies of 0, 2, 4, 6, 8, and 12. Capital costs along with operation and maintenance costs are developed, in present value, utilizing cost curves to develop Knee-of-the-Curve cost performance. The impact of the size of practices are analyzed in the following subsection. In the event two Control Technologies give identical benefits, the lower cost option is evaluated. The goal of this analysis is to develop implementable and cost effective Control Technologies.

To give an idea of current conditions, specifically with regard to percent capture, **Table 9-1** gives current percent capture by segment during wet weather flow. Wet weather is categorized as the time during precipitation and the 6 hours following the end of precipitation.

Table 9-1: Current Conditions Percent Volume Capture by Segment

Percent Capture by Segment			Total Percent Capture
Delaware River	Ridley Creek	Chester Creek	
81.7%	74.5%	89.5%	82.3%

Table 9-2 gives a detailed breakdown of the resulting wet weather percent capture for each of these overflow scenarios (0, 2, 4, 6, 8, and 12 overflow events required by the consent decree, as well as 20 overflow events, and the approximate overflows given by reaching 85% volume capture). These scenarios all assume that no outfall discharges more than a given number per year and no one outfall can exceed that number of discharges at any point during the typical year that is modeled for estimating wet weather flow for estimation of CSO volumes.

Table 9-2: Current Conditions Percent Volume Capture

Overflows	% Captured	Vol Captured (MG)
0	100.0%	272.22
2	98.4%	246.18
4	97.7%	235.79
6	96.5%	217.15
8	95.5%	199.94
12	94.1%	178.98
20	91.7%	140.48
43	85.0%	35.61

Current number of overflows at each regulator based on baseline conditions for the typical year as modeled by the H&H model are listed in **Table 9-3**. The number of overflows is shown at each regulator, with the Typical Year average given as well. **Table 9-4** lists the current or baseline overflow volumes for each regulator per year with the Typical Year average.

Table 9-3: Current Conditions Number of Overflows by Regulator

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32	NREG33
1994	45.0	60	43	21	69	47	48	43	51	2	49	30	43	28	54	76	53	30	2	40	13	19	43	25	0	2
1995	31.4	53	34	14	56	40	42	37	46	0	42	24	35	20	47	69	46	24	1	29	5	11	37	16	0	0
1996	52.1	71	53	28	72	57	61	54	65	0	60	39	53	33	66	88	65	36	1	49	8	22	55	30	0	1
Average	42.8	61.3	43.3	21.0	65.7	48.0	50.3	44.7	54.0	0.7	50.3	31.0	43.7	27.0	55.7	77.7	54.7	30.0	1.3	39.3	8.7	17.3	45.0	23.7	0.0	1.0

Table 9-4: Current Conditions Overflow Volumes by Regulator (MG)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32	NREG33
1994	45.0	16.0	9.4	1.2	43.7	4.6	49.2	14.5	11.5	0.031	15.6	8.9	1.0	5.5	13.5	46.7	39.7	3.0	0.084	2.3	0.3	0.8	6.2	4.0	0.0	0.5
1995	31.4	10.4	5.4	0.3	31.1	3.2	31.1	8.1	7.4	0.000	9.7	4.4	0.5	2.1	9.2	26.9	22.3	1.1	0.003	1.3	0.1	0.2	3.9	1.7	0.0	0.0
1996	52.1	18.8	10.4	0.5	56.6	5.8	58.1	16.0	13.6	0.000	18.2	8.5	0.9	3.9	17.5	49.8	44.9	2.1	0.005	2.6	0.1	0.4	7.3	2.9	0.0	0.0
Average	42.8	15.1	8.4	0.7	43.5	4.5	46.1	12.9	10.8	0.010	14.5	7.3	0.8	3.8	13.4	41.1	35.6	2.1	0.031	2.1	0.2	0.5	5.8	2.9	0.0	0.2

9.3.2 Targeted Approach

Compared to the Consent Decree approach, the Targeted approach utilizes information obtained from analysis of hydrologic/hydraulic and water quality modeling. By narrowing down areas to site Control Technologies, this allows for a more strategic focus to add more value to the Technologies being used as opposed to blanketing the combined sewer area with Alternatives to meet certain overflow scenarios.

The first step in determining which CSO areas to focus in was to look at the preliminary water quality modeling analysis. Results looked at each CSO outfall to the next downstream CSO. When examining the impact of CSOs on WQSs with background source exceedances left out of the analysis, there are no enterococcus, fecal coliform, or E. coli monthly geomean levels above the limits set by WQSs. The number of months when water quality standards were exceeded for the three receiving water segments for background and CSO sources and CSOs only are presented in **Table 5-3**

CSO volume capture still provides a pollution control benefit, and Control Technologies should be focused on the largest CSO overflow discharge volumes to maximize these benefits. The total percent capture needed is 85%, and the Control Technologies utilized should focus on the volume capture needed on each segment or regulator to attain the desired volume capture. This is the first step in the Targeted approach: identify a starting point to focus efforts to site Control Technologies.

9.4 Cost/Performance Evaluation of CSO Control Alternatives

An overview of the cost methodology utilized for looking at different Control Technologies is given in **Appendix O**. This overview looks at the development of cost curves for both capital and life cycle costs, along with the methodology to come up with Operation and Maintenance costs, contingencies, and escalation factors. The finalized costs for the Control Alternatives is given in the Implementation Plan presented in Section 10. The cost factors that have been considered for the ultimate ranking and selection of Control Technologies:

- Aligns with typical engineering practice
  - Normal design guidelines are followed with proven technology being able to serve as an example or precedent
  - The local construction market able to handle the installation
- Site constraints
  - Added variables making the construction more difficult to design, such as existing utilities or infrastructure, adjacent structures to the building site, or narrow streets
- Land availability
  - Public or private
  - Land can be utilized for its intended purpose
  - Is the site expandable for variations for the alternative in the future
- "Expandable" Alternatives
  - Fluctuations in population and the CSS sewershed will result in variations of flow in the future
  - Can the Alternative expand or be modified in its services and capacity with the changing needs of the city
- Ease of permitting/potential permitting issues
  - How easily can permits be obtained for local, state, or federal agencies regarding areas such as wetlands, roads/streets, open space, etc.
  - How does the Alternative couple with the effluent permit?

9.5 Non-Monetary Factors for CSO Control Alternatives

Non-Monetary factors consist of multiple items that go into the ultimate ranking and selection of Control Technologies. Some of these factors involve certain aspects of cost, but aren't related to the direct capital cost as dictated in the cost curve information. The following is a breakdown of the non-cost factors that have been considered for ultimate ranking and selection of Control Technologies:

- Short term public impact during construction
  - Minimizing negative impacts like traffic and water shut-off
- Long-term public impact post-construction
  - Maximizing direct benefits like new park installation or improvement
- Incorporating multiple ancillary community benefits
  - Consideration of community benefits such as aesthetics, green stormwater infrastructure utilization, energy efficiency, and resource recovery.
- Effective at reducing CSO-related items
  - Flooding reduction
  - Effective at reducing the number and volume of CSOs beyond the Consent Decree requirements
- Consideration of sensitive/priority areas

9.6 Development of CSO Control Technology Alternatives

9.6.1 Consent Decree Approach Control Alternatives

The Consent Decree approach is used in this LTCPU to size alternatives for each of the overflow event scenarios. In the model itself, the Technologies located are theoretical locations where they would more than likely be sited if taken further in design. For example, a large tunnel for storage would most likely be placed along the Delaware River Interceptor on Route 291. Storage tanks would be placed next to the regulator as opposed to higher up in the sewershed. Green infrastructure will be included from recommendations from Corvias in specific CSO locations, which consist of green streets, permeable pavement, and underground storage.

The sizing of the Control Technologies is completed by a combination of spreadsheet calculation and formal modeling using EPA-SWMM. In situations where the control technology will have an impact on the hydrology of the downstream areas, such as sewer separation or green infrastructure, modeling is necessary. For technologies that will only detain overflow for release back into the conveyance system to the WRTP, spreadsheet calculations can be utilized to store the appropriate storm event. For instance, if the goal is to find the size of a storage tank for 4 overflow events a year, the storm event causing the fifth-largest CSO overflow volume that year is identified. The storage tank will then be sized to accommodate the entire overflow volume equivalent for this storm for the corresponding regulators. All storm events with less CSO overflow volumes will be fully captured, and any overflows occurring from volumes greater than this storage tank will still be significantly reduced.

Some Control Technologies have been identified by the Consent Decree to help meet the maximum number of yearly overflow events (0, 2, 4, 6, 8, and 12). Some of these Control Technologies can be used globally to help reduce the volume and number of overflows, but make it difficult to meet the desired overflow conditions. Sewer separation, for example, completely disconnects an area, to allow no

overflows in a year, but can be difficult to predict which areas would be ideal for any other overflow amount. Storage Technologies (tanks, tunnels) are the most reliable Control Technologies to guarantee these overflow conditions are met.

In addition, the overflow volumes for each regulator was calculated from current, or baseline, conditions to determine what the system wide sanitary sewer capture percentage would be to meet Consent Decree compliance. These can be found in **Table 9-2**, along with 20 overflows a year, and the compliance minimum of 85% system wide capture. By calculating these capture percentages for the yearly overflows, it provides a good comparison between the alternatives developed from the Consent Decree approach and the Targeted approach by providing equivalent capture.

9.6.2 Targeted Control Alternatives

The Targeted approach is used in this LTCPU to determine groupings of control technologies to help achieve the water quality requirements of the Consent Decree while still following the cost and non-cost factors listed in **Subsections 9.4 and 9.5**, respectively. The relative importance of these factors' weights on the control technologies used was determined in an internal DELCORA workshop in Spring 2018. After the workshop, the cost factors were determined to be significantly more important to the final control technologies than the non-cost factors, and are the primary influence on the alternatives' development. The non-cost factors are still considered in the grouping of control technologies as a secondary influence, when possible. For example, tanks can be used for stormwater capture along the well-trafficked areas along Edgmont Avenue, but green infrastructure provides an additional aesthetic the public can enjoy, while also capturing stormwater flows that would otherwise drain toward CSOs in Ridley Creek.

The primarily targeted overflows are from CSO regulators 2, 5, 7, 17, 18, and 19. These areas generally correspond to the highest CSO volume discharges (found in **Table 9-2)** in the Delaware River, Ridley Creek, and Chester Creek with the exception of CSO regulator 7, which is located near the Flower Street Chester City Boat Ramp on the Chester Riverfront, an area identified by the public as an area of interest. Other CSO regulators in nearby areas are included as secondary targets if any control technologies can also provide capture in addition to the primarily targeted overflows. Corvias recommended a number of locations for green infrastructure, and DELCORA requested a focus on maximizing the use of locations near CSO regulators 18 and 19. Regulator modifications are a low-cost option DELCORA can implement in all regulators, and are included in every one of the Targeted control alternatives. This creates a distinction between "global" alternatives created by the control technologies listed in the Consent Decree to control for various overflow levels, and "regulator modification" alternatives created through this targeted control of overflow.

Once the technologies were identified, they were combined into alternatives and modeled in EPA-SWMM. Storage tanks were sized and added to some of the alternatives to provide additional options for the Consent Decree approach. This continued until a total of 15 alternatives were finalized for final discharge and cost analysis.

9.7 Alternatives for Final Analysis

To assemble alternatives for a final selection, the technologies required by the Consent Decree were first considered. These include the following:

- Tunnel Storage
- Tank Storage
- Green Stormwater Infrastructure
- Plant Expansion
- Sewer Separation

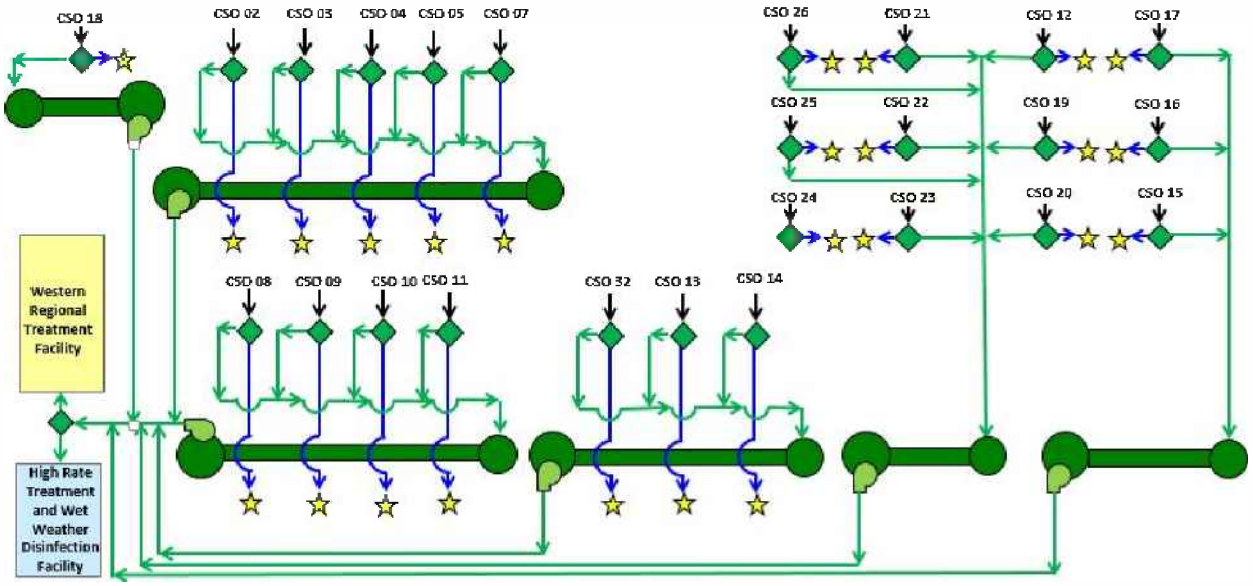
Other feasible CSO control technologies identified through the alternative screening and targeted approach include the following:

- Regulator Modification
- CSO 5 Partial Separation
- West End Interceptor Expansion to PS-6
- Delaware River Parallel Interceptor

Tunnel Storage

This CSO control technology consists of 6 storage tunnels of various diameters at the most downstream point of grouped CSO areas through various transmission mains that lead from the CSO regulators to the downstream storage tunnels. The diameters of the tunnels are sized for the level of overflow control desired, and can be used to supplement other control technologies. It is assumed that these tunnels will be gravity fed (no pumping required). **Figure 9-1** shows a schematic of the grouped CSO areas that feed the various tunnels serving as temporary storage devices.

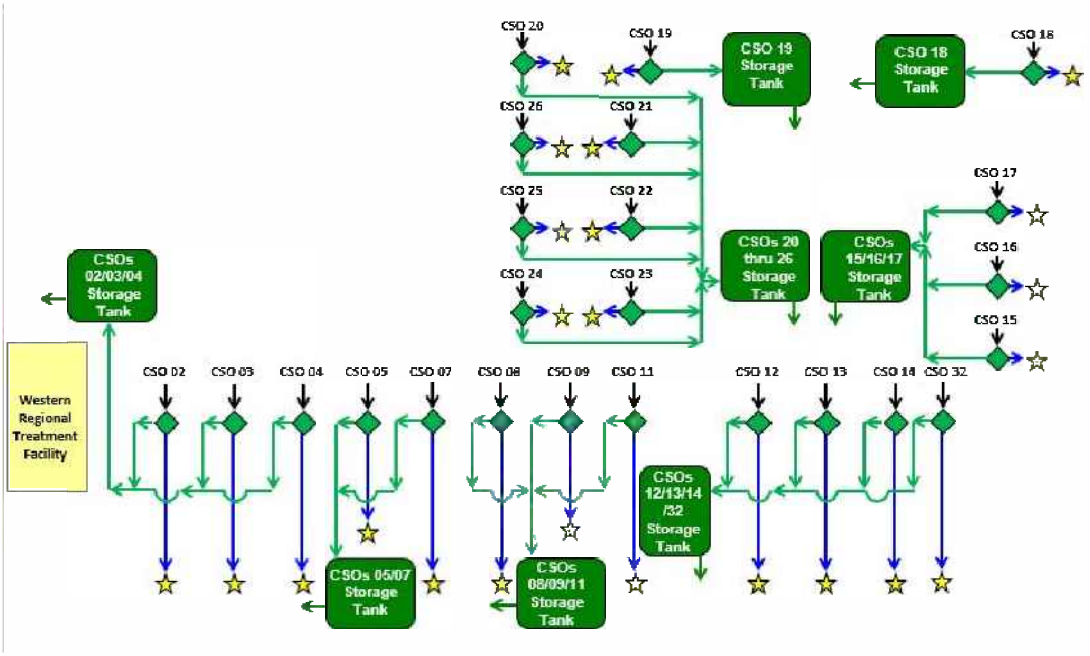
Figure 9-1: Schematic of Tunnel Storage Grouping



Tank Storage

This CSO control technology consists of 8 storage tanks throughout the study area at a depth of 15-feet at the most downstream point of grouped CSO areas through various transmission mains that lead from the CSO regulators to the downstream storage tanks. The tanks are sized for the level of overflow control desired, and can be used to supplement other control technologies. It is assumed that these tanks will be gravity fed (no pumping required). **Figure 9-2** shows a schematic of the grouped CSO areas that feed the various tanks serving as temporary storage devices.

Figure 9-2: Schematic of Tank Storage Grouping



Green Stormwater Infrastructure

This CSO control technology consists of 4 green infrastructure Control Technologies identified by Corvias in CSO areas 18 and 19. **Appendix N** in this document describes the overall process to determine the type and placement of the green infrastructure Control Technologies, also known as Green Stormwater Infrastructure (GSI). Strategically placed to ensure value in its installation, the GSIs include underground storage, permeable pavement, and green streets. Refer to **Subsection 8.5** for more details regarding Green Infrastructure Technologies applicable in these areas. One major constraint of this technology is its inability to achieve the levels of overflow control desired alone. However, GSI is a gravity fed source control and removes some levels of CSO-contributing stormwater through infiltration, making it an effective supplemental technology.

Plant Expansion

This CSO control technology consists of an expansion of the primary and secondary capacity of the WRTP by modeling ideal pumps, increased interceptor capacity, and regulator modifications to get this additional flow to the expanded WRTP. Pump station upgrades will be needed for an ideal pumping rate that allows all water at a pump station to reach the WRTP and not the CSO outfall. The additional

conveyance does not consider the piping outside of interceptor improvements to get flow from the inlets to the pump stations, so there may still be overflows that occur before reaching the interceptors. Plant expansion examined the following three options: equalization/storage tank at the WRTP, chemically enhanced primary treatment with discharge to CSO 002, and side stream secondary treatment/secondary treatment equivalent. These three options were estimated for cost, and the lowest-price option for each overflow requirement was selected for the most cost-effective treatment. The wet weather blending and side stream treatment sizing and costs were developed into a cost curve based on WRTP Process and Hydraulic Evaluation report in **Appendix P** for system modifications to receive increased flows at the wastewater treatment plant.

Sewer Separation

Sewer separation is a technology used to approach zero overflow events in a Typical Year. To comply with the Consent Order evaluation of alternatives, sewer separation has been applied as a system wide approach to reducing CSOs, implemented within the whole CSO area. By converting the combined sewer system into separate stormwater and sanitary sewage collection systems, this prevents any sanitary wastewater from being discharged to receiving water.

Regulator Modifications

Regulator modification is a Control Technology that allows the current regulator structures to be altered to maximize existing inline storage and flow, and minimize CSOs. Building diversion weirs up inside of the regulator prevents CSOs during smaller storm events, pushes more water into the interceptors, and utilizes upstream pipes as temporary storage. The regulator gates, orifice plates, and outflow pipes to the interceptors must also be altered to accommodate the increased flow. Should the increased flow be significant enough, plant expansion will also need to be incorporated utilizing one of the options presented in Alternative 5. **Table 9-5** gives more detail for the proposed regulator modifications that should be undertaken to obtain the desired conditions within the sewer network.

Each of the regulator modifications were made with a specific purpose. In general, the modifications can be classified in five categories: increasing the regulator gate opening, increasing the orifice plate opening, increasing the weir length, increasing the weir height, and increasing the effluent pipe diameter. The regulator gate and orifice plate sizes generally change together, as they both regulate flow. Increasing one may provide some increase of flow to the interceptor, but increasing both will decrease the hydraulic limitation. Increasing the length and height of the weir generally occurs together, but it depends on the existing weir height. Since the pipes are circular, if the existing weir is not covering at least half of the overflow pipe, then the weir length will increase with the weir height as the pipe gets wider at its center point. If the weir is already at covering at least half of the pipe, the length will actually decrease with the increasing height. This weir length adjustment is only done for modeling purposes, as the height is the important concept to understand when constructing the modifications. Increasing the weir's height holds back combined flow from the overflow pipe, and provides a very small form of inline storage utilizing the existing upstream piping. The water surface level of the inline storage is at its peak at the weir's new height, and provides some additional pressure for the stored water toward the interceptor. The last category, the increased effluent pipe diameter, is used when the additional water being pushed to the interceptor is limited by the existing pipe size. As this modification requires construction outside of the regulator to make a new connection to the interceptor, it is the most expensive, and used sparingly. Each of these modifications are made with the intent to make sure the downstream interceptor capacity is fully utilized before overflow occurs, to maintain a similar hydraulic grade line during peak flow, and to not cause significant surcharging from existing manholes.

Table 9-5: Overall List of Proposed Regulator Modifications

		Regulator Modifications				Increase Effluent Pipe Size
		Increase Gate Opening	Increase Orifice Plate Opening	Increase Weir Length	Increase Weir Height	
RCI	#013	x	x	x	x	x
	#014	x	x	x	x	
	#015	x		x	x	x
	#016	x	x	x	x	
	#017	x		x	x	x
	#018	x		x	x	x
CCEI	#019	x			x	
CCWI	#020	x	x		x	
PSI	#024					
	#025	x	x			
	#026	x	x			
EAI	#012					
	#021	x	x			
	#022	x	x			
	#023	x	x			
SSI	#08	x	x		x	
	#09	x	x		x	
	#11	x	x			
DRI	#05		x		x	
	#02					
	#03					
	#04					
	#07					

WEI Add a 36" connection at MH-1765 for #10 overflow

Note:

RCI: Ridley Creek Interceptor (CSO 33, 18, 17, 16, 15, 14, 13, 32)
CCEI: Chester Creek East Interceptor (CSO 19)
CCWI: Chester Creek West Interceptor (CSO 20)
PSI: Penn Street Interceptor (CSO 26, 25, 24)
EAI: Edgmont Ave Interceptor (CSO 21, 22, 23, 12)
SSI: Second Street Interceptor (CSO 11, 10, 9, 8)
DRI: Delaware River Interceptor (CSO 7, 5, 4, 3, 2)
WEI: West End Interceptor (CSO 10)

In addition to these changes, a specific modification will be made to CSO Regulator #10, where the orifice plate will be completely removed, the weir opening for overflow covered more, and the 15" effluent pipe fully replaced with a 36" pipe connected to the West End Interceptor. Before these changes, all overflow went to Regulator #9, where it would either flow into the 2nd Street Interceptor or overflow into the Delaware River. After these changes, the underutilized West End Interceptor will receiving significantly more flow from Regulator #10, providing in-line storage should the WRTP need to detain flow during larger storms. Detail of this connection can be found in **Figure 9-3**.

Figure 9-3: CSO Regulator #10 Modifications

All regulator modification costs assume a fixed cost based on an approximate regulator gate replacement size, which was obtained from discussions with the current contractor replacing upgrading the existing regulators for DELCORA. The three fixed costs are:

- 12" x 12" = $175,000
- 15" x 15" = $180,000
- 18" x 18" = $215,000

$12,000 is added for each regulator to account for access covers, 1 week of labor, traffic control, asphalt replacement, and scaffolding.

CSO 5 Partial Combined Sewer Separation

This CSO control technology differs from the complete separation option in scale. A partial sewer separation was identified specifically for the combined sewer area north of Veterans Memorial Park. By separating combined flow at Townsend St, stormwater flow will be reduced to the overloaded Delaware River Interceptor. The separated sanitary line will continue to CSO 5 with the remaining combined flow. Only a fraction of the stormwater is from the City of Chester; the remainder comes from the separated Chester Township lines that discharge over the surface at Veterans Memorial Park and into the existing CSS system. With this disconnection, the overland flow from Chester Township and the City of Chester will be diverted away from the CSS system and back into an existing storm sewer line. The estimate for this Alternative was provided by Remington & Vernick Engineers.

West End Interceptor Expansion to PS-6

The Delaware River Interceptor (DRI) has a bottleneck before it reaches the WRTP, not providing the correct amount of pipe conveyance capacity for the combined sewer area flow during storm events. A segment of the West End Interceptor (WEI) was discontinued, and flow was joined to the Delaware River Interceptor, placing the active 54" line into an already full 24" going to EPS-1. With the construction of PS-6, more flow can be pumped to the WRTP. Rehabilitating the discontinued segment of the West End Interceptor and building a connecting line to PS-6 would help relieve overflows along the Delaware River Interceptor regulators caused by this bottleneck.

Parallel Delaware River Interceptor

The DRI has a bottleneck before it reaches the WRTP, which limits the pipe conveyance capacity for the combined sewer area flow during storm events. The interceptor increases to a maximum of 24", but experiences frequent CSO overflows, especially near CSO regulator #5. This CSO control technology adds a 30" parallel interceptor to the DRI flow. The parallel interceptor connects CSO regulators 2, 3, and 4 to PS-6, following the same path as the existing DRI as a complimentary flow path when the 24" DRI line needs the additional conveyance capacity, as well as the additional pumping capacity necessary at PS-6 to handle the desired level of control.

The evaluation of some technologies for grouping led to some being utilized more than others. Green stormwater infrastructure cannot meet the water quality standards of the Presumption Approach in isolation, so this technology was combined to provide a system wide alternatives with other of those required by the Consent Decree. However, due to its ease of use and effectiveness, regulator modifications were used as a base modification for the targeted alternatives. The details the various alternatives that will be looked into further for final selection are presented in **Table 9-6.**

Table 9-6: Alternatives for Final Analysis

Alternative Number	Alternative Description
1	Tunnel Storage
2	Tank Storage
3	GSI + Tunnel Storage
4	GSI + Tank Storage
5	Plant Expansion
6	Sewer separation
7	Regulator Modifications
8	Regulator Modifications + Tank Storage
9	Regulator Modifications + GSI
10	Regulator Modifications + CSO 5 Partial Separation
11	Regulator Modifications + WEI Expansion to PS-6
12	Regulator Modifications + WEI Expansion to PS-6 + Parallel Interceptor
13	Regulator Modifications + WEI Expansion to PS-6 + Parallel Interceptor + Storage
14	Regulator Modifications + WEI Expansion to PS-6 + Parallel Interceptor + Storage + GSI + CSO 5 Partial Separation
15	Regulator Modifications + WEI Expansion to PS-6 + Parallel Interceptor + GSI + CSO 5 Partial Separation

Of note is the breakdown of alternatives between those system wide alternatives required by the Consent Decree (Alternatives 1-6), and the targeted alternatives built on regulator modifications (Alternatives 7-15). Based on the results of the model analysis and spreadsheet calculations, the volume capture percentages for each alternative will be understood, and costs assigned. The final alternative selection for each equivalent capture percentage will essentially be chosen based on the cheapest life-cycle cost option.

The following subsections are descriptions of each of the Alternatives listed in **Table 9-6**. Costs have been escalated to Philadelphia July 2018 using the Engineering News Record Construction Cost Index.

9.7.1 Alternative 1

- Tunnel Storage

Figure 9-4 depicts the locations of the various transmission mains that lead from the CSO regulators to the downstream storage tunnel. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-7**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 1 COP @ $470,000/COP/yr, 1% Tunnel Maintenance/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-4: Tunnel Storage and Transmission Locations (Alt 1)

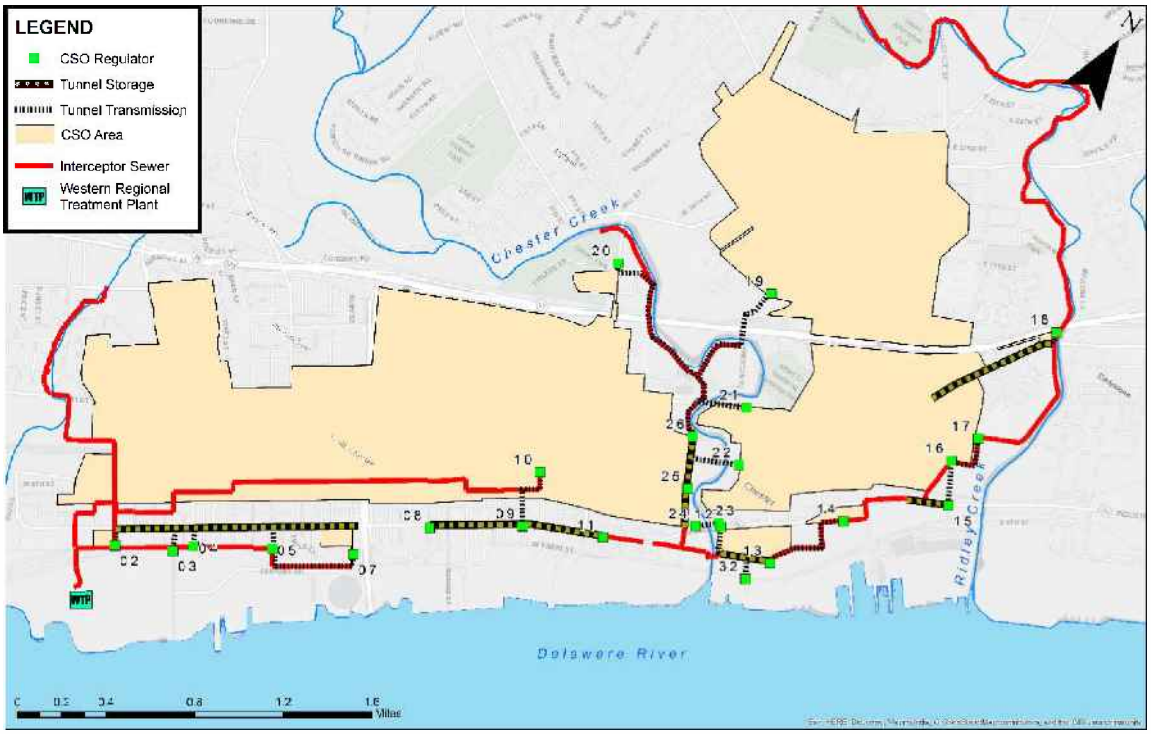


Table 9-7: Capital and Life Cycle Costs by Overflow for Alternative 1

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 198,300,000	$ 232,200,000
2	$ 165,900,000	$ 195,300,000
4	$ 153,900,000	$ 181,800,000
6	$ 133,300,000	$ 158,400,000
8	$ 126,100,000	$ 150,300,000
12	$ 111,700,000	$ 133,900,000
20	$ 76,500,000	$ 94,000,000
43	$ 27,600,000	$ 38,500,000

9.7.2 Alternative 2

- Tank Storage

Figure 9-5 depicts the various transmission mains that lead from the CSO regulators to the downstream storage tank The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-8**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 0.5 COP @ $470,000/COP/yr, 3% Tanks and Structure

Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-5: Tank Storage and Transmission Locations (Alt 2)

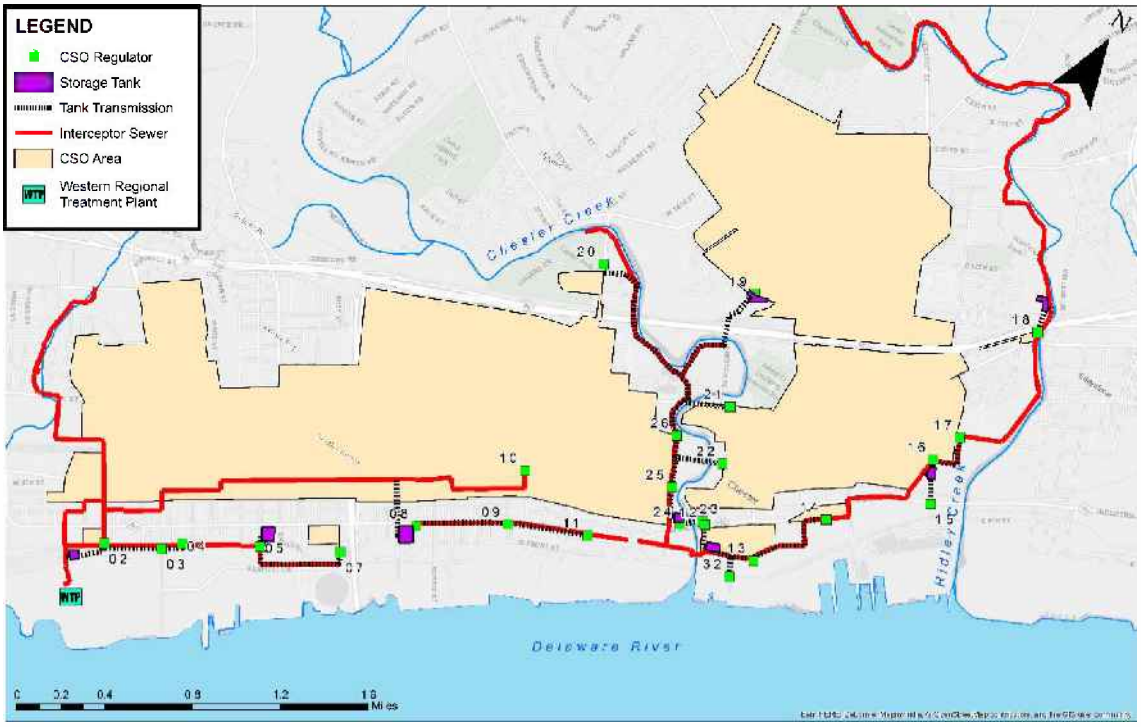


Table 9-8: Capital and Life Cycle Costs by Overflow for Alternative 2

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 246,000,000	$ 338,500,000
2	$ 159,700,000	$ 217,500,000
4	$ 142,800,000	$ 193,900,000
6	$ 123,300,000	$ 166,500,000
8	$ 108,900,000	$ 147,100,000
12	$ 95,100,000	$ 128,600,000
20	$ 73,000,000	$ 99,800,000
43	$ 52,900,000	$ 71,600,000

9.7.3 Alternative 3

- Tunnel Storage
- Green Stormwater Infrastructure

Figure 9-6 has the layout for Control Technologies comprising Alternative 3. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-9**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; GSI costs are estimated in the Green Stormwater Infrastructure report in **Appendix N**; and 1 COP @ $470,000/COP/yr, 1% Tunnel Maintenance/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-6: GI, Tunnel Storage and Transmission Locations (Alt 3)

Table 9-9: Capital and Life Cycle Costs by Overflow for Alternative 3

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 199,500,000	$ 233,800,000
2	$ 164,100,000	$ 193,700,000
4	$ 146,200,000	$ 173,300,000
6	$ 130,100,000	$ 155,100,000
8	$ 124,500,000	$ 148,700,000
12	$ 110,800,000	$ 133,200,000
20	$ 78,500,000	$ 96,500,000
43	$ 37,700,000	$ 50,200,000

9.7.4 Alternative 4

- Tank Storage
- Green Stormwater Infrastructure

Figure 9-7 presents the layout for the Control Technologies included in Alternative 4. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-10**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; GSI costs are estimated in the Green Stormwater Infrastructure report in **Appendix N**; and 0.5 COP @ $470,000/COP/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-7: GI, Tank Storage, and Transmission Locations (Alt 4)

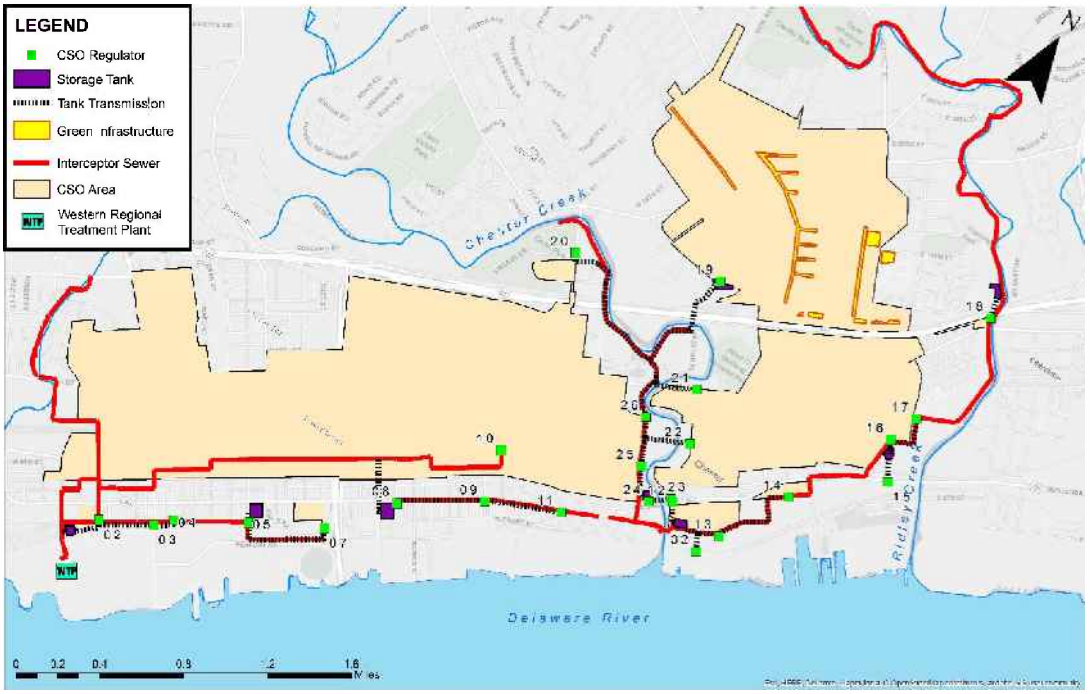


Table 9-10: Capital and Life Cycle Costs by Overflow for Alternative 4

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 247,900,000	$ 338,800,000
2	$ 163,500,000	$ 220,400,000
4	$ 145,500,000	$ 195,200,000
6	$ 128,100,000	$ 170,800,000
8	$ 114,200,000	$ 152,100,000
12	$ 101,700,000	$ 135,300,000
20	$ 79,700,000	$ 106,800,000
43	$ 63,000,000	$ 83,300,000

9.7.5 Alternative 5

- Plant Expansion

Figure 9-8 demonstrates which interceptor pipes would be upgraded for Alternative 5. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-11, Table 9-12** and **Table 9-13**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 45% Pump Station - Difficult Installation, 50% WWTP Upgrade – Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 1 COP @ $470,000/COP/yr, 3% Tanks and Structure Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-8: Interceptor Improvements for Plant Expansion (Alt 5)

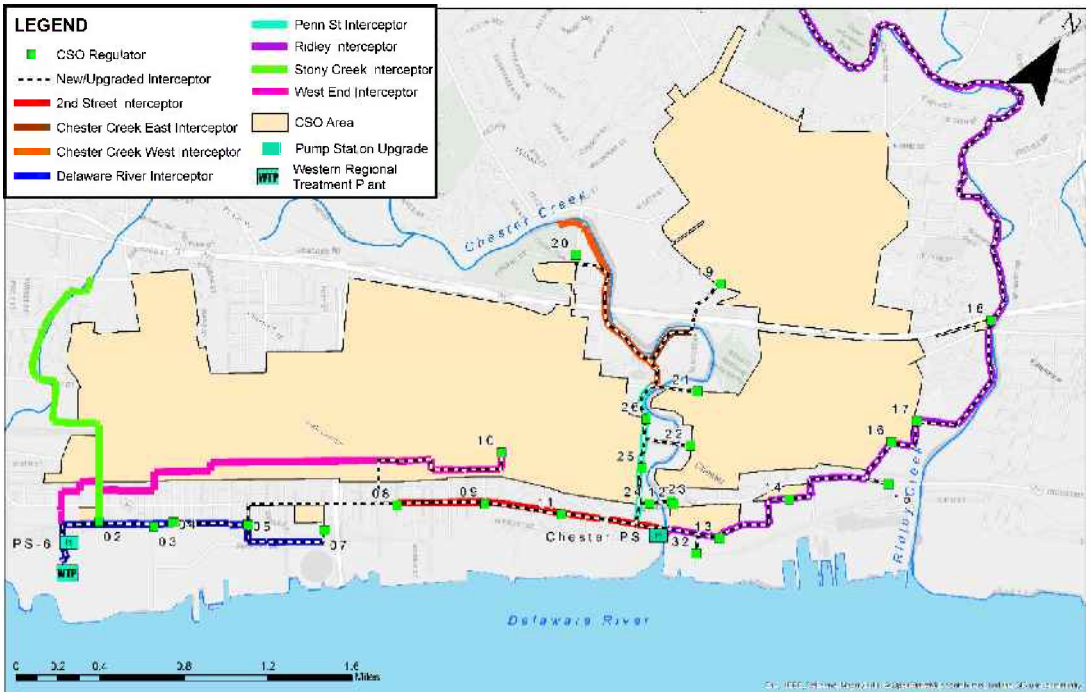


Table 9-11: Capital and Life Cycle Costs by Overflow for Alternative 5 Wet Weather Blending

Alt 5 - Wet Weather Blending			
OF/yr	Capital Cost ($)	Life Cycle Cost ($)	Plant Inflow (MGD)
0	$ -	$ -	N/A
2	$ -	$ -	N/A
4	$ 204,800,000	$ 268,200,000	258.8
6	$ 138,800,000	$ 186,600,000	170.8
8	$ 120,700,000	$ 164,300,000	149.9
12	$ 101,300,000	$ 140,300,000	143.5
20	$ 75,100,000	$ 114,100,000	136.7
43	$ 36,800,000	$ 69,600,000	106.8

Table 9-12: Capital and Life Cycle Costs by Overflow for Alternative 5 BIOACTIFLO

Alt 5 - BIOACTIFLO			
OF/yr	Capital Cost ($)	Life Cycle Cost ($)	Plant Inflow (MGD)
0	$ -	$ -	N/A
2	$ -	$ -	N/A
4	$ 243,200,000	$ 315,500,000	258.8
6	$ 157,400,000	$ 209,600,000	170.8
8	$ 134,900,000	$ 181,800,000	149.9
12	$ 112,500,000	$ 154,100,000	143.5
20	$ 79,400,000	$ 121,000,000	136.7
43	$ 36,800,000	$ 70,600,000	106.8

Table 9-13: Capital and Life Cycle Costs by Overflow for Alternative 5 Equalization Basin

Alt 5 – Equalization Basin			
OF/yr	Capital Cost ($)	Life Cycle Cost ($)	Plant Storage (MG)
0	$ -	$ -	N/A
2	$ -	$ -	N/A
4	$ 211,400,000	$ 276,300,000	18.1
6	$ 135,000,000	$ 182,000,000	8.1
8	$ 109,000,000	$ 149,900,000	4.7
12	$ 82,700,000	$ 117,300,000	3.2
20	$ 55,300,000	$ 89,900,000	2.3
43	$ 36,800,000	$ 65,000,000	N/A

9.7.6 Alternative 6

- Sewer Separation

Figure 9-9 depicts the combined sewer area to be separated – the entirety of the Combined Sewer Area in the City of Chester. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-14**. All separated sewer costs assume a per acre cost calculation except the regulator 18 drainage area, which uses the recommended approach cost in the Draft Feasibility Study for Pipe Repairs From M.H. 329 to M.H. 3070 and Combination Flow Mitigation for C.S.O. No. 18 in **Appendix Q**. These costs assume 45% Heavy Utilities Pipe Contingency, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from pipe installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 1 COP @ $470,000/COP/yr, 3% Tanks and Structure Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-9: Total Sewer Separation (Alt 6)

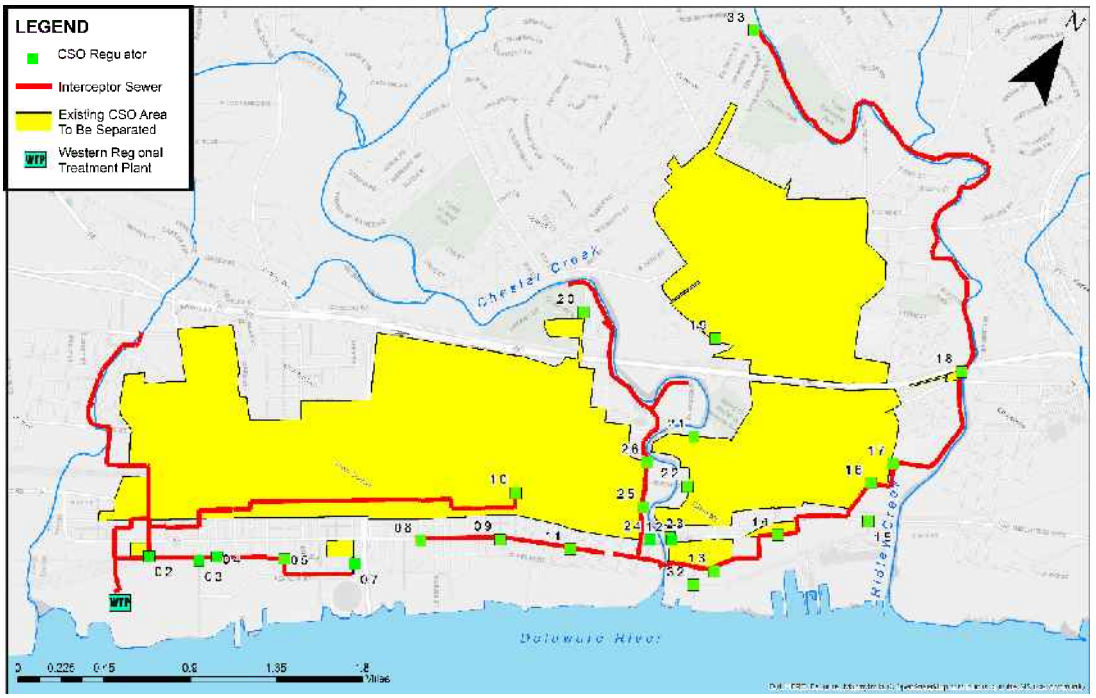


Table 9-14: Capital and Life Cycle Costs by Overflow for Alternative 6

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 186,000,000	$ 193,100,000

9.7.7 Alternative 7

- Regulator Modifications

The locations for any regulators identified for modification are listed on **Figure 9-10**. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-15.** These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from pipe installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-10: Regulator Modifications (Alt 7)

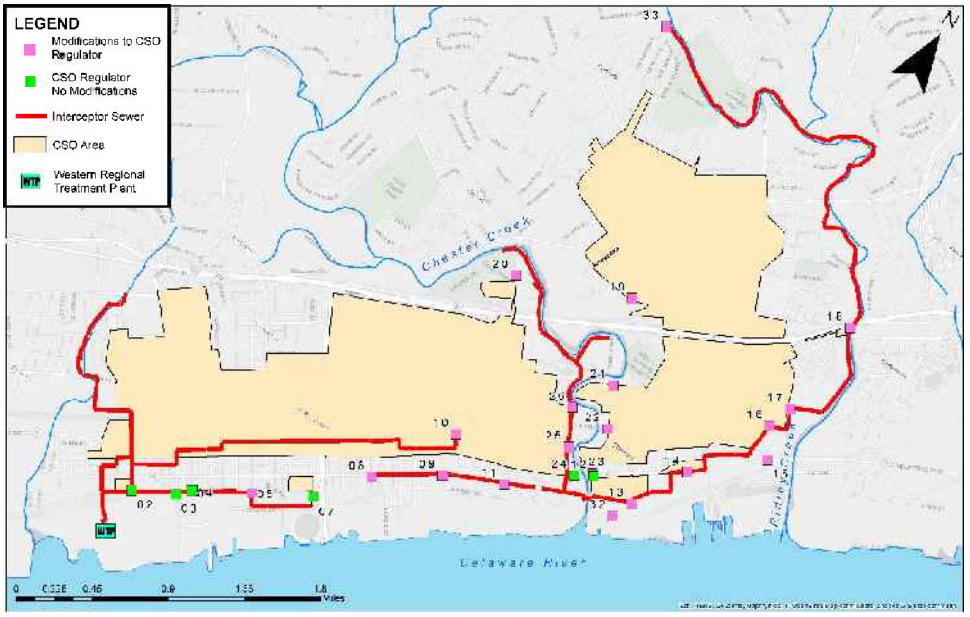


Table 9-15: Capital and Life Cycle Costs by Overflow for Alternative 7

% Capture	Capital Cost ($)	Life Cycle Cost ($)
88.8%	$ 5,100,000	$ 14,200,000

9.7.8 Alternative 8

- Tank Storage
- Regulator Modifications

Figure 9-11 shows specific locations of storage tanks needed in addition to the implementation of regulator modifications. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-16**. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; and 0.5 COP @ $470,000/COP/yr, 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-11: Regulator Modifications w/ Storage Tanks (Alt 8)

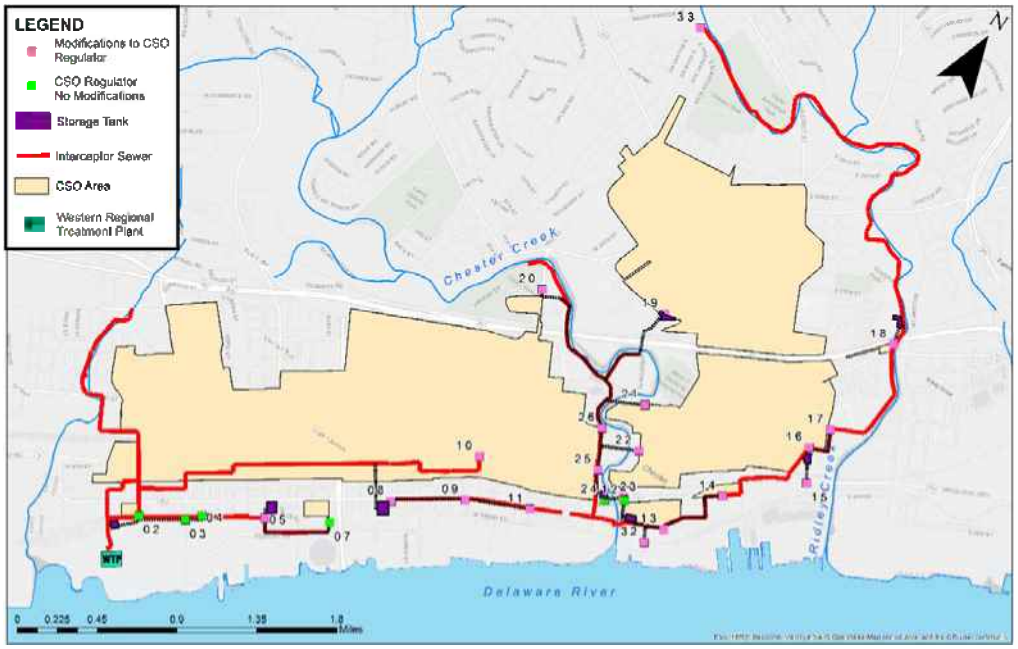


Table 9-16: Capital and Life Cycle Costs by Overflow for Alternative 8

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 223,300,000	$ 306,700,000
2	$ 136,400,000	$ 184,700,000
4	$ 116,900,000	$ 157,500,000
6	$ 105,300,000	$ 141,200,000
8	$ 95,600,000	$ 128,400,000
12	$ 84,200,000	$ 113,200,000
20	$ 54,800,000	$ 74,300,000

9.7.9 Alternative 9

- Tank Storage
- Regulator Modifications

See **Figure 9-12** for the layout of the GSI and the locations for any regulators identified for modification in this Alternative. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-17**. These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; GSI costs are estimated in the Green Stormwater Infrastructure report in **Appendix N**; and 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital cost for life cycle costs.

Figure 9-12: Regulator Modifications w/ CSO 18 Green Infrastructure (Alt 9)

Table 9-17: Capital and Life Cycle Costs by Overflow for Alternative 9

% Capture	Capital Cost ($)	Life Cycle Cost ($)
89.0%	$ 9,400,000	$ 26,000,000

9.7.10 Alternative 10

- Regulator Modifications
- CSO 5 Partial Combined Sewer Separation

Figure 9-13 displays this Alternative's implementation of the partial sewer separation with the locations of regulators identified for modification. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-18**. These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the estimate for the partial separation of the regulator 5 drainage area was gathered from Remington & Vernick Engineers, which included 20% Sewer Separation – Heavy Utilities, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from transmission installation costs and 15% Engineering and Inspection, and 3% Permitting markups from construction costs for capital costs; and 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the total of both capital costs for life cycle costs.

Figure 9-13: Regulator Modifications w/ CSO 5 Partial Sewer Separation (Alt 10)

Table 9-18: Capital and Life Cycle Costs by Overflow for Alternative 10

% Capture	Capital Cost ($)	Life Cycle Cost ($)
89.9%	$ 9,500,000	$ 18,700,000

9.7.11 Alternative 11

- Regulator Modifications
- West End Interceptor Expansion to PS-6

Figure 9-14 is an overall plan view of the layout of the WEI pipe expansion with the regulators identified for modification. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-19**. These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/ Demobilization markups from transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the pipe rehabilitation and installation capital cost estimate for the WEI portion of this alternative taken from the Weston Solutions, Inc. LTCPU (April, 2012); and 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the total of both capital costs for life cycle costs.

Figure 9-14: Regulator Modifications w/ West End Interceptor Extension (Alt 11)

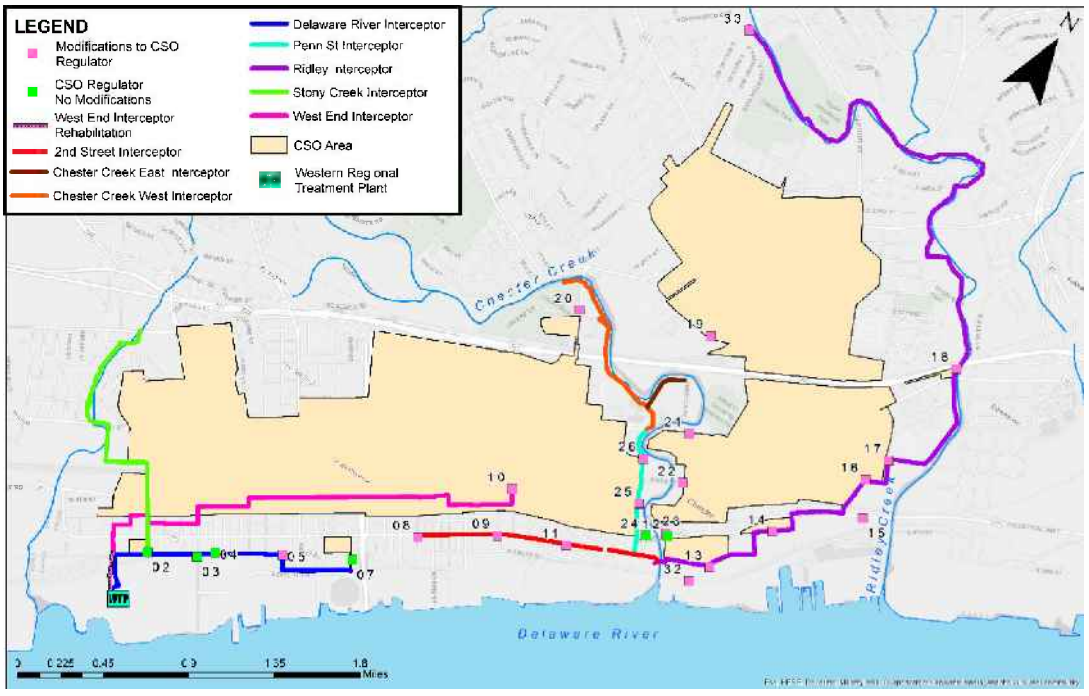


Table 9-19: Capital and Life Cycle Costs by Overflow for Alternative 11

% Capture	Capital Cost ($)	Life Cycle Cost ($)
88.4%	$ 7,500,000	$ 16,700,000

9.7.12 Alternative 12

- Regulator Modifications
- West End Interceptor Expansion to PS-6
- Parallel Delaware River Interceptor

Figure 9-15 is an overall plan view of the layout of the WEI pipe expansion and DRI parallel interceptor with the regulators identified for modification. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-20**. Jack and bore costs for the parallel DRI pipe were estimated at 500 LF @ $1,500/LF based on the same work for the regulator 5 partial sewer separation. These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the pipe rehabilitation and installation capital cost estimate for the WEI portion of this alternative taken from the Weston Solutions, Inc. LTCPU (April, 2012); and 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the total of both capital costs for life cycle costs.

Figure 9-15: Regulator Modifications w/ WEI Expansion & DRI 30" Parallel Interceptor (Alt 12)

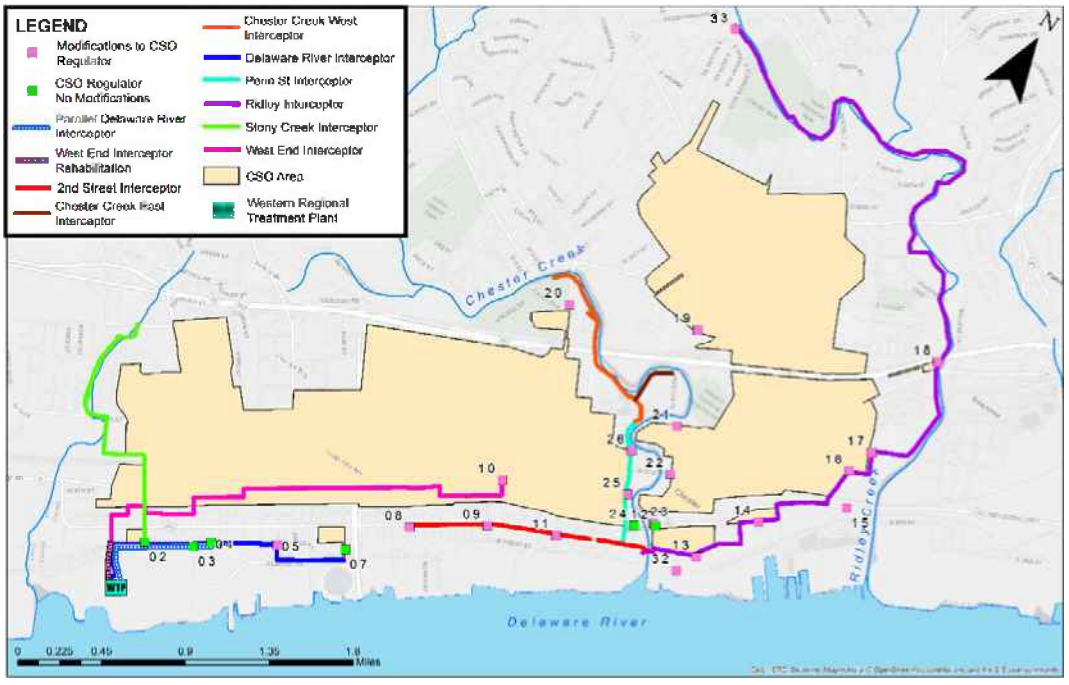


Table 9-20: Capital and Life Cycle Costs by Overflow for Alternative 12

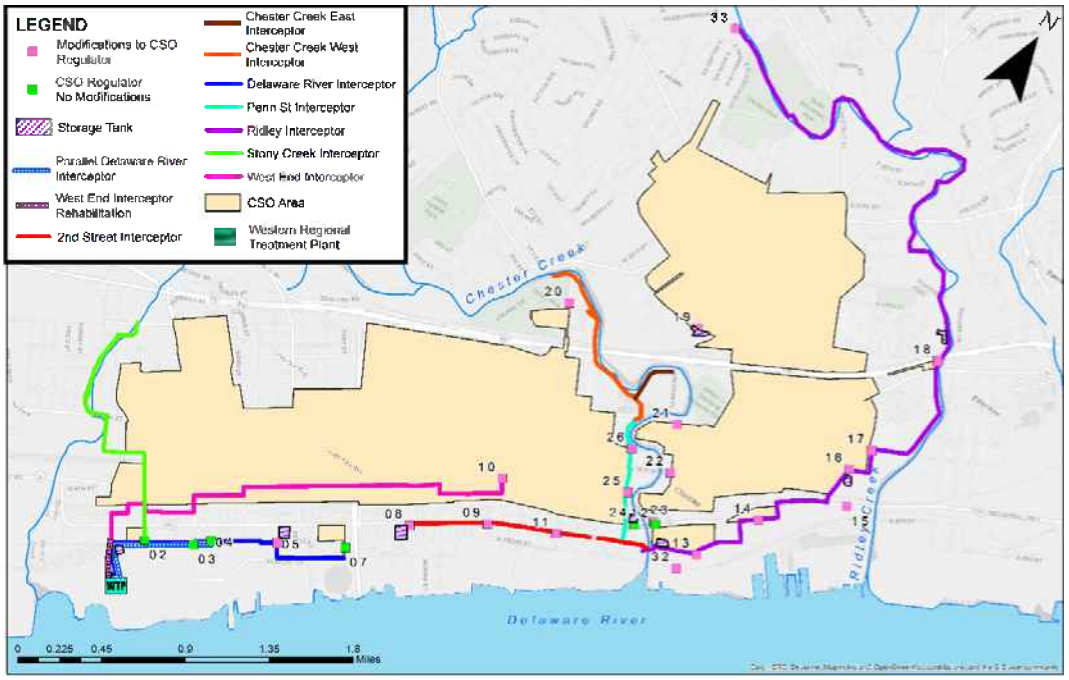
% Capture	Capital Cost ($)	Life Cycle Cost ($)
91.2%	$ 28,500,000	$ 37,800,000

9.7.13 Alternative 13

- Tank Storage
- Regulator Modifications
- West End Interceptor Expansion to PS-6
- Parallel Delaware River Interceptor

Figure 9-16 is an overall plan view of the layout of the WEI pipe expansion and DRI parallel interceptor with the regulators identified for modification and additional tank storage to meet the desired level of overflow control.

Figure 9-16: Regulator Modifications w/ WEI Expansion, DRI PI, and Tank Storage (Alt 13)



The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-21**. Jack and bore costs for the parallel DRI pipe were estimated at 500 LF @ $1,500/LF based on the same work for the regulator 5 partial sewer separation. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 25% Regulator/Real Time Control Contingency – Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the pipe rehabilitation and installation capital cost estimate for the WEI portion of this alternative taken from the Weston Solutions, Inc. LTCPU (April, 2012);and 0.5 COP @ $470,000/COP/yr, 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital costs for life cycle costs.

Table 9-21: Capital and Life Cycle Costs by Overflow for Alternative 13

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 230,100,000	$ 314,000,000
2	$ 143,400,000	$ 192,300,000
4	$ 127,500,000	$ 170,100,000
6	$ 118,000,000	$ 156,900,000
8	$ 109,200,000	$ 145,300,000
12	$ 100,400,000	$ 133,700,000
20	$ 73,100,000	$ 97,700,000

9.7.14 Alternative 14

- Tank Storage
- Green Stormwater Infrastructure
- Regulator Modifications
- CSO 5 Partial Combined Sewer Separation
- West End Interceptor Expansion to PS-6
- Parallel Delaware River Interceptor

Figure 9-17 is an overall plan view of the layout of the WEI pipe expansion, DRI parallel interceptor, GSI additions, and partial sewer separation in the CSO regulator #5 drainage area, with the regulators identified for modification and additional tank storage to meet the desired level of overflow control. The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-22**. Jack and bore costs for the parallel DRI pipe were estimated at 500 LF @ $1,500/LF based on the same work for the regulator 5 partial sewer separation. These costs assume 45% Heavy Utilities Pipe Contingency, 50% Heavy Utilities Storage Contingency, 25% Regulator/Real Time Control Contingency – Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the pipe rehabilitation and installation capital cost estimate for the WEI portion of this alternative taken from the Weston Solutions, Inc. LTCPU (April, 2012); the estimate for the partial separation of the regulator 5 drainage area was gathered from Remington & Vernick Engineers, which included 20% Sewer Separation – Heavy Utilities, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from transmission installation costs and 15% Engineering and Inspection, and 3% Permitting markups from construction costs for capital costs; GSI costs are estimated in the Green Stormwater Infrastructure report in **Appendix N**; and 0.5 COP @ $470,000/COP/yr, 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital costs for life cycle costs.

Figure 9-17: Regulator Modifications w/ DRI BN, DRI PI, CSO 18 GI, CSO 5 PSS and Tank Storage (Alt 14)

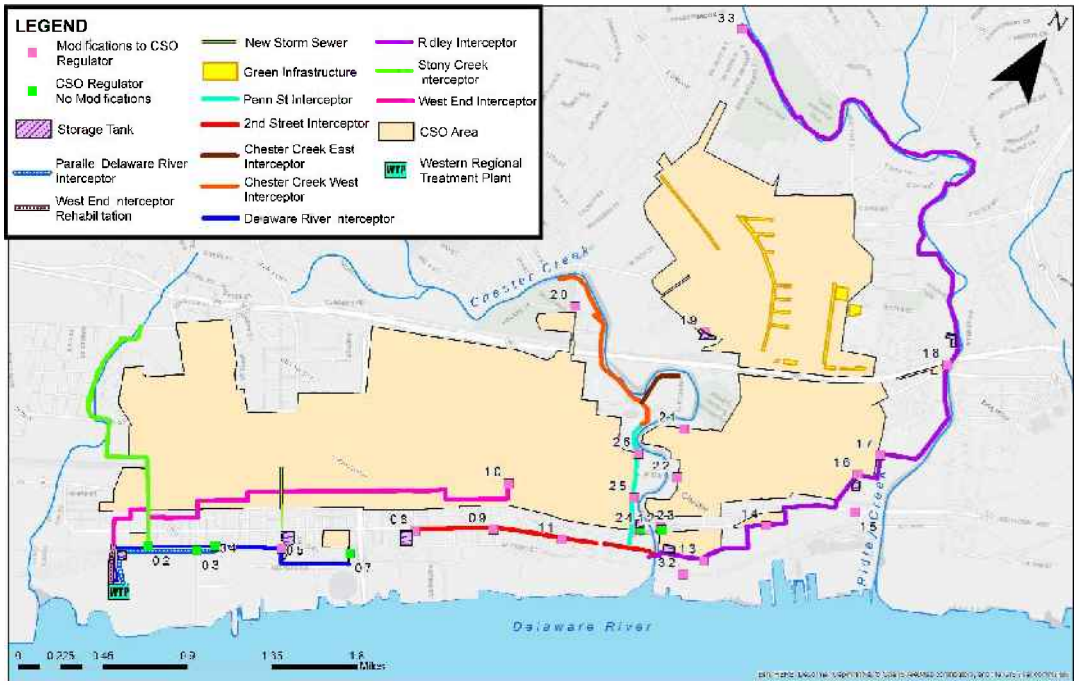


Table 9-22: Capital and Life Cycle Costs by Overflow for Alternative 14

OF/yr	Capital Cost ($)	Life Cycle Cost ($)
0	$ 246,300,000	$ 322,700,000
2	$ 161,000,000	$ 203,000,000
4	$ 145,300,000	$ 181,000,000
6	$ 138,000,000	$ 170,800,000
8	$ 131,400,000	$ 162,300,000
12	$ 123,400,000	$ 151,900,000

9.7.15 Alternative 15

- Green Stormwater Infrastructure
- Regulator Modifications
- CSO 5 Partial Combined Sewer Separation
- West End Interceptor Expansion to PS-6
- Parallel Delaware River Interceptor

Figure 9-18 is an overall plan view of the layout of the WEI pipe expansion, DRI parallel interceptor, GSI additions, and partial sewer separation in the CSO regulator #5 drainage area, with the regulators identified for modification.

The Capital and Life Cycle Costs for this alternative are estimated in **Table 9-23**. Jack and bore costs for the parallel DRI pipe were estimated at 500 LF @ $1,500/LF based on the same work for the regulator 5 partial sewer separation. These costs assume 45% Heavy Utilities Pipe Contingency, 25% Regulator/Real Time Control Contingency - Difficult Modification, 15% Overhead & Profit, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from storage and transmission installation costs for construction costs; 10% Engineering, and 3% Permitting markups from construction costs for capital costs; the pipe rehabilitation and installation capital cost estimate for the WEI portion of this alternative taken from the Weston Solutions, Inc. LTCPU (April, 2012); the estimate for the partial separation of the regulator 5 drainage area was gathered from Remington & Vernick Engineers, which included 20% Sewer Separation – Heavy Utilities, 3% Bonds and Insurance, and 5% Mobilization/Demobilization markups from transmission installation costs and 15% Engineering and Inspection, and 3% Permitting markups from construction costs for capital costs; GSI costs are estimated in the Green Stormwater Infrastructure report in **Appendix N**; and 0.5 COP @ $470,000/COP/yr, 18 Operational Labor Costs @ $2,500/regulator/yr, 3% Tanks and Structure Maintenance Cost/yr, 0.25% Transmission Pipe Maintenance Cost/yr, O&M Present Value @ 20 yrs, 2.75% interest from the capital costs for life cycle costs.

Figure 9-18: Regulator Modifications w/DRI BN, DRI PI, CSO 18 GI, and CSO 5 PSS (Alt 15)

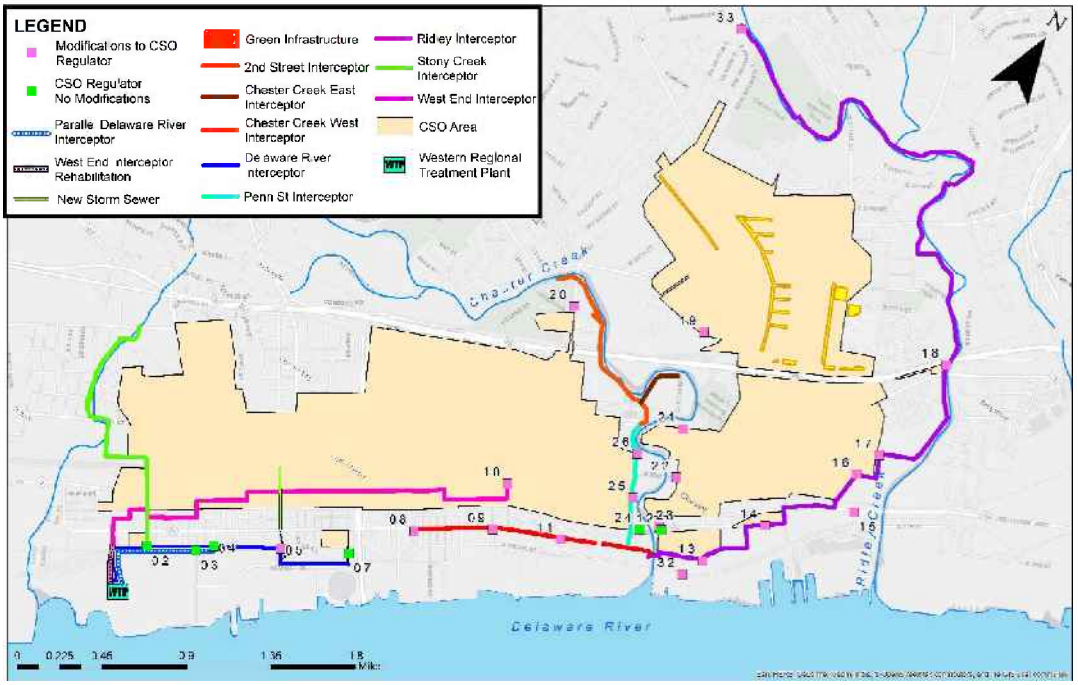


Table 9-23: Capital and Life Cycle Costs by Overflow for Alternative 15

% Capture	Capital Cost ($)	Life Cycle Cost ($)
94.0%	$ 43,000,000	$ 59,300,000

9.8 CSO Control Technology Knee of the Curve (KOTC) Analysis

The alternative plans above were modeled in EPA-SWMM before having the typical year run to find each plan's impact on CSOs and system wide percent capture. Alternative plans that allowed for CSOs to be limited to a specific number of discharges for a given year used spreadsheet analysis to determine the necessary storage sizes for each regulator grouping. The equivalent capture percent by overflows per year is presented in **Table 9-2**, and allows for a comparison between the alternatives that are tied to a maximum number of overflows per year, and the targeted approach alternatives based on system wide wet weather capture. The estimated capital cost for each project is presented in **Table 9-24**.

Table 9-24: Capital Costs by Control Technology Project

Project	Capital Costs (July 2018)
Regulator Modifications	$ 5,100,000.00
Parallel DRI	$ 3,500,000.00
WEI Interceptor Rehab & Extension	$ 2,400,000.00
CSO 18 & 19 GSI	$ 10,100,000.00
Plant Expansion/Upgrade	$ 15,500,000.00
CSO-5 Partial Separation	$ 4,400,000.00

The Unless a specific control technology cost was gathered from another estimate or quote, typical markups from the initial capital costs include the following list, where applicable, due to the heavily urbanized area of Chester City:

- Pipe Installation – Heavy Utilities Contingency (45%)
- Tank/Storage Conduit – Heavy Utilities Contingency (50%)
- Pump Station – Difficult Installation Contingency (45%)
- WWTP Upgrade – Difficult Modification Contingency (50%)
- Sewer Separation – Heavy Utilities Contingency (45%)
- Overhead and Profit (15%)
- Bonds and Insurance (3%)
- Mobilization/Demobilization (5%)

These costs are combined for a construction cost subtotal. This subtotal then has the following additional markups applied to get a Total Cost:

- Engineering (10%)
- Permitting (3%)

The total cost then has the following O&M costs applied, where applicable:

- Continuous Operating Post (1 COP = $470,000/yr)
- Tank/Structure Maintenance (3% of Construction Cost)
- Tunnel Maintenance (1% of Construction Cost)
- Pipe Transmission Maintenance (0.25% of Pipe Construction Costs)
- Regulator Cleaning Maintenance ($2,150/month)

The Present Values for these combined costs are then found for the next 20 years at $i = 2.75\%$. The sum of the Total Cost and the Present Value yields the Total Life Cycle Cost for each alternative plan. These costs can then be categorized by system wide capture percentage and compared. The Life Cycle costs for each alternative can be found on **Table 9-25.** This allows the lowest-cost Alternative to be identified by capture percentage. The lowest-cost Alternatives are selected and plotted by cost and capture percentage. This comparison is used to find which Alternative will yield the greatest results before significant increases in cost are needed. The point where this is to occur is the Knee of the Curve, and can be found on **Figure 9-19**. Alternative 15 was found to be this point on the KOTC curve, capturing 94.0% of the wet weather flow during wet weather conditions for $59.3M in Life-Cycle costs. Per the consent decree, the 0, 2, 4, 6, 8, and 12 overflow conditions for every CSO regulator were also specifically examined using the same procedure above. This KOTC by overflow can also be found in **Table 9-25.**

9.9 Current LTCPU Progress

DELCORA is currently making progress to improve WQ in the Delaware River, Ridley Creek, and Chester Creeks. The design and construction of the Regulator Monitoring System and replacement of Regulators 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 23, 24, 25 and 26 has been completed. Pipe grouting and other miscellaneous repairs have been made to the Ridley Creek Interceptor. In collaboration with Brookhaven Borough, DELCORA has performed partial sewer separation for the combined sewer area flowing into CSO regulator 33, reducing its overflow volume and frequency, and therefore the POC introduced into Ridley Creek. This action corresponds to reducing flows into an area of the Ridley Creek upstream of an area designated as Approved Trout Waters and Trout Stocked Streams, which were identified as a priority area because of this special environmental use. Chester East and Chester West Interceptors have also had grouting work performed on their pipe joints. Property has been purchased to expand the available area for future projects relating to the LTCPU. Construction of pump Station 6 is complete, and now conveys more flow to the WRTP. A table of all of the improvements made since the original LTCP in 1999 through 2018, including those implemented for the Nine Minimum Controls, can be found in **Table 9-26.** These costs have amounted to roughly $150M in work performed.

9.10 Selection of Alternative Plans

Of all the alternatives, Alternative Plans 7 and 15 efficiently utilize the pollution control benefits of the existing CSO system through reduction of wet weather overflows into the receiving waters. Alternative 15 has a higher cost and public disturbance, balanced by increased overall community benefit.

Alternative 7 was modeled to achieve almost 89% capture through regulator modifications alone. This technology alone best utilizes the existing infrastructure, and therefore provides the best cost savings of any of the proposed alternatives. Alternative 7 requires minimal investment into the infrastructure, but does not provide any further advantages outside of cost and minimizing short-term land disturbance. Wet weather flows to the WRTP will increase, and an additional study of the impact of these modifications on the WRTP may need to be performed after the alternative's operation.

Alternative 15 achieves a 94% system wide capture of wet weather flows before costs significantly increase for the higher capture rates. There are more CSO control technologies proposed in this alternative than in Alternative 7, but if further investment is possible, there is an argument that this is the best alternative based on the KOTC. All of the proposed targeted control technologies are utilized in this alternative. This means that all of the higher volume CSOs will be reduced in some form from this

alternative, something Alternative 7 does not guarantee. It also means that the non-cost factors considered in the development of the Targeted control technologies will be employed.

Utilizing green infrastructure for the regulator 18 and 19 drainage areas provides additional benefits for the surrounding community. The residential neighborhood, Widener University, and Edgmont Ave areas with the green street additions provide an aesthetic dimension to the road that was not there before. The Edgmont Ave corridor benefits even more from this green infrastructure beautification as a main thoroughfare into the city. The Stormwater Authority of Chester will ensure the continual operation and maintenance of the GSI.

The other additional control technologies implemented in Alternative 15 support DELCORA in the long-term to handle future increases in wet weather flow. The partial separation of the CSO regulator 5 drainage area is the most efficient control technology by cost per MG of overflow, and provides more capacity in the DRI during wet weather. Removing the DRI bottleneck and adding a parallel DRI interceptor line significantly increases flow to the WRTP instead of out of the CSO outfalls along the Delaware River. The newly completed PS-6 allows for these greater flows to be conveyed to the WRTP. Further studies on the impact of these flows to the WRTP need to be conducted after the completion of each control technology, but the CSO impact on receiving streams will be greatly lessened.

After evaluating the cost factors from the KOTC analysis, the non-cost factors and the existing infrastructure improvements made through LTCP early action items, an adaptive management plan that incorporates both Alternatives Plans 7 and 15 is the plan selected by DELCORA. Through adaptive management, improvements from Alternative 7 will be evaluated after their implementation, and further control technologies added from Alternative 15 pending the results of post-construction monitoring. A summary of the current baseline, Alternative 7, and Alternative 15 conditions are in **Table 9-27**, **Table 9-28** and **Table 9-29**. The control technologies can be modified based on flow data received from post-construction monitoring.

9.11 Unauthorized Releases

The selected CSO alternative plans will address most of the unauthorized releases within the DELCORA CSS. Based on the current modeling and monitoring, the LTCPU has identified four areas where the conveyance capacity level of service is known to be inadequate, leading to unauthorized releases. Four areas will require control technologies for the remaining unauthorized releases. These include the following:

- Central Delaware Pump Station
- Manhole 2897 in Nether Providence Township
- Manhole 591 in Upland Borough
- Old Mill Pump Station (OMPS)

Projects and Schedules to address these areas are described as follows:

The June 2018 Central Delaware Pump Station Act 537 plan addresses overflows above the DELCORA Central Delaware Pump Station (CDPS) through the construction of the Crum Creek Diversion Pipeline. This will reduce flows to the CDPS at an estimated cost of $8.6 Million and reduce the incidence of SSOs above the CDPS. This project is moving forward. DELCORA's evaluation of metered flows above the

CDPS indicates that there is likely excessive infiltration inflow that can be removed from the drainage area thereby further reducing the risk of SSOs.

Manhole 2897, located in Taylor Arboretum along the RCI, has a history of unpermitted CSOs. The following adaptive plan is incorporated into the LTCPU addressing Manhole 2897:

- Regulator and overflow modifications at CSO regulators 18 and 33 to reduce surcharge conditions in the Ridley Creek Interceptor
- Evaluation/implementation of manhole modifications to address additional surcharging without damaging existing infrastructure or causing sewer backups
- Evaluation/implementation of controls to address excessive I/I
- Adaptive management review after implementation of the above steps to determine if storage or pumping upgrades are needed to meet the design level of service and/or if continued cost effective I/I control should continue

Regulator, manhole, and I/I actions needed to address Manhole 2897 will occur in the DELCORA-owned and operated service in Nether Providence. If adaptive management indicates a need for storage, DELCORA believes at least one appropriate location is available in Nether Providence.

Manhole 591 is located in the Upland are of the DELCORA Owned and Operated service area, near the intersection of 10th and Church Streets. It has a history of capacity-related SSOs. Current modeling of the collect system indicates that installation of a relief sewer line will mitigate unauthorized releases and provide the design level of service. This parallel sewer is to be installed from Manhole 591 to Manhole 641. In addition, cost effective I/I control will be evaluated and implemented if needed to meet the design level of service.

The Rose Valley service area includes the OMPS which conveys flow to the Rose Valley Pump Station (RVPS), which pumps flow out of the Middletown Township collection system and ultimately to the Chester Ridley Creek Pump Station and Force Main to the WRTP. In 2018 it was discovered that the OMPS includes a wet well overflow to a submerged outfall in Ridley Creek. The following actions have been taken and are planned as a part of the LTCPU:

- The OMPS overflow has been sealed
- A supplemental pump has been installed at the OMPS
- I/I studies have begun
- I/I controls including manhole rehabilitation, public sewer lining, and pump station capacity increases will be implemented based on the results of the I/I studies
- Adaptive management review after completion of the above steps to determine if private I/I sources need to be addressed or increases in wet well storage capacity are needed.

Most of the sewer infrastructure in the Rose Valley service area is owned and operated by DELCORA with the exception of sewers in Nether Providence. These sewers contribute significant peak wet weather flows to the OMPS. Controls in Nether Providence will need to be implemented to control peak flows.

The above actions will be evaluated for adequate levels of service based on the two-year storm recurrence design. These projects will be implemented regardless of the selected alternative, and the implementation schedule for these projects in addition to the CSO control alternatives is in **Subsection 10.3.6**.

9.12 Satellite System Infiltration and Inflow Control Program

Monitoring and modeling conducted by DELCORA indicates that there is I/I in the satellite systems. Satellite systems are areas served by but not owned by DELCORA. Such excessive peak flows must be addressed for the following reasons:

- The Consent Decree requires that SSOs be addressed. Excessive infiltration and Inflow is the cause of capacity-related SSOs;
- The success of the CSO control program laid out in the LTCPU is contingent on controlling existing and future excessive I/I in the satellite systems;
- System deterioration over the long-term must be addressed in order to minimize future capacity-related SSOs and CSOs;
- Addressing excessive I/I should reduce the long term cost to all DELCORA users

Based on the LTCPU studies there are opportunities to cost-effectively address peak wet weather flows to provide higher levels of system service. Examples include the overflow at the Taylor Arboretum and at the Central Delaware Pump Station discussed above in **Subsection 9.11**.

DELCORA has begun a program of I/I evaluation and remediation in areas where DELCORA owns the sewer infrastructure. In areas where DELCORA does not own the sewer system, the responsible jurisdiction will be asked to conduct an I/I evaluation with DELCORA's assistance to meet the four objectives listed above. DELCORA may also offer its services to conduct I/I evaluations for any jurisdiction which requests it.

The determination of cost effective I/I control requires balancing the cost of reducing I/I against the costs to convey and treat such flows. Because cost effective evaluation is based in part on the cost of treatment, cost effectiveness will be evaluated based on the receiving treatment facilities. A cost effectiveness evaluation will be performed for the Western Service Area served by the DELCORA WRTP and another cost evaluation will be performed for the Eastern Service Area served by the Philadelphia Water Department's Southwestern treatment facility.

Table 9-25: Alternative Life Cycle Cost by Overflow per Year and Wet Weather Capture Percentage[9]

Life Cycle Costs (in Million $)												
OF/yr	0	2	4	6	8	12	20					43
% Capture	100%	98.4%	97.7%	96.5%	95.5%	94.1%	92%	91%	90%	89%	88%	85%
Alt 1	$ 232.1	$ 195.3	$ 181.7	$ 158.4	$ 150.2	$ 133.9	$ 93.9	X	X	X	X	$ 38.5
Alt 2	$ 338.5	$ 217.5	$ 193.8	$ 166.5	$ 147.0	$ 128.5	$ 99.8	X	X	X	X	$ 71.6
Alt 3	$ 233.8	$ 193.7	$ 173.3	$ 155.0	$ 148.7	$ 133.1	$ 96.5	X	X	X	X	$ 50.2
Alt 4	$ 338.7	$ 220.4	$ 195.2	$ 170.7	$ 152.1	$ 135.3	$ 106.8	X	X	X	X	$ 83.3
Alt 5	X	X	$ 268.2	$ 182.0	$ 149.9	$ 117.3	$ 89.9	X	X	X	X	$ 65.0
Alt 6	$ 193.1	X	X	X	X	X	X	X	X	X	X	X
Alt 7	X	X	X	X	X	X	X	X	X	$ 14.2	X	X
Alt 8	$ 306.6	$ 184.7	$ 157.4	$ 141.2	$ 128.3	$ 113.1	$ 74.2	X	X	X	X	X
Alt 9	X	X	X	X	X	X	X	X	X	$ 25.9	X	X
Alt 10	X	X	X	X	X	X	X	X	$ 18.7	X	X	X
Alt 11	X	X	X	X	X	X	X	X	X	X	$ 16.6	X
Alt 12	X	X	X	X	X	X	X	$ 37.8	X	X	X	X
Alt 13	$ 314.0	$ 192.3	$ 170.1	$ 156.9	$ 145.3	$ 133.6	$ 97.7	X	X	X	X	X
Alt 14	$ 322.6	$ 203.0	$ 180.9	$ 170.7	$ 162.3	$ 151.8	X	X	X	X	X	X
Alt 15	X	X	X	X	X	$ 59.2	X	X	X	X	X	X

= Selected Alternative for the % Capture KOTC
= Consent Decree Global Alternative Requirement
= Regulator Modification Alternative

[9] Alternatives grouped by approximate wet weather capture percentage based on the average typical year results. Baseline (not listed) capture is 82.3%, $0 cost.

Figure 9-19: Knee-of-the-Curve Life Cycle Cost by Capture Percentages

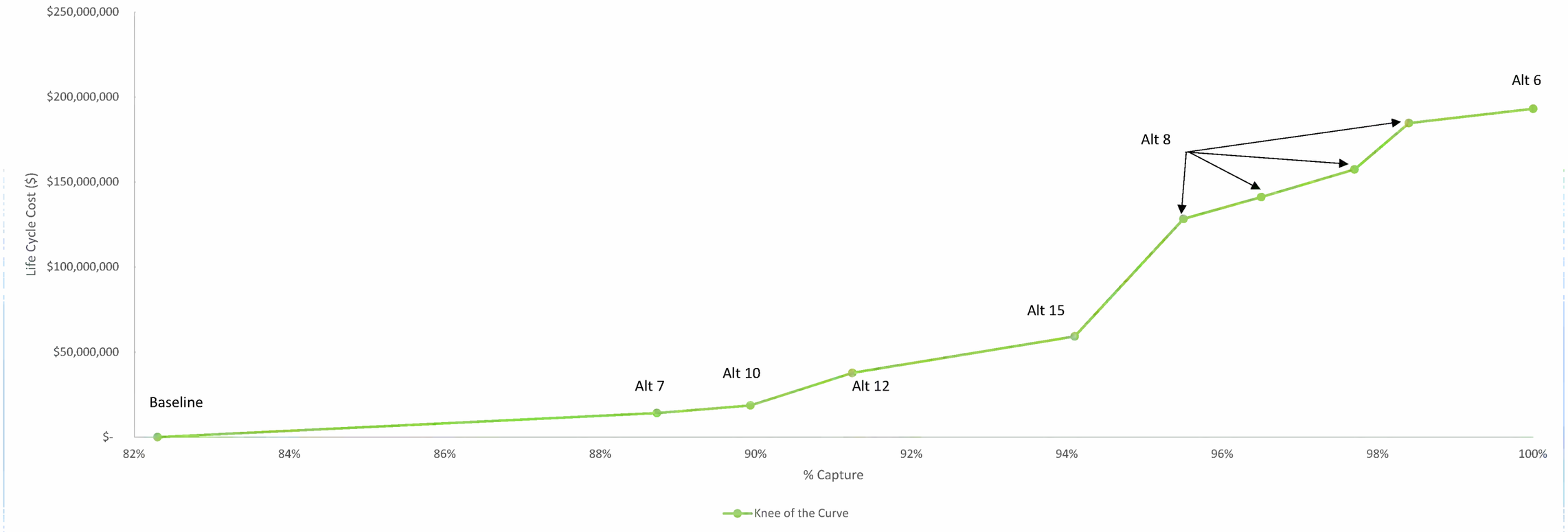


Table 9-26: DELCORA Service Area Improvements Since 1999 LTCP

Description	Approximate Date of Implementation	Cost ($)
2001 Capital Projects Bond	12/31/2001	$ 30,730,000.00
CSO Repairs	7/31/2004	$ 1,200,000.00
CSO NPDES	7/31/2004	$ 225,000.00
System Repairs	7/31/2004	$ 750,000.00
DCPS	7/31/2004	$ 2,500,000.00
Route 291 Widening	7/31/2004	$ 2,917,914.00
2004 Capital Projects Bond	12/31/2004	$ 23,000,000.00
Diversion	6/4/2004	$ 400,000.00
CSO Repairs	6/4/2004	$ 1,075,667.00
CSO	6/4/2004	$ 225,000.00
Sewer System Repair	6/4/2004	$ 248,272.00
TV Truck	6/4/2004	$ 85,000.00
GIS	6/4/2004	$ 646,794.00
Delaware Avenue Interceptor	6/4/2004	$ 498,000.00
I/I FUNDING for WRTP INTERCEPTORS	6/4/2004	$ 1,000,000.00
Lining of I-95 and Chester Creek	6/4/2004	$ 400,000.00
Chichester Pit	6/4/2004	$ 170,000.00
Route 291 (2004Bond increment)	6/4/2004	$ 750,000.00
Act 537 Plan re-rate	6/4/2004	$ 500,000.00
Trainer PS and Force Main	6/4/2004	$ 950,000.00
3rd Street	6/4/2004	$ 455,000.00
Hyatt, 9th and 10th streets	6/4/2004	$ 620,000.00
8th Street	6/4/2004	$ 620,000.00
3rd Street	6/4/2004	$ 1,300,000.00
Replacement of CSO Regulators 16, 20, 22, 26	6/21/2005	$ 3,650,573.00
Inflow and Infiltration Study	8/1/2008	$ 160,771.00
Sewer Improvements	8/1/2008	$ 686,051.00
Replacement of CSO Regulators 12, 23, 24	10/13/2005	$ 424,883.00
2009/2010 Sewer Maintenance Projects	7/1/2010	$ 717,025.00
Replacement of CSO Regulators 2, 3, 5	7/20/2010	$ 639,760.00
Chester Force Main Replacement	6/20/2011	$ 9,961,391.00
Replacement of CSO Regulators 10, 13, 14	10/13/2013	$ 682,953.00
Chester Ridley Creek Pump Station	7/1/2015	$ 9,924,396.00
Ridley Interceptor Grouting	7/1/2016	$ 2,020,197.00
WRTP Upgrades	6/1/2018	$ 39,622,123.00
Replacement of CSO Regulators 4 and 15	6/1/2018	$ 563,673.00
Property Purchase	6/1/2018	$ 4,404,550.00
Consent Decree Early Action CSO Control Measures	6/1/2018	Included in WRTP Upgrades
Chester East Grouting and Chester West Grouting	6/1/2018	$ 1,091,157.00
PS-6 Construction	1/1/2019	Included in WRTP Upgrades
PS-6 Engineering	1/1/2019	Included in WRTP Upgrades
LTCPU Costs	7/26/2018	$ 4,184,929.00
Total		**$ 150,001,079.00**

Table 9-27: Baseline and Alternative 15 System Wide Average Overflow Volume for Typical Year

	Total WRTP Flow (MG) during wet conditions (precipitation time+6 hr)	Total Overflow (MG)	Total Sanitary Sewer Overflow (MG)	Total Wet Weather Flow (MG)	Wet Weather Capture
Baseline Average	1,309	273	9	1,590	82.3%
Alt 7 Average	1,372	162	11	1,545	88.8%
Alt 15 Average	1,391	78	11	1,480	94.0%

Table 9-28: Baseline, Alternative 7, and Alternative 15 Avg Frequency of Overflows for Typical Year (Rainfall in/yr)

Overflow Frequency (occurrence)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14
Baseline Average	42.8	61.3	43.3	21.0	65.3	48.0	50.3	44.7	54.0	0.7	50.3	30.7
Alt 7 Average	42.8	61.3	43.3	21.0	60.0	49.3	15.7	16.3	36.7	0.7	12.7	11.7
Alt 15 Average	42.8	17.3	3.3	4.0	25.0	1.7	15.7	16.3	36.7	1.0	12.7	11.7

	[illegible]	[illegible]	[illegible]	NREG18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Baseline Average	43.7	27.0	55.7	77.7	54.7	30.0	1.3	39.3	8.3	17.3	45.0	23.7	0.0	1.0
Alt 7 Average	3.0	19.3	25.0	61.7	40.3	21.0	1.3	2.7	9.3	17.3	20.7	14.3	0.0	1.0
Alt 15 Average	2.7	16.7	22.0	41.0	35.3	21.0	1.3	2.7	9.3	17.3	20.7	14.3	0.0	1.0

Table 9-29: Baseline, Alternative 7, and Alternative 15 Avg Volume of Overflows (MG) for Typical Year (Rainfall in/yr)

Overflow Volume (MG)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14
Baseline Average	42.8	15.1	8.4	0.7	43.8	4.5	46.1	12.9	10.8	0.0	14.5	7.3
Alt 7 Average	42.8	15.1	8.4	0.8	44.1	4.8	10.2	2.7	5.3	0.0	2.5	2.3
Alt 15 Average	42.8	2.6	1.0	0.2	4.5	0.3	10.2	2.8	5.3	0.0	2.5	2.3

	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32	NREG33
Baseline Average	0.8	3.8	13.4	41.1	35.6	2.0	0.0	2.1	0.2	0.5	5.8	2.9	0.0	0.2
Alt 7 Average	0.2	4.2	6.1	22.2	26.4	1.7	0.1	0.2	0.2	0.5	2.2	1.7	0.0	0.2
Alt 15 Average	0.2	3.6	4.9	11.9	19.6	1.7	0.1	0.2	0.2	0.5	2.2	1.7	0.0	0.1

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Section 10 Implementation of the CSO LTCP Update

10.1 Introduction

The conclusion reached from the Alternatives Analysis (**Section 9**) was a selected plan for the completion of implementing the CSO control technologies as capital projects in an affordable manner. The purpose of this section is to discuss the overall execution of the LTCPU, including the financial capabilities of DELCORA and the impact of the selected plan to determine how and when DELCORA will be able to implement the chosen control technologies. This implementation will provide a path for the completion of these capital projects within 10 years.

10.2 Financial Environment

At the request of USEPA and PADEP, a draft Financial Capability Assessment (FCA, **Appendix R**) and Supplement (**Appendix S**) was submitted prior to the completion of an H&H model for the DELCORA system. As a result, a number of assumptions regarding contributions of the separate and combined systems to wet weather flow and CSO discharges were made. As LTCPU development continued, the H&H model was updated, calibrated, and validated. As a result of this modeling effort, the assumptions utilized for the preparation of the Draft FCA have been superseded by the information obtained through the H&H model. Modeling results of the DELCORA system suggest that reducing excessive I/I in the separate areas will be necessary in order to achieve the required reduction of CSOs in the combined system. Therefore, this LTCPU has been developed with the understanding that both separate and combined systems will fund the LTCPU as appropriate. The current recommended plan is affordable without exceeding acceptable levels of cost on an MHI basis, as long as:

- Upstream communities' excessive I/I into downstream sewer infrastructure is affordably addressed;
- DELCORA's Eastern Service Area costs do not upset the City of Chester's financial capability to implement its share of these wet weather controls;
- Excess flow wet weather treatment as recommended at DELCORA's WRTP to obtain over 90%, is approved by PADEP and/or USEPA.

Out of the 44 municipalities DELCORA serves, the City of Chester is the poorest municipality in the DELCORA service area, and also the only municipality with a combined sewer system. The City of Chester is a financially distressed municipality as defined by the 1987 Financially Distressed Municipalities Act 47, and will remain in the Act 47 program until financial health improves. When 37% of Chester's citizens are living under the poverty line but the population is increasing, and median household income is flat, it can be difficult to fund the projects required for the selected plan. DELCORA also does not own or operate all of the wastewater collection systems in their service area, making the exact costs to residential customers unknown and difficult to assess all costs across their service area.

The following values provide a good assessment of financial capability of the City of Chester, and if values are weak or strong financial indicators according to the FCA:

- Median household income: $28,350 (weak)
- Total annual wastewater and CSO control costs per household as a percent of median household income: 1.6% (mid-range)

- Overall net debt as a percent of full maker property value: 13.4% (weak)
- Property tax revenues as a percent of full market property value: 1.2% (strong)
- Property tax collection rate: 81.7% (weak)
- Unemployment: 8.6% (weak)
- Bond rating: A (mid-range, suspended 1/6/2014)

Whatever approach is taken to increase rates, the City of Chester must avoid a "high burden" by refining a proportional cost methodology to attribute CSO events to each municipalities. Current rate of increase averages out to approximately 4% rate increase in DELCORA's fees per year.

The current Chester base rate is $5.32 per 1,000 gallons in 2019, or $372.40/EDU/yr (assuming 70,000 gallons/EDU/yr). Under the Long Term Control Plan, the City of Chester is responsible for completely financing the regulator modifications to reach 85% capture in the CSO area for the typical year. The allocation of the remainder of the LTCP costs will be determined in the future by the DELCORA Board. Additional needs beyond the LTCP may result in greater increases to customer rates.

10.3 Long-Term Control Plan Implementation

10.3.1 Combined Sewer Overflow & Unauthorized Release Projects

The following is a list of LTCPU CSO & SSO capital projects to be completed based on the selection of the chosen plan, listed by the receiving water body:

Delaware River

- Modifications in regulators 5, 8, 9, 11, 13, and 14 to push more flow into the interceptors and build higher diversion weirs to hold flow back from outfalls to the Delaware River.
- Regulator 10 outfall connection modification to the WEI using a 36" pipe, redirecting additional flow from the Second Street Interceptor from this regulator.
- A sewer separation of the combined sewer area upstream of Veterans Memorial Park in the Regulator 5 drainage area will be separated at Townsend Street, and reduce stormwater flow to the overloaded DRI. The separated sanitary line will still flow to Regulator 5, along with the remaining combined sewer piping in the drainage area.
- Construction of a parallel 30" interceptor next to the DRI. This will be connected to regulators 2, 3, and 4 and allow more flow to reach the new Pump Station 6 (PS-6).
- Rehabilitating an existing portion of the 54" WEI, then extending it for a direct connection to PS-6 to relieve a bottleneck of flow where the WEI and DRI join at a single 24" line.

Ridley Creek

- Modifications in regulators 15, 16, 17, and 18 to push more flow into the Ridley Creek Interceptor and construction of higher diversion weirs to hold flow back from outfalls to the Ridley Creek.
- Subsurface infiltrating Green Stormwater Infrastructure (GSI), or equal, between Providence Ave, Upland St. and 13th St.

- Permeable pavement and possible bioretention GSI (or equal) along Walnut St. from 13th to 18th Streets.
- Evaluation and implementation of modifications and I/I control along the RCI to determine if storage or pumps are needed near Taylor Memorial Arboretum.

Chester Creek

- Modifications in regulators 19, 20, 21, 22, 23, 25, and 26 to push more flow into the interceptors and construction of higher diversion weirs to hold flow back from outfalls to the Chester Creek.
- Permeable pavement and bioretention GSI (or equal) along Crozer St. from Gray to 21st Streets.
- Permeable pavement and bioretention GSI (or equal) along Edgmont Ave. from 14th to 22nd Streets.
- Installation of relief sewer line to mitigate unpermitted manhole discharge in Upland Borough.

Other

- I/I controls in the Rose Valley area pending the results of the ongoing I/I studies.
- WRTP construction to meet criteria for 50 MGD daily rerate and new wet weather flow capacity beyond 88 MGD.
- Installation of a visual public notification system for CSOs at regulators 2, 7, 11, 16, 18, 19, 22, 24, and 33.

Additionally, DELCORA will evaluate whether it would be more cost-effective to transfer ESA flows to a new/expanded DELCORA facility. Such evaluation will factor into the financial analysis reimbursement from PWD of the value of DELCORA's right to use 50 MGD (long-term average) and 100 MGD (peak) at the PWD's Southwest Water Pollution Control Plant. Based upon the outcome of that evaluation, DELCORA may propose an amendment to this overflow control plan and/or implementation schedule for the regulatory agency's review and approval.

10.3.2 Performance Criteria

Upon completion of the CSO and SSO projects described in **Subsection 10.3.1**, post-construction monitoring should be in place to study the changes in overflow rates and volumes. The selected plan was modeled to achieve 94.0% capture, which equates to an average of 78.5 MG of CSO overflows per year occur, with zero SSO events. The consent decree requires an 85% wet weather capture on an annual system wide basis for the typical year, however, and is the performance criteria that will be used for the LTCPU capital projects, with the potential for additional capture. The additional LTCPU capital projects will be monitored internally by DELCORA to achieve a minimum wet weather capture percentage of 90%, with the intention of capturing as close to the modeled capture percentage as possible, if not more with the selected plan.

10.3.3 Anticipated Water Quality Improvements

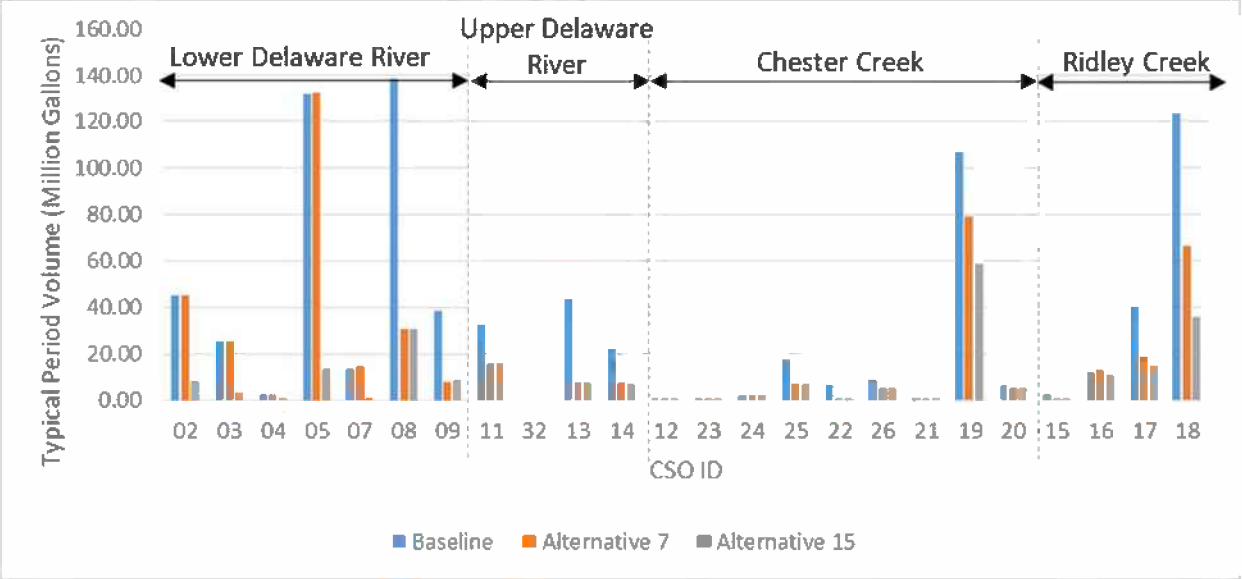
The Water Quality Model confirmed that the contributions of the selected plans do not cause CSOs to preclude WQS in their respective discharge waters. **Table 10-1** contains the number of baseline exceedances for the POCs. The WQSs for these POCs can be found in **Table 2-3**. The Applicable Water Quality Standards Master Table that was developed to identify the specific WQS for each of the three receiving water bodies is presented in **Appendix B**.

The results are the same as the baseline except that for Alternative 15, the fecal coliform excursions in Ridley Creek are reduced from 24/36 to 23/26 (1 month). Both selected plans help decrease the relative contribution from CSOs to water quality impairments, however, and the impact on receiving water quality is relatively greater for Alternative 15 than Alternative 7, as evident by the one-month decrease in fecal coliform excursions. **Figure 10-1** is a bar graph comparing each of the CSO regulator's discharge volumes between the three scenarios. The results of this bar graph presents a reduction in CSO volume from the Baseline condition to Alternative 7 and Alternative 15, respectively.

Table 10-1: Baseline Water Quality Standard Excursions for Pollutants of Concern

	Enterococcus Monthly Geomean	Fecal Coliform Monthly Geomean	E.coli[1] Monthly Geomean	E.coli[1] STV
Ridley Creek				
All Sources	36/36	24/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Chester Creek				
All Sources	21/36	1/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Upper Delaware				
All Sources	1/36	0/36	n/a	n/a
CSOs only	0/36	0/36	n/a	n/a
Lower Delaware				
All Sources	6/36	1/36	2/36	13/36
CSOs only	0/36	0/36	0/36	0/36

Figure 10-1 CSO Volumes Discharged (3-yr typical year period)



This reduction in volume decreases the CSO contributions of the POCs into the receiving streams. For fecal coliforms, Alternative 15 had enough impact to reduce the POCs to a level that met WQSs by one month. This POC reduction can be observed in **Figures 10-2**, **10-3**, and **10-4** through the decreasing size of the black portion of the bar graphs. The increased efforts to reduce bacteria loading in the Delaware River from CSO outfalls demonstrates DELCORA's readiness to improve the water quality upstream for year-of-young Atlantic Sturgeon. This habitat is approximately one-half mile downstream of DELCORA's southernmost outfall, CSO regulator #2, but the proposed improvements along the Delaware River Interceptor will also improve water quality by decreasing CSOs from upstream regulators #3, #4, #5, and #7.

Figure 10-2 All Sources' Fecal Coliform Contributions for the Baseline Condition

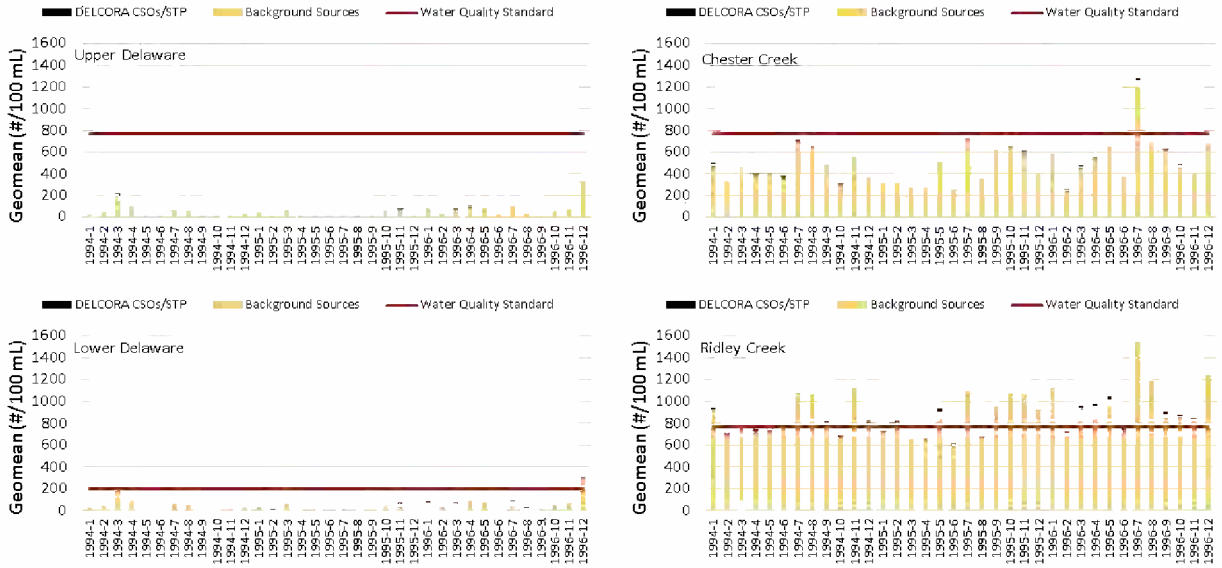


Figure 10-3 All Sources' Fecal Coliform Contributions for Alternative 7

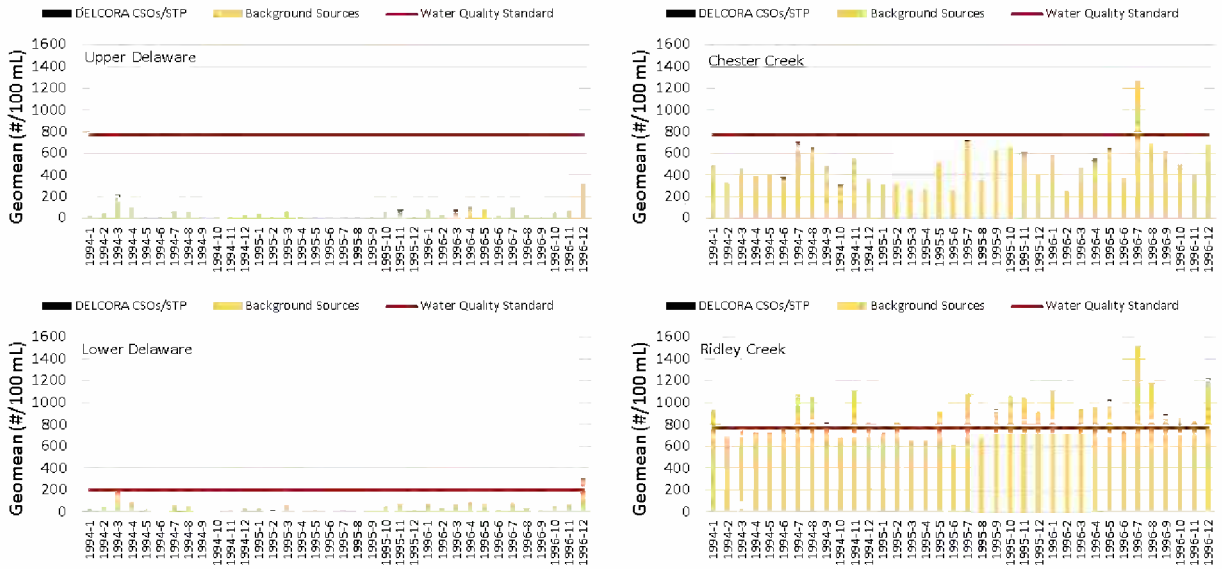
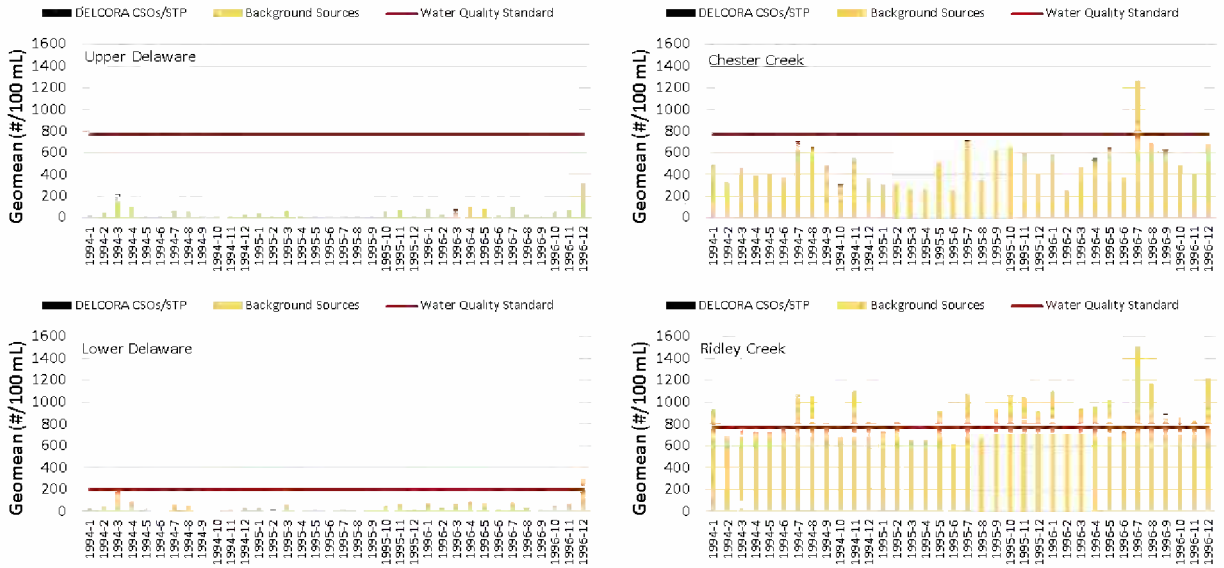


Figure 10-4 All Sources' Fecal Coliform Contributions for Alternative 15



10.3.4 WRTP Peak Flow Treatment

Implementing the parallel DRI will result in significantly increased flow delivered to the WRTP. Based on estimates developed early in the LTCPU process, PS-6 was added to the WRTP as an early action item. PS-6 was planned to increase the available peak pumping capacity to the WRTP to about 128 MGD, providing the potential for additional flow in excess of the peak hourly treatment capacity to come to the plant. It has been determined that 128 MGD is the required peak flow rate into the WRTP with the LTCPU capital projects. Based on the current peak flow analysis of all LTCPU capital projects, the Existing Service Area Characterization in **Section 6 – Existing Service Area Characterization** and the H&H model in **Section 4 – Sewer System Hydrologic and Hydraulic Model Update and Calibration**, and the WRTP Process and Hydraulic Evaluation from Weston Solutions, Inc. in **Appendix P**, complete secondary treatment is not possible with the current infrastructure at the plant.

The WRTP is currently rated for dry-weather treatment of 44 MGD, with a peak maximum of 88 MGD, twice the plant's rated flow. While flows in excess of 88 MGD do come through the plant, there is a decrease in efficiency from full secondary treatment at levels exceeding this flow rate. Attempting to provide a sufficient secondary treatment equivalent while providing at least primary clarification and solids and floatables removal and disposal could result in severe property damage as higher flows wash out the WRTP's secondary treatment system. DELCORA has a wet weather operations plan they follow during precipitation to handle wet-weather flows, which follow graduated steps dependent on the inflow volume. WRTP improvement projects were evaluated to provide the additional 40 MGD of secondary treatment up to the new estimated 128 MGD peak flow, but they were determined to be either technically or financially unattainable or practical based on the Weston report found in **Appendix P**, respectively. The list of projects at the WRTP that can address the LTCPU peak flow treatments needs include, but is not limited to, wet weather blending, chemically enhanced primary treatment, redirecting excess flow out of the CSO regulator #2 outfall, and additional storage detention at PS-6. Satellite treatment is also an option to address the peak flows offsite. An adaptive management assessment of these available projects

will be performed after the initial implementation of LTCPU capital projects in the selected plan to determine what modifications are necessary.

The WRTP has already been approved for 50 MGD rerating upgrade if an outfall extension in installed. The outfall extension projects in included in an Act 537 plan approved by a PADEP NPDES permit in February 2009, and Delaware River Basic Commission docket approval given in September 2011. This upgrade is possible due to DELCORA properly operating and maintaining their current secondary treatment system in order to meet secondary limits for flows greater than the peak dry weather flow, plus an appropriate quantity of wet weather flow.

10.3.5 Final Program Costs

The Life Cycle Costs to meet 85% wet weather capture for the typical year in Chester through regulator modifications alone is estimated at $14.2M. This cost will be recovered from the City of Chester. The funding for the remaining projects will be obtained from all contributing parties. This is expected to result in the City of Chester contributing $18.2M toward CSO control capital projects. **Table 10-2** contains the all estimated costs for the proposed projects. I/I flows from surrounding municipalities contribute significantly to the Chester CSS, and remaining capture costs for the CSOs and unauthorized releases is expected to be $103.7M.

Table 10-2: Estimated Capital & Life Cycle Costs of the Proposed Improvement Projects

Regulator Control Improvements	Capital Cost ($M)	Life Cycle Cost ($M)
Regulator Modifications	$ 5.1	$ 14.2
Targeted Overflow Reduction		
Parallel Delaware River Interceptor	$ 3.5	$ 3.6
WE Interceptor Rehab & Extension	$ 2.4	$ 2.5
CSO-5 Partial Sewer Separation	$ 4.4	$ 4.5
CSO 18 & 19 Green Infrastructure	$ 10.1	$ 11.7
RCI Arboretum Modifications	$ 7.2	$ 17.0
Upland Relief Sewer Line	$ 0.8	$ 1.0
Rose Valley I/I Controls	$ 3.0	$ 3.0
Monitoring and Modeling	$ 5.0	$ 5.0
Public Outreach	$ 3.0	$ 3.0
WRTP Plant Expansion/Upgrade	$ 15.2	$ 27.4
Visual CSO Public Notification System	$ 0.3	$ 1.4
Real Time Control	$ 0.4	$ 1.0
Crum Creek Diversion Pipeline	$ 8.6	$ 8.6
Adaptive Management		
Adaptive Management	$ 13.0	$ 13.0
Project Management	$ 5.0	$ 5.0
Total	$ 86.9	$ 121.9

10.3.6 Implementation Schedule

Based on the final program costs, an implementation schedule for the selected plan has been developed based on three elements, each containing different projects based on the element's purpose.

The first element consists of only regulator control improvements. These improvements increase the level of system wide annual average wet weather flow capture to 88.8%. This level of capture exceeds Federal Clean Water Act requirements under USEPA's Presumption approach. These modifications can also be paid for by the City of Chester in their entirety. For that reason, implementation of this project can begin immediately, but divided into three groups due to the number of modifications to be completed.

The second element encompasses the remaining projects that target overflow reduction to specific CSO regulator areas, but is dependent on other factors. While the regulator control improvements meet the Presumption approach requirements, monitoring and modeling indicate that the frequency and volume of CSOs are exacerbated by excessive peak flows from the separate sewer areas. The I/I from the separate areas upstream are filling the interceptors during wet weather, preventing the CSS in Chester from utilizing more of the interceptor conveyance capacity to prevent CSOs. These separate area flows can be addressed cost-effectively by adding to the regulator modifications with the following additional controls to alleviate the wet weather flow loading to the interceptor:

- Multiple locations for green infrastructure, including currently identified areas in Widener University's campus, between Providence Ave and Upland Street, on Edgmont Avenue north of I-95, Crozer Street, and other viable areas[10].
- Partial sewer separation of the neighborhood upstream of Veterans Memorial Park.
- Improving flow in conveyance piping along the Delaware River by adding to, extending, and rehabilitating the existing piping to alleviate bottlenecks.
- Overflow modifications at CSO Regulators 18 and 33 to reduce surcharge conditions in the RCI[11].
- Installation of a relief sewer line in Upland to mitigate unauthorized releases[11].
- I/I controls implemented to prevent wet weather flow from Rose Valley Pump Station[11].
- Public outreach to inform the general public about the status of the DELCORA system.

Each of these LTCPU capital projects have specifically targeted effects to reduce overflow in the DELCORA service area. For example, the removal of the noted sewer bottlenecks significantly increases the peak wet weather flows that can be delivered to the wastewater plant instead of overflowing. These controls will also significantly reduce the impact on the Flower Street Chester City Boat Ramp on the Delaware River as requested at public meetings.

As a result of delivering greater peak wet weather flows to the treatment plant through the regulator control improvements and these targeted overflow reduction projects, the current capacity of the treatment plant (88 MGD) would be exceeded about 3 times in the design year. While these flows could be

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[10] In addition to the specific Green Infrastructure Project in the (CSO 18 & CSO 19) Neighborhoods, DELCORA anticipates funding additional Green Projects where such projects contribute to the cost-effective reduction of overflows.

[11] The location and scope of this technology has not been determined and will be open to public comment after more study is completed and before implementation

discharged out the combined system, real-time controls will be evaluated during a post-construction monitoring period. It will be necessary to study the peak wet weather flows and determine if real-time motor operated valves and controls in the regulators and conveyance system are necessary. The evaluation will provide confidence that any increased flows do not back up into homes or deliver excessive flow to the treatment plant without losing hydraulic and process control. After the flows are evaluated, additional improvements to the WRTP will be addressed. Excess flow wet weather treatment will include screening to remove trash and grit settling, (settling of solids and removal of floatables). This treated excess wet weather flow will be discharged out the existing CSO located adjacent to the plant. This partially treated flow will not increase the frequency of overflows at this CSO. This approach will simply capture more flow for partial treatment a few times in a typical year, whereas the flow would otherwise be discharged out of a CSO outfall without any treatment. Details of this wet weather treatment will be evaluated further, at a future date once the first group of LTCPU capital projects are implemented.

With regulatory approval, the Regulator Control Improvements can proceed with the current and anticipated finances available to DELCORA. Targeted Overflow Reduction implementation is dependent on a number of factors including the three stated in **Subsection 10.2.** If these factors can be addressed, it is anticipated that the Regulator Control Improvements and the Targeted Overflow Reduction projects can be fully implemented within the next 10 years.

The third element is adaptive management of the post-construction monitoring plan, which is further detailed in Section 11. The expected results of the previous two elements will meet the necessary requirements of the Presumption approach, but additional monitoring is still planned by DELCORA, especially in locations with CSOs that may continue at a higher frequency. The completed projects will be monitored to determine if they are operating as intended, and the Clean Water Act and community goals are met. This monitoring period is an appropriate time to compare observed flow growth to population growth projections, and revise projects based on the results. If this post construction monitoring indicates more investment or actions are needed, those investments and actions will be evaluated and a supplemental control plan will be developed for review and approval by the PADEP. This would allow for DELCORA to assess if the flow growth aligns with the Delaware Valley Regional Planning Commission's projected population increases, and revise projects based on the flow data from the post-construction monitoring and studies. However, should the LTCPU capital projects perform as modeled or better, future projects of significant cost can be scaled back or eliminated from the proposed schedule. In order to account for the schedule to be flexible enough for adaptive management, the CSO control projects are split up into one of two categories: 1) High-Efficiency and Unauthorized Release Projects, and 2) WRTP Inflow Projects.

The projects in the first category can be completed relatively inexpensively and quickly to meet the requirements of the Consent Decree or resolve issues identified in public meetings. After the completion and operation of the first category of projects in December 2023, a post-construction monitoring period of one year will be conducted in 2024 to investigate if the projects are all performing as modeled and to find the new CSS wet weather baseline. The completed report from this investigation will be delivered in June 2025. Special attention to locations with higher overflow & flooding frequencies will be evaluated during this post construction monitoring period. Based on the results, DELCORA will continue to examine sewer system optimization through additional monitoring and potentially using real time control and other I/I measures to further reduce the surcharge frequency at these overflow & discharge points. Further measures will be implemented to the modeled area as necessary, depending on the projects' performance,

and a schedule will be developed that takes into the account the modeled area's financial capability at that time.

The projects in the second category are higher-cost and create more of a public disturbance than the first category, but are also focused around the WEI and DRI. This should allow projects to be concentrated in specific sections of the City before completion, preventing city-wide construction and the increased traffic that may result. Pending the results of the one-year post-construction monitoring, the second category of projects can be adapted to meet the 90% wet weather capture percentage goal and begin in 2025. An updated WRTP plant flow evaluation for proposed upgrades will also be conducted, and is expected to be completed in 2025. By providing additional time for these larger projects, DELCORA can find ways to further increase efficiencies based on financial capability, whether it is combining other planned projects with this work or making use of improved technologies developed since LTCPU approval. After the second category of projects are completed, a second year-long post-construction monitoring will take place to again confirm the modeled results meet the DELCORA's goals.

DELCORA's goals involve actions within two areas:

- Addressing CSO controls in its owned and contracted service areas
- Addressing the cost of the Eastern Service Area treatment provided by the Philadelphia Water Department

Given the localized nature of the peak wet weather flow issues and control measures proposed along with State delegation and oversight of program implementation, State oversight of our program implementation makes the most sense. DELCORA plans to propose a State implementation mechanism to PADEP and/or USEPA in the near future for their consideration. Streamlined State implementation oversight is particularly warranted because EPA/DEP program approval will substantively control other State planning mechanisms, such as Act 537 plan updates. It will be important for PADEP to assist DELCORA to timely secure any actions required by DELCORA's satellite customers, such as the requirement that they update their Act 537 plans to reflect the EPA/PADEP-approved program, in order to maintain the approved implementation schedule.

The implementation plan schedule includes assumes time for facility planning, design, permitting, approvals, land acquisitions, notice to proceed, construction, and place in operation. The initial schedule can be found in **Table 10-3**, incorporating the regulator modifications immediately and the other projects within 10 years of LTCPU approval. All projects will be evaluated using an adaptive management approach, where the selected plan may be adjusted when monitoring and modeling show cost-effectiveness. The implementation schedule itself is also separated into two 5-year periods (2020-2024 & 2025-2029) not only for the purpose of adaptive management, but more importantly, to align with DELCORA's current NPDES permit schedule. Once the post-construction monitoring is completed, the results can be submitted with the next permit application. The timeline for all reports proposed by this plan can be found in **Table 10-4**. The O&M Plans will be updated 60 days after the full implementation of the Taylor Arboretum storage tank and again after the WRTP modifications are first placed in operation.

Table 10-3: Proposed Project Milestone Deadlines

Project Milestone Deadlines[1]	
Project	**Placement in Operation**
6 Regulator Modifications Completed	December 31, 2020
Upland Relief Sewer Line	December 31, 2020
6 Additional Regulator Modifications Completed	December 31, 2021
RCI Regulator Manhole Modifications	December 31, 2021
CSO-5 Partial Separation	December 31, 2022
Green Stormwater Infrastructure	December 31, 2022
Rose Valley Infiltration & Inflow Improvements	December 31, 2022
Crum Creek Diversion Pipeline	December 31, 2024
Visual CSO Public Notification System	December 31, 2024
6 Additional Regulator Modifications Completed	December 31, 2025
West End Interceptor Rehab & Extension	December 31, 2026
Parallel Delaware River Interceptor	December 31, 2028
Western Regional Treatment Plant Modifications	TBD

[1] Assuming LTCPU approval by December 31st 2019

Table 10-4: Reporting Requirements

Reporting Submission Timeline[1]	
Project	**Date**
Rose Valley Infiltration & Inflow Evaluation Report	December 31, 2020
Five-Year Milestone and Post Construction Compliance Monitoring Report	Submitted with NPDES Permit Application
Adaptive Management Report	December 31, 2025
Western Regional Treatment Plant Flow Evaluation Report	December 31, 2025
Five-Year Milestone and Final Post Construction Compliance Monitoring Report	Submitted with NPDES Permit Application
Adaptive Management Report	December 31, 2030

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Section 11 Post-Construction Monitoring Plan

11.1 Introduction

Paragraph V.A.21 of the Consent Decree requires that a post-construction compliance monitoring program be developed to ascertain the effectiveness of CSO controls and to verify compliance with water quality standards and protection of designated uses. This section describes the Post-Construction Monitoring Program (PCMP) that will be used to monitor the effectiveness of the long-term CSO controls and complies with NPDES permit conditions for measuring compliance. This monitoring program is consistent with and informed by National CSO Control Policy and USPEA's *CSO Post Construction Compliance Monitoring Guidance*, May 2012. The main elements of the PCMP include the following:

- A process to determine whether the CSO control measures are meeting the Performance Criteria established in Section 10.
- A monitoring schedule, initial CSO outfall monitoring locations, receiving water sampling locations, and rain gauge locations.
- The approach for analysis of the PCMP data for CSO control measure performance assessment and for reporting progress to regulatory agencies and the general public.
- A Public Notification System to visually notify the public of the occurrence of Combined Sewer Overflows at each receiving water body.

11.2 Purpose and Scope

Post-construction monitoring is anticipated to provide enough data to evaluate the effectiveness of the CSO control measures constructed during the implementation of DELCORA's CSO Long-Term Control Plan Update. The evaluation of the control measures will be based on the Performance Criteria described in this section, and whether DELCORA's CSO discharges comply with its NPDES permit limits. The general scope of the PCMP will include the implementation of a monitoring program as well as a detailed analysis and evaluation of the CSO control measures' efficacy. The PCMP has been developed for the DELCORA service area and its discharges into the receiving waters, including the Delaware River, Chester Creek and Ridley Creek. The program will be conducted during the LTCPU implementation to corroborate that the CSO control measures that are constructed perform adequately, while providing sufficient data to identify and remedy underperforming control measures.

As mentioned in Section 5 of this report, since there are various sources contributing to bacteria water quality impairments including CSOs, urban stormwater, and wild life, WQS will not be achieved in the receiving waters if CSOs are the only source controlled. Post construction monitoring will serve its role in demonstrating that CSOs will be reduced to the levels predicted in the recommended LTCPU based on Typical Hydrologic Period (1994-1996) conditions and therefore are not causing or contributing to the exceedance of the current WQS. When the control measures for pollutant sources other than DELCORA's CSOs are completed, it is expected that the WQSs will be attained.

In accordance with the CSO Policy, the LTCPU is based on "typical year" conditions. Rainfall varies substantially from year to year and from storm to storm. It will require normalizing a given year's rainfall to the Typical Hydrologic Period to assess performance. The same is true for receiving water monitoring where the variables include other pollutant sources that are also driven by wet weather conditions. For these reasons, considerable judgment must be employed when assessing results. The post-construction

monitoring will focus on verifying that the CSO control facilities are being operated as described in the LTCPU.

DELCORA will evaluate the performance of the control measures through use of the H & H model. The model output will be compared with actual CSO flow data for the post-construction monitoring period to determine whether recalibration of the H&H model is needed. Once the H&H model has been determined to be adequately calibrated, a continuous simulation of the Typical Hydrologic Period (1994-1996) will be run to determine whether the CSO control measures have achieved the Performance Criteria.

11.3 Performance Criteria and Compliance Assessment

The Performance Criteria developed in **Subsection 10.3.2** were based on a percentage of total volume entering the CSS that is "captured" for treatment at the WRTP, as part of the Presumption approach. Upon full implementation of the CSO control measures of the LTCPU, the Performance Criteria will be a minimum of 85% capture by volume of the system-wide wet weather volume for treatment at the WRTP based on the Typical Hydrologic Period (1994-1996), also referred to as the "typical year". The minimum 85% capture by volume meets the requirements of the Presumption approach, and this minimum capture amount may increase based on the selected CSO control measures detailed in Section 9. Actual overflow volume will vary from one year to another after full implementation of the CSO control measures, based on real-life precipitation conditions. Recognizing the hydraulics of the combined sewer system and the interconnection between CSO regulators, CSO control measures that do not achieve the performance criteria as a result of other controls that have yet to be completed will not be fully evaluated until all CSO control measures are constructed.

11.4 Post-Construction Compliance Monitoring Data Collection

Data collection is a central element of the PCMP. The type, location and frequency of monitoring to be performed for the LTCPU capital projects will be determined after their scheduled implementation in 2024 and 2029. Currently, the monitoring that was used during the development of the LTCPU is planned on being used as a basis for the PCMP, albeit on a reduced scale. The types of planned monitoring will include:

- Rainfall Monitoring
- CSO Outfall Monitoring
- Sewer System Flow Monitoring

A PCMP schedule with monitoring locations is proposed in **Table 11-1**.

11.5 Data Management and QA/QC

DELCORA has been collecting flow metering data, system-wide CSO outfall data, and rainfall data for several years. The continued collection of this data as part of the PCMP will be integrated into DELCORA's existing data retrieval, management, and quality assurance and control protocols, including their extensive SCADA system. As data management and analysis techniques continue to develop over the implementation period, DELCORA will consider new and improved approaches for managing this data. Monitoring and modeling will be taken to provide proper data validation and QA/QC.

Table 11-1: Proposed Post-Construction Monitoring Plan

Monitoring Type	Delaware River	Chester Creek	Ridley Creek	Frequency
Rainfall Monitoring (9 Locations)	Rose Valley, Chester PS, Central Delaware PS, Muckinipates PS, Darcy Creek PS, Naamans Creek PS, Springfield, Upper Providence, WRTP			Monitor for 1-year period every 5 years*
CSO Overflow Monitoring (6 Locations)	02, 03, 05, 08	19	18	Monitor for 1-year period every 5 years*
CSO Visual Notification System Locations (9 Locations)	02, 07, 11	19, 22, 24	16, 18, 33	Post-Construction Continuous

11.6 Performance Assessment

Under the Presumption approach to demonstrate compliance, DELCORA will continue to update and calibrate the H&H model after the implementation of CSO control measures and after the post-construction monitoring phase data has been collected. The models will be used to simulate CSS performance in the DELCORA collection system and to demonstrate compliance with the performance criteria identified in **Subsection 11.3**, a minimum of 85% capture by volume of the system-wide wet weather volume during the typical year. The models will also be used to assess the performance of green infrastructure control measures. DELCORA will submit a series of milestone reports to the USEPA and/or PADEP detailing the implementation and performance of CSO control measures. A corrective action plan shall be developed in the event that CSO control measures do not meet the Performance Criteria. The Performance Assessment approach, reporting, and corrective action plan are outlined in the following subsections.

11.6.1 Approach

DELCORA will evaluate the performance of the CSO control measures through the use of its H&H model. The following steps will be used to determine compliance with the Performance Criteria:

1. Collect flow monitoring data, CSO outfall data, and rainfall data for the continuous 12-month post-construction monitoring period of each phase of CSO control measures. Perform QA/QC on the data.

2. Once every five years, update the H&H model to include all completed CSO control measures and any other modifications to the CSS since the H&H model was calibrated for the 2018 LTCPU.

3. Run a continuous simulation for the 12-month post-construction monitoring period for the updated model, for the typical year.

11.6.2 Corrective Action Plan

DELCORA is confident that the CSO control measures implemented prior to the 2024 post construction monitoring period will meet the 85% wet weather capture percentage Performance Criteria based on the simulation of the Typical Hydrologic Period (1994-1996). However, should the post construction monitoring suggest the CSO control measures do not perform anticipated, performance factors and deficiencies responsible for this shortfall will be identified. Additional control measures will then be implemented to allow DELCORA to meet the 85% Performance Criteria. A Corrective Action Plan shall be developed that details this analysis, including the implementation plan and schedule of the additional controls. This Corrective Action Plan will include any adaptive management modification based on Post-Construction Monitoring and evaluation. The Corrective Action Plan shall be submitted to USEPA and/or PADEP as part of each Five-Year Milestone Report and include the Post Construction Compliance Monitoring Plan (PCCMP) Reports for the 2024 and 2029 monitoring periods.

DELCORA will consider multiple corrective actions for underperforming CSO control measures, including constructing additional grey infrastructure (i.e. storage tanks) or green infrastructure (i.e. bioretention). Upon review and approval of the Corrective Action Plan by the USEPA and/or PADEP, DELCORA shall implement those measures in accordance with the schedule set forth in the Corrective Action Plan.

11.6.3 Reporting

The PCCMP will evaluate whether the CSO control measures are achieving the Performance Criteria and assess water quality conditions in DELCORA's receiving waters. The progress and evaluation of the CSO control measure implementation and water quality assessment will be reported to the USEPA and/or PADEP, and to the public through a series of milestone reports, including Annual Progress Reports, Five-Year Milestone Reports, and a Final PCCMP Report. DELCORA will also continue to submit annual CSO status reports in the form of the Municipal Wasteload Management Report, in accordance with its NPDES permit requirements.

The Five-Year Milestone Reports shall follow the same timeline as DELCORA's NPDES permits, and shall be submitted alongside their permit application, providing the following information:

- A statement setting forth the deadlines and other terms that DELCORA was required to meet since the last Reporting Period;
- A general description of work completed within the prior period, and a projection of work to be completed within the succeeding period;
- A summary principal contacts with USEPA and/or PADEP during the reporting period relating to CSOs, SSOs, or implementation of the Consent Decree;
- NDPES permit violations;
- A summary of all known SSOs, Unauthorized Releases, and Unpermitted Discharges occurring within the previous reporting Period, including estimated frequency duration, and volume, of each discharge.
- The results of water quality sampling conducted during the five-year reporting period;
- An analysis of the impact in water quality observed within the DELCORA receiving waters related to the implementation of the CSO control measures;
- A summary of all monitoring data collected by DELCORA during the five-year reporting period;

- A description of the CSO control measures completed within the five-year reporting period and a projection of CSO control measure work to be performed during the next five-year period; and,
- An evaluation of the effectiveness of the CSO control measures constructed to date, including Corrective Actions, if needed and as outlined in **Subsection 11.6.2**.

Within one NPDES permit cycle following achievement of full operation for all of the LTCPU projects, DELCORA shall submit a Final PCCMP Report to the USEPA and/or PADEP for their review and approval. This is currently scheduled for 2030 alongside the second and final Five-Year Milestone Report. The purpose of the Final PCCMP Report shall be to evaluate and document the system-wide performance of DELCORA's fully implemented LTCPU CSO control measures. The report shall include an assessment of whether the control measures are meeting the Performance Criteria and complying with water-quality based CWA requirements and DELCORA's NPDES permit, including the following information:

- A complete Post-Construction Monitoring Period data summary and analysis;
- A reporting of all of the CSO control measures that have been constructed, implemented, and that are in operation;
- An evaluation of the system-wide CSO control measure performance, and whether the controls meet the Performance Criteria
- An analysis and discussion of the long-term trend in water quality within DELCORA service area receiving waters; and,
- A description of any Corrective Actions that need to be implemented to meet the Performance Criteria, if the Performance Criteria are not achieved.

11.7 Future Regulatory Requirements

Chester CSO loadings are a very small/insignificant part of the overall bacteria loadings to both the Delaware River and Ridley Creek.

The Delaware River appears to generally meet the bacteria water quality standard. Thus, existing programs addressing NPDES dischargers and upstream loadings may well achieve compliance. Accordingly, any future regulatory requirements, including TMDLs, should be given a low priority due to the low level of non-attainment. Because CSO loadings will be a truly insignificant source, the level of control to be achieved by the implementation of this LTCP should be established as the wasteload allocation for the CSO system.

Ridley Creek experiences significant upstream bacteria loadings along with relatively small/insignificant Chester CSO loadings. To the extent Ridley Creek is the subject of a future effort to reduce bacteria loadings, a use attainability analysis will be warranted given the substantial upstream loadings which appear to preclude consistent water quality standards attainment. As with the Delaware River, any future regulatory effort to further reduce bacteria loadings to the Creek should assign a wasteload allocation to the CSOs which is consistent with the reduced loadings that will be achieved by this LTCP for Chester's CSOs.

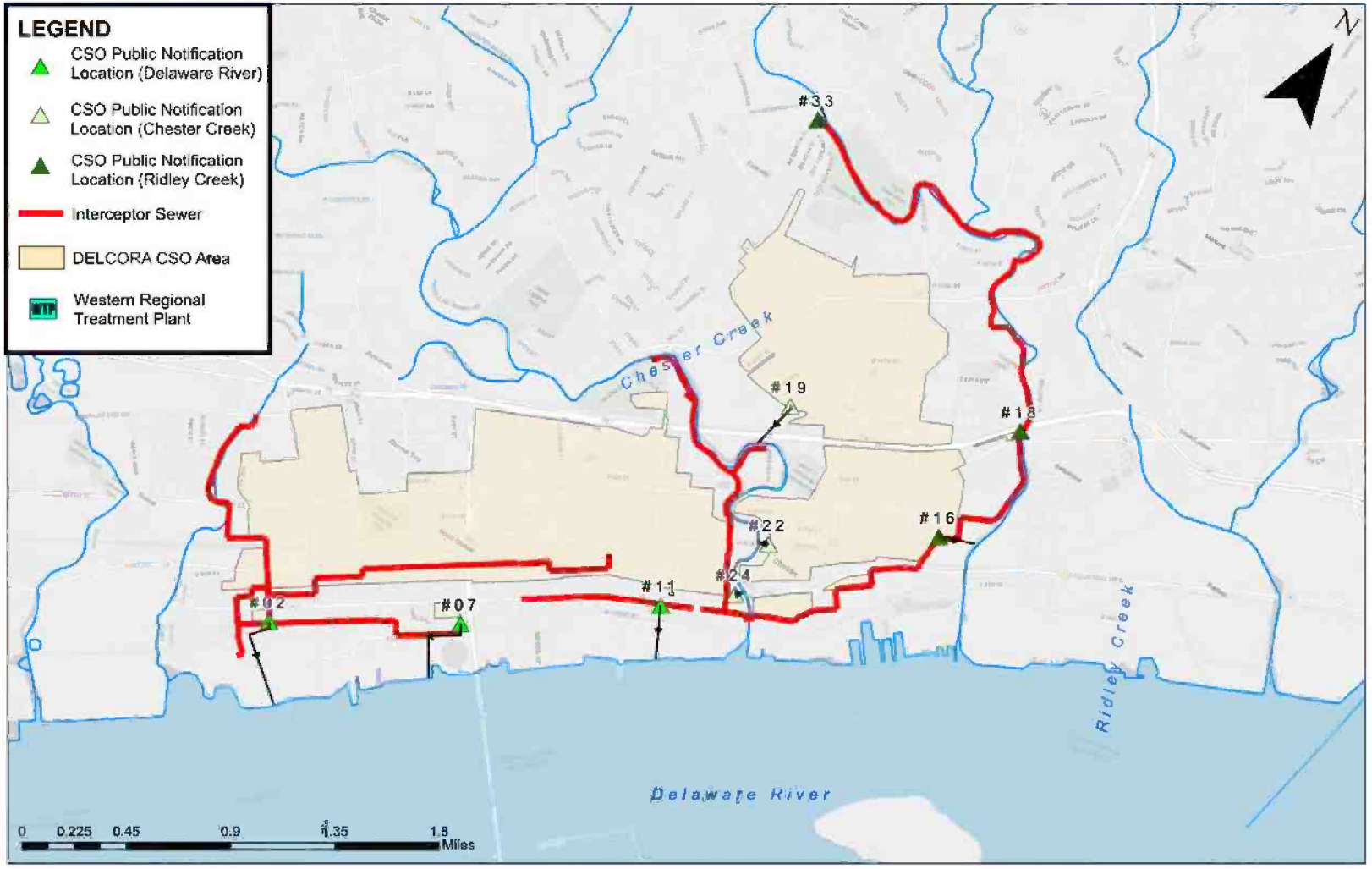
11.8 Public Notification

In order to advise the public of overflows, a visual notification system will be installed at three locations on each receiving body of water (9 total) at public access locations. This system will serve to notify the public of the occurrence of CSOs based on the outfall monitoring at the representative CSO outfalls. The system will be comprised of two colored lights that will operate as follows:

- Color A (red) will be displayed as long as flow is detected from the representative outfall;
- Color B (yellow) will be displayed for 24 hours after flow is no longer detected from the representative outfall;
- The visual notification system will be described and explained on DELCORA's website.

The CSO locations where the visual notification lights will be installed are illustrated in **Figure 11-1**.

Figure 11-1 CSO Visual Public Notification Light Locations



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Section 12 Revision of Operation and Maintenance Plans

DELCORA has a comprehensive Operation and Maintenance (O & M) Program to ensure the appropriate and consistent operation its collection system facilities. DELCORA has developed this plan in accordance with CSO Policy requirements for Nine Minimum Controls and its NPDES permit. However under Consent Decree Paragraph V.A.22 (Revision of Operation and Maintenance Plan), the LTCPU is required to identify CSO control measures that require a revised O&M plan and include a procedure for the revision and dissemination of such plans within sixty days of the Placement in Operation of each such control. As defined under the Consent Decree, the Placement in Operation shall mean a CSO control measure is operational with the level of control designed, even if construction close-out activities may not yet be complete. This section summarizes the current DELCORA Operation and Maintenance Program and how that program will be updated as the CSO control measures are implemented.

12.1 Current Operation and Maintenance Plan

DELCORA's current O & M Program consists of the following elements:

- Operation and Maintenance Manuals: DELCORA maintains a library at its Western Regional Treatment Plant as a central location for current O&M manuals for critical operations equipment. Procedures for routine maintenance, including maintenance and inspection of CSO regulators and tide gates are also kept at the library. Manuals detailing specific pump operations are available at DELCORA's remote pumping stations. When new equipment is installed operating instructions, a maintenance summary, description and frequency of maintenance activity, and recommended spare parts are obtained from the vendor. DELCORA has a procedure for cataloging and disseminating these manuals to the on-site library and other appropriate locations. In addition, as new equipment is acquired, procedures are in place to add data to DELCORA's computerized maintenance management database and to place recommended spare parts into inventory.
- Routine Inspections Schedule: Critical elements of the CSS are inspected routinely according to a schedule that is maintained electronically. Video inspections, maintenance records, and work orders are likewise, all maintained electronically for future reference.
- Organizational Structure: The organization, authority, and responsibility of operations and maintenance are clearly communicated through chain of command, which comes from the Director of Operations and Maintenance and follows to the Sewer Maintenance Supervisor, Foremen, Crew Chiefs, and sewer maintenance personnel, including key on-call personnel.
- Critical Facilities List: DECLORA has an established inventory list of critical facilities, including CSO regulators and tide gates. Information about these critical facilities is electronically maintained and updated in DELCORA's internal system for accuracy and reliability.
- Emergency Response Plans: DELCORA maintains on-call staff that are available 24 hours a day every day throughout the year to respond to sewer related problems. Specific Emergency Response Plans and protocol have been developed to allow a swift response from DELCORA's staff to resolve the issue.
- Training and Safety Programs: Upon hiring, all new employees experience a period of probation where they receive on the job training by supervisors and experienced personnel. It is the policy of DELCORA to provide an active workplace Safety & Health Program. The objective of the program is to ensure a safe environment for all employees and visitors as well as to protect Authority buildings, equipment, and other property. As part of the Safety & Health Program, employees are issued a Health and Safety Manual, which is reviewed yearly with the employees.

- Periodic Review of O&M Program: Each year, the Director of Operation and Maintenance and the Sewer Maintenance Supervisor review O&M practices on the sewer system as part of the Chapter 94 Municipal Wasteload Management Annual Report. All revisions are incorporated swiftly into the existing program.

12.2 Operation and Maintenance Program Updates for CSO Control Measures

As required by the Consent Decree, DELCORA will prepare updates to the current O&M manuals to include any new facilities which are a part of this LTCPU and disseminate those plans within sixty days of the Placement in Operation of each CSO control measure. O & M manuals are stored in the central database with the physical copies handed to the relevant staff when necessary. Typically, an O&M Manual will be developed for each facility constructed as part of this LTCPU. These manuals will include a description of the equipment and features of the facility, operating instructions, maintenance guides, and safety considerations. Manuals should be reviewed for the optimization of LTCPU capital projects after new projects are brought online.
Year

The updates to the O & M Program will begin within sixty days of placing the following CSO Control Measures into operation, and will follow a two-step process:

1. Proposed Operation and Maintenance Manual Updates – DELCORA will submit to USEPA and/or PADEP for review and commit the proposed O&M Manual updates for
    a. a Ridley Creek Interceptor SSO tank improvement at Taylor Memorial Arboretum and
    b. WRTP modifications

    that are placed into operation for the first time, if and when construction is completed, within ninety days of the full operation of the CSO Control Measure in accordance with the implementation schedule presented in Section 10.

2. Integrated Operation and Maintenance Manual – Once approved by USEPA and/or PADEP, DELCORA will incorporate the proposed updates into the current O&M Manuals, described in the preceding section.

12.3 Staffing Needs

In developing the LTCPU, DELCORA has made preliminary estimates of O&M costs, which include labor. The exact number of staff, and the specific staff responsibilities and qualifications will be determined during the implementation of the LTCPU and reviewed annually as part of the annual budget process. It is expected that operator experience will increase as similar facilities come online, potentially reducing end-of-program staffing requirements.

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GREELEY AND HANSEN

APPENDIX A

Alternatives Evaluation Approach Report

- DELCORA Alternatives Evaluation Approach Report dated April 2016
- USEPA Approval of the Alternatives Evaluation Approach Report dated October 13, 2016

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Alternatives Evaluation Approach Report (Final)

April 2016

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Alternatives Evaluation Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	4/13/16 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	4/12/16 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	4/13/16 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

1.1 Background

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal wastewater authority that owns, operates and maintains collection systems that serve approximately a half-million people in southeastern Pennsylvania, including 42 municipalities in Delaware and Chester Counties. DELCORA operates a Combined Sewer System (CSS) that is comprised of sewer sections that accept both stormwater and sanitary wastewater, which is treated at DELCORA's Western Regional Treatment Plant (WRTP).

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP).

1.2 Purpose

As part of the Long Term Control Plan Update (or "LTCPU"), the Consent Decree requires DELCORA (in coordination with the USEPA and PADEP) to propose what approach to the Long Term Control Plan Alternative Evaluation (i.e., the "Presumption Approach" or the "Demonstration Approach") is appropriate for the each of DELCORA's receiving waters, and to submit a written explanation to the USEPA and PADEP for review and approval. The three water bodies that receive overflows from DELCORA's CSS include the Delaware River, Chester Creek and Ridley Creek.

DELCORA is in the process of developing the LTCPU for its Combined Sewer System, and the purpose of this report is to meet the requirement in the Consent Decree for the submission of a written explanation of DELCORA's Alternatives Evaluation Approach to the USEPA and PADEP, while also addressing those requirements from USEPA's "Combined Sewer Overflow Control Policy," April 1994 and also considering the "Combined Sewer Overflows Guidance for Long-Term Control Plan," September 1995 (CSO Guidance Document). Determination of the use of the Presumption or Demonstration Approach is important because it can potentially affect the development of the CSO control alternatives.

Section 2 Regulatory Framework

There are various documents that discuss the Alternatives Evaluation Approach that may be taken for the development of a long term control plan. These documents are discussed in further detail in this Section.

2.1 Consent Decree Requirements

The Consent Decree requires DELCORA to complete and submit a LTCPU to the USEPA and PADEP for review and approval. Section V.A.13 of the Consent Decree ("Alternatives Evaluation Approach") specifically requires that:

> *"Within nine (9) months after the Date of Lodging, DELCORA shall propose, in coordination with the EPA and PADEP and in accordance with Section II.C.4 of the CSO Control Policy, what approach to LTCP Alternative Evaluation (i.e., Presumption or Demonstration) is appropriate for each of DELCORA's Receiving Waters, and to submit a written explanation of such determination to Plaintiffs for review and approval pursuant to Section VI (Review and Approval of Submittals)."*

The Consent Decree further states that:

> *"Use of the Presumption Approach will be allowed only where EPA and PADEP each agree that the specific presumption(s) to be used in a particular water body are reasonable pursuant to Section II.C.4.a of the CSO Control Policy".*

2.2 USEPA's CSO Control Policy Requirements

Section II.C.4 of the USEPA's CSO Control Policy states that the long term CSO control plan should adopt one of the following two approaches for CSO controls sufficient to meet CWA requirements: 1) the Presumption Approach, and 2) the Demonstration Approach.

2.2.1 Presumption Approach from USEPA's CSO Control Policy

Sub-section II.C.4.a of the USEPA's CSO Control Policy (Presumption Approach) states that:

> *"A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas... These criteria are provided because data and modeling of wet weather events*

often do not give a clear picture of the level of CSO controls necessary to protect WQS."

Under the Presumption Approach, CSO controls proposed in the LTCPU are presumed to protect water quality in the receiving water bodies if the Combined Sewer System achieves any of the following three criteria:

i. *"No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or*

ii. *The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or*

iii. *The elimination or removal of no less than the mass of the pollutants identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under the paragraph ii above."*

"Minimum treatment," as noted in Item "*i*" above, is defined in Sub-section II.C.4.a of the CSO Control Policy as:

- *"Primary Clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);*
- *Solids and floatables disposal; and*
- *Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary."*

2.2.2 Demonstration Approach from USEPA's CSO Control Policy

Sub-section II.C.4.b of the USEPA's CSO Control Policy (Demonstration Approach) states that:

"A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA."

Under the Demonstration Approach, the municipality would be required to successfully demonstrate compliance with each of the following criteria from the CSO Control Policy:

i. *"The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;*

ii. *The CSO discharges remaining after implementation of the proposed control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribution to their impairment. Where WQS are not met in part because of natural background conditions or pollution sources other than CSO discharges, a total maximum daily load, including a waste load allocation and a load allocation or other means should be used to apportion pollutant loads;*

iii. *The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and*

iv. *The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are determined to be necessary to meet WQS or designated uses."*

2.3 USEPA's CSO Guidance for Long-Term Control Plan Requirements

The USEPA's CSO Guidance for Long-Term Control Plan (or "CSO Guidance Document") states that the Demonstration Approach and the Presumption Approach are the two general approaches to attainment of WQS, and that these two approaches provide municipalities with targets for CSO controls that achieve compliance with the Clean Water Act, particularly the protection of designated uses.

Section 1.3 of the CSO Guidance Document states:

> *"Permittees should develop long-term control plans (LTCPs) for controlling CSOs. A permittee may use one of two approaches: 1) demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or 2) implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach")."*

Section 2.6.2.1 states that:

> *"Under the CSO Control Policy, a municipality should develop an LTCP that adopts either the demonstration or the presumption approach to attainment of*

WQS. The demonstration approach is based on adequately demonstrating that the selected CSOs will provide for the attainment of WQS, including designated uses in the receiving water. The presumption approach does not explicitly call for analysis of receiving water impacts. The presumption approach usually involves at least screening-level models of receiving water impacts, however, because the approach will not apply if the NPDES permitting authority determines that the LTCP will not result in attainment of CWA requirements."

2.3.1 Presumption Approach from USEPA's CSO Guidance for LTCP

For the Presumption Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

"If the data collected by a community do not provide "...a clear picture of the level of CSO controls necessary to protect WQS", the presumption approach may be considered. Use of the presumption approach is contingent, however, on the municipality presenting sufficient data to the NPDES permitting authority to allow the agency to make a reasonable judgment that WQS will probably be met with a control plan that meets one of the three presumption criteria."

Furthermore, the CSO Guidance Document states:

"Use of the presumption approach does not release municipalities from the overall requirement that WQS be attained. If data collected during system characterization suggest that use of the presumption approach cannot be reasonably expected to result in attainment of WQS, the municipality should be required to use the demonstration approach instead. Furthermore, if implementation of the presumption approach does not result in attainment of WQS, additional controls beyond those already implemented might be required."

2.3.2 Demonstration Approach from USEPA's CSO Guidance for LTCP

For the Demonstration Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

"Generally, if sufficient data are available to demonstrate that the proposed plan would result in an appropriate level of CSO control, then the demonstration approach will be selected. The demonstration approach is particularly appropriate where attainment of WQS cannot be achieved through CSO control alone, due to the impacts of non-CSO sources of pollution. In such cases, an appropriate level of CSO control cannot be dictated directly by existing WQS but must be defined based on water quality data, system performance modeling, and economic factors."

The Demonstration Approach is consistent with the total maximum daily load (TMDL) development approach and may be used in the TMDL process where the WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs. Section 3.2.1.1 of the CSO Guidance Document states:

> *"the demonstration approach encourages the development of total maximum daily loads and/or the use of a watershed approach throughout the LTCP process. In conducting the existing baseline water quality assessments as part of the system characterization, for example, the specific pollutants causing nonattainment of WQS, including existing or designated uses, would be identified, and then the sources of these pollutants could be identified and loads apportioned and quantified."*

2.4 Comparison of the Two Approaches

The following table summarizes the major differences between the Presumption Approach and the Demonstration Approach.

Table 2-1: Comparison of the Two Approaches

Item	Presumption Approach	Demonstration Approach
Criteria	• Meet one of three criteria and compliance is **presumed**: 1) No more than an average of 4-6 overflow events per year; 2) 85% capture (by volume) 3) Elimination or removal of the mass of pollutants, identified as causing water quality impairment.	• Number of CSO events, flow or pollutant loading limited by a proposed CSO system Waste Load Allocation which will comply with Water Quality Standards (WQS). • Relies on data collection and model simulation to **demonstrate** that the proposed LTCP results in meeting the current WQS and designated uses.
Monitoring Data Collection	• Flow metering of the collection system and/or water quality sampling of CSOs.	• Flow metering of the collection system and water quality sampling of CSOs **and** receiving water bodies.
Modeling	• Combined sewer system (CSS) hydrologic and hydraulic (H&H) model.	• CSS H&H Model **and** Receiving Water Quality Model(s).
Pollutant Sources Evaluated	• Only CSOs.	• The contributing pollutant sources in the watershed including urban stormwater, agricultural (if any), wildlife, etc.

The Demonstration Approach takes a holistic watershed based approach to understand the pollutant sources and their relative contributions, so that appropriate level of controls can be cost-effectively applied to each pollutant source instead of focusing on just the CSOs. The

Demonstration Approach can help to understand where the current CSO program is in terms of meeting the WQS and demonstrate the impact of future WQS changes on the CSO controls. Under the Demonstration Approach, the permittee must document that their CSO control program is adequate to meet the water quality-based requirements of the CWA.

Use of the Presumption Approach for a particular water body is only allowed when approved by the USEPA and PADEP and each agree that the specific presumption(s) to be used in a particular water body are reasonable pursuant to Section II.C.4.a of the CSO Control Policy.

Certain tasks must be completed regardless if the Presumption or Demonstration Approach is used, such as system characterization, sewer and GIS mapping, and the evaluation of alternatives. However, it is to be noted that the study phase for the Demonstration Approach also requires water quality sampling and water quality modeling of the receiving waters.

Section 3 CSO System Description

3.1 Background of DELCORA's Facilities

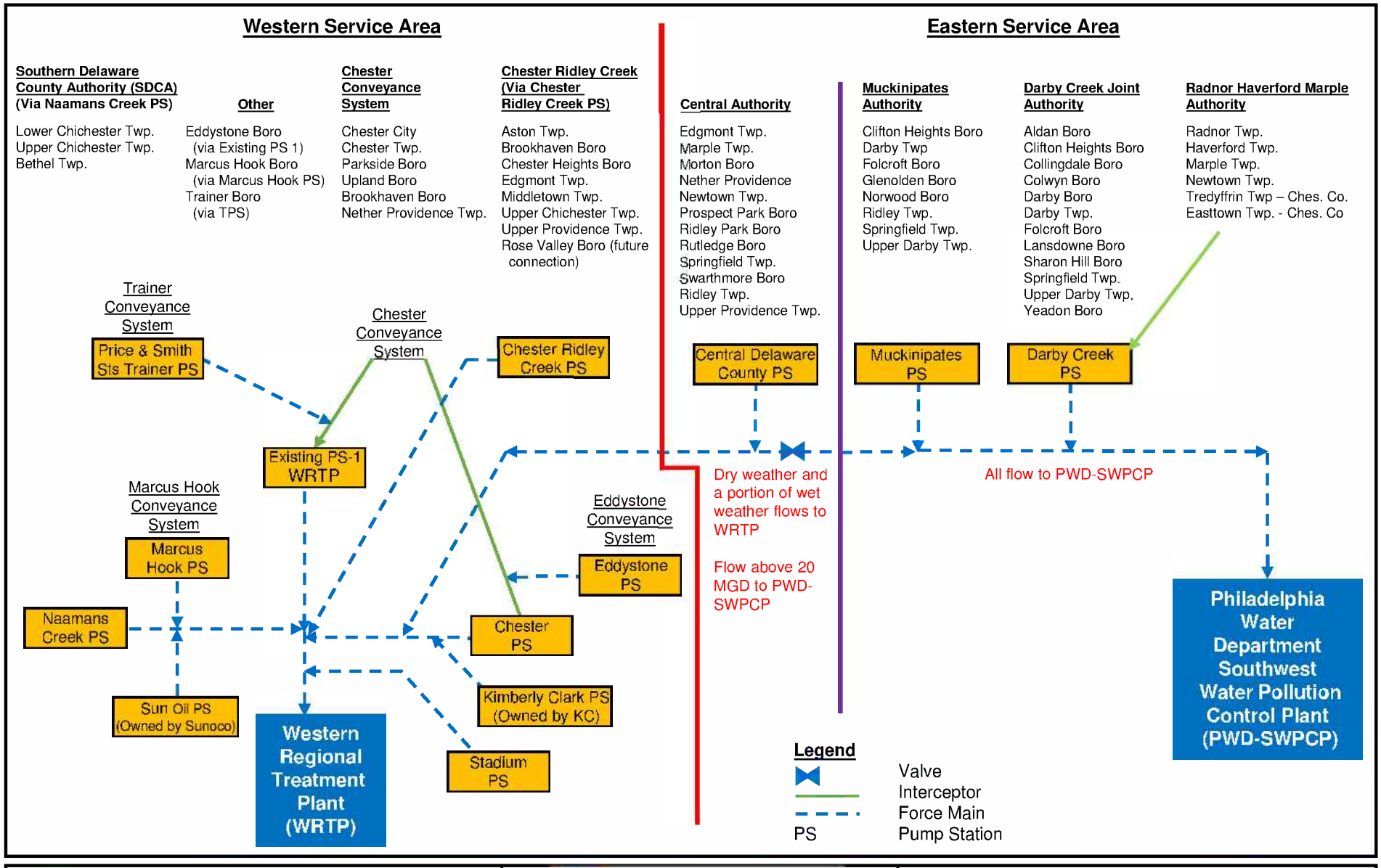
The Delaware County Regional Water Quality Control Authority is responsible for the safe collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 3-1. The total service area served by DELCORA, as shown on Figure 3-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic (H&H) model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows.

Historically, DELCORA has characterized its service areas as the "Eastern" and "Western." The Western Service Area wastewater is treated at DELCORA's Western Regional Treatment Plant, located at 3201 W. Front Street in Chester, Pennsylvania. The WRTP treats all wastewater from Southern Delaware County Authority, Marcus Hook Borough, Trainer Borough, Upland Borough, Parkside Borough, Eddystone Borough, Chester Township and the City of Chester as well as a portion of the wastewater from Brookhaven Borough and Nether Providence Township.

The Eastern Service Area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

There are a total of 26 combined sewer overflows with 25 discharge points listed in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection, DELCORA is authorized to discharge from the Western Regional Treatment Plant (#001), four storm water outfalls at the WRTP (#028-031),



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WESTON SOLUTIONS
Restoring Resource Efficiency

Figure 3-1
DELCORA'S CONVEYANCE SYSTEM

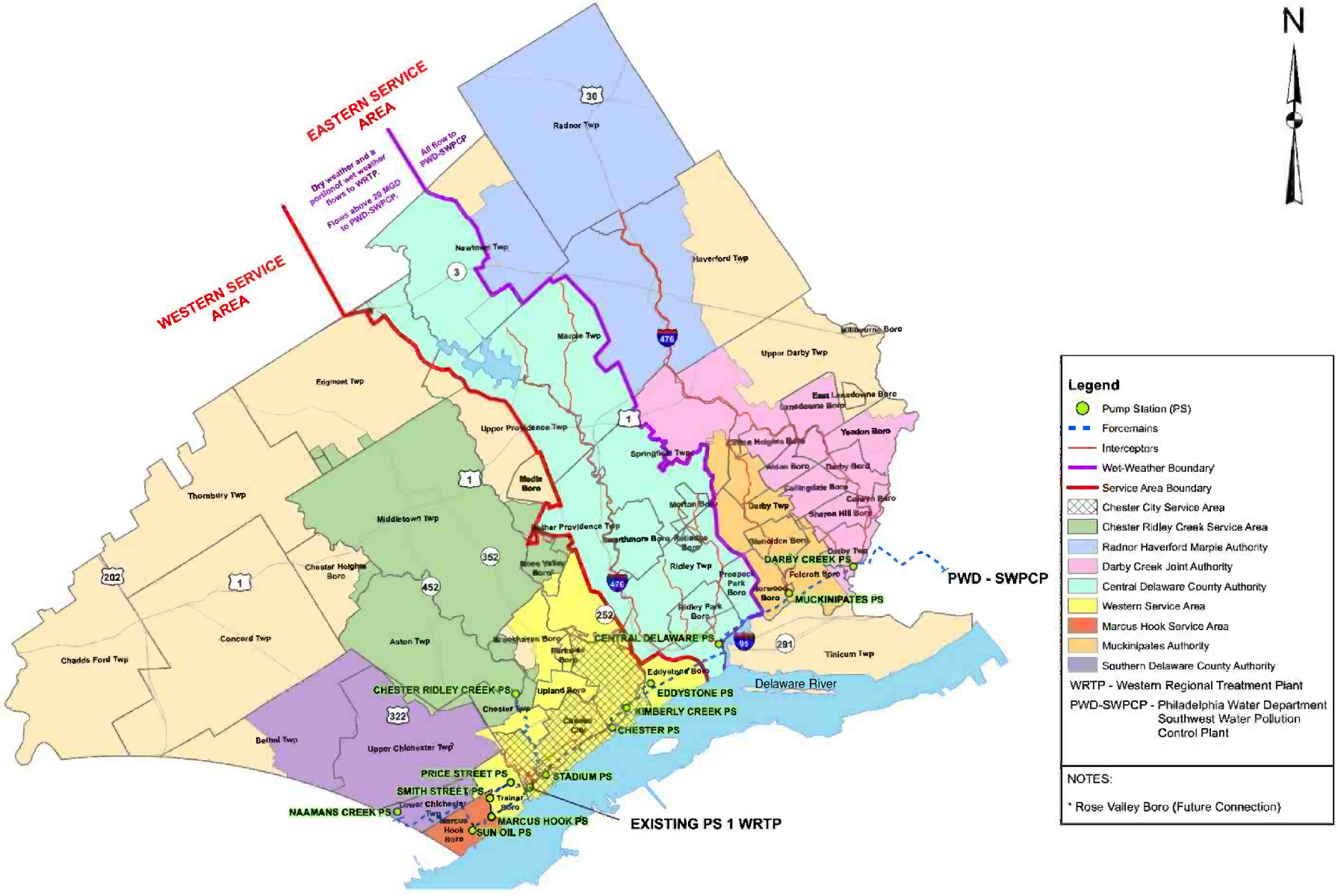

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Figure 3-2
DELCORA'S SERVICE AREA

and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek. CSOs #009 and #010 both discharge at CSO #009.

3.2 City of Chester CSO System

As noted in Section 3.1, the combined portion of DELCORA's sewer system is located within the City of Chester (City) and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The Chester CSO system contains 26 permitted outfalls as listed in Table 3-1 that discharge to three receiving water bodies; the Delaware River, Chester Creek and Ridley Creek. Figure 3-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility.

Table 3-1: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W
Ridley Creek	033	Elkington Boulevard and Ridley Creek	39°52'22"N	75°22'29"W

Notes:
(1) CSO Outfall 010 discharges to the Delaware River through CSO Outfall 009.

Figure 3-3 and Table 3-2 also provide a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 3-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

3.3 CSO System Modeling

Since 1997, DELCORA has conducted annual modeling of the CSO system using the USEPA's Storm Water Management Model (SWMM) to estimate overflows to its receiving waters. SWMM is a dynamic rainfall-runoff model for "single-event" or "continuous" simulations of runoff quantity and quality from primarily urban areas. The model simulates the time-varying process of rainfall onto land surfaces, the conversion of rainfall to infiltration, evaporation, or surface runoff, and the routing of mixed stormwater runoff and sanitary sewage through the collection system. DELCORA's SWMM is also referred to in this report as the Hydrologic and Hydraulic (H&H) model.

Section 2.6.1 (Combined Sewer System Modeling) of the USEPA's CSO Guidance for Long-Term Control Plan states that:

> *"The primary objective of CSS modeling is to understand the hydraulic response of the CSS to a variety of precipitation and drainage area inputs. CSS modeling can also be used to predict pollutant loadings to receiving waters. Once the model is calibrated and verified, it can be used for numerous applications that support CSO planning efforts, including (EPA, 1995d):*

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Figure 3-3
Location of Regulators and Combined Sewer Outfalls With Drainage Areas

Table 3-2: Subarea Type and Size

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
2	02A	CSS	20.7
	02B	CSS	31.7
	02C	CSS	0.3
			52.7
3	03A	Separate	12.8
	03B	CSS	21.9
	03C	CSS	46.5
	03D	CSS	18.5
	03E	CSS	2.9
			102.5
4	04A	CSS	10.8
	04B	CSS	22.6
	04C	CSS	2.5
	04D	Separate	1.0
			36.8
5	05A	Separate	97.4
	05B	Separate	26.4
	05C	CSS	32.0
	05D	CSS	29.1
		Unsewered	32.1
	05E	CSS	28.6
			245.7
6	Converted to Regulator 7 subareas		
7	07A	CSS	12.8
	07B	CSS	18.5
	07C	CSS	16.3
			47.6
8	08A	CSS	83.2
	08B	CSS	90.2
	08C	Separate	9.8
	08D	CSS	3.8
			187.0

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
9	09A	CSS	29.3
10	10A	CSS	46.6
11	11A	CSS	11.8
	11B	CSS	31.4
	11C	CSS	6.3
	11D	CSS	2.5
			52.0
12	12A	CSS	3.3
13	13A	CSS	25.3
	13B	CSS	19.7
	13C	CSS	7.2
			52.1
14	14A	CSS	41.4
	14B	CSS	11.8
	14C	CSS	10.5
	14D	CSS	2.4
			66.1
15	15A	CSS	8.6
	15B	Separate	4.1
			12.7
16	16A	CSS	6.9
16/17	16/17A	CSS	36.4
	16/17B	CSS	41.4
	16/17C	CSS	17.2
			95.0
17	17A	CSS	7.6
18	18A	CSS	27.2
	18B	CSS	4.8
			32.1

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
19	19A	Separate	30.7
	19B	CSS	73.5
	19C	CSS	138.2
	19D	CSS	71.5
	19E	CSS	36.3
	19F	CSS	38.7
	19G	CSS	6.1
			395.0
20	20A	CSS	12.8
21	21A	CSS	18.3
22	22A	CSS	17.3
23	23A	CSS	9.1
24	24A	CSS	6.1
25	25A	CSS	23.7
26	26A	CSS	18.3
	26B	CSS	8.6
			26.9
31	31A	CSS	5.9
Stoney Creek Collector	SC1	CSS	49.1
Booth Street Inteceptor	BS1	Separate	18.4
	BS2	CSS	22.2
	BS3	CSS	14.3
	BS4	Separate	63.2
	BS5	Separate	60.3
			178.4
West End Interceptor	WE1	Separate	39.7
Delaware River Interceptor	DR1	CSS	5.8

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
2nd Street Interceptor	SS1	Separate	7.1
	SS2	Separate	19.0
	SS3	Separate	30.4
			56.5
Penn Street Interceptor	PS1	CSS	2.9
	PS2	CSS	3.4
			6.3
Chester Creek West Interceptor	CCW1	CSS	18.9
	CCW2	CSS	6.2
			25.1
Chester Creek East Interceptor	CCE1	Separate	6.9
Edgmont Avenue Interceptor	EA1	CSS	3.8
Ridley Creek Interceptor	RC1	CSS	2.2
	RC2	Separate	24.7
	RC3	Separate	19.2
	RC4	Separate	27.7
	RC5	Separate	21.4
	RC6	Separate	27.2
	RC7	Separate	23.9
	RC8	Separate	25.1
	RC9	Separate	31.6
	RC10	CSS	7.7
			210.7
		CSS	**1,506.1**
		Separate	**632.4**
TOTAL			**2,138.5**

NOTE: CSS = Combined Sewer System

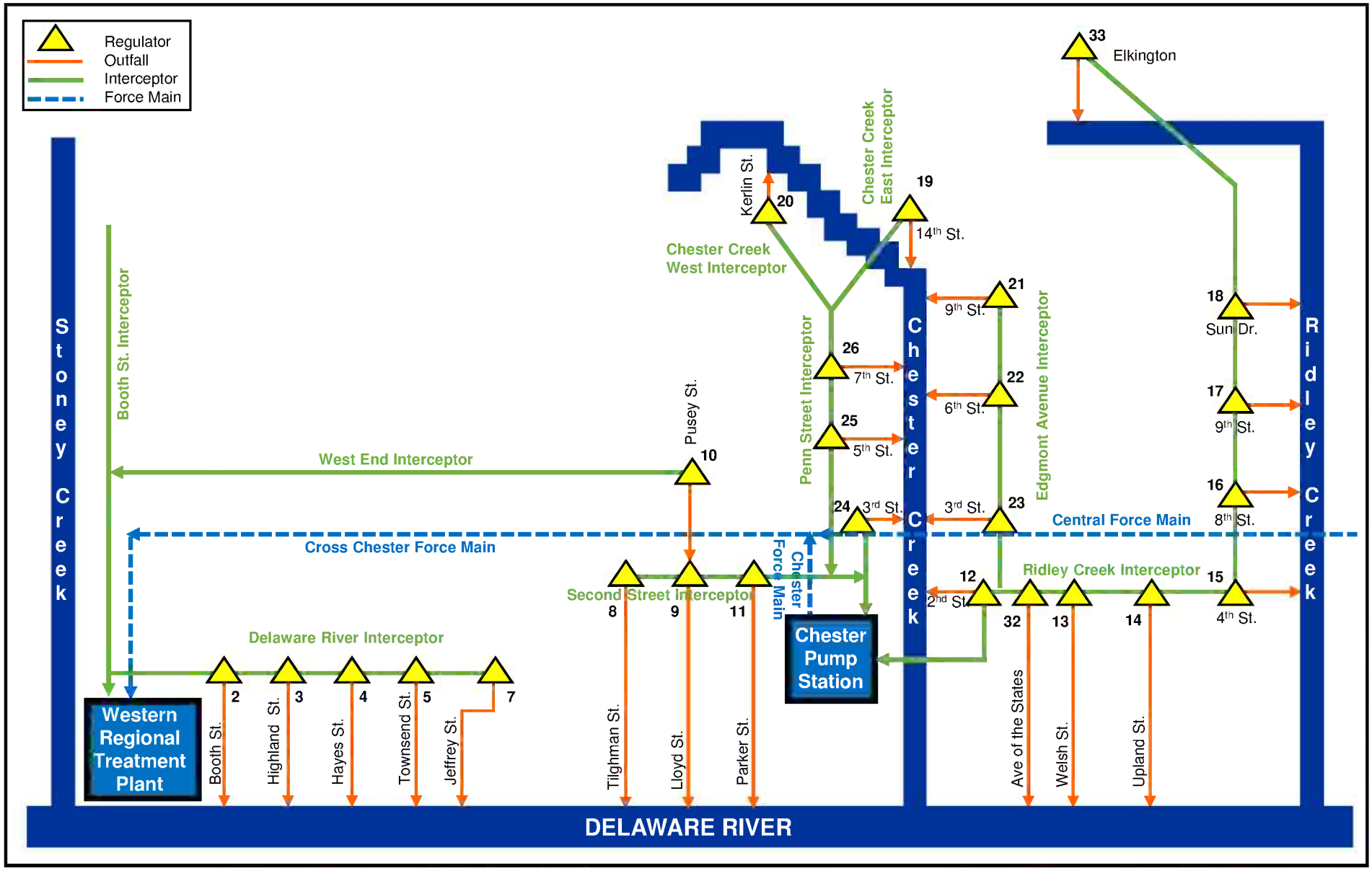

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Figure 3-4
SCHEMATIC OF CHESTER CSO SYSTEM

- *To predict overflow occurrence, volume, and, in some cases, quality for rain events other than those which occurred during the monitoring phase. These can include a storm event of large magnitude (long recurrence period) or numerous storm events over an extended period of time.*

- *To predict the performance of portions of the CSS that have not been extensively monitored.*

- *To develop CSO statistics, such as annual number of overflows and percent of combined sewage captured in response to the presumption approach of the CSO Control Policy.*

- *To optimize CSS performance as part of NMC implementation. In particular, modeling can assist in locating storage opportunities and hydraulic bottlenecks and demonstrate that system storage and flow to the POTW are maximized.*

- *To evaluate and optimize control alternatives, from simple controls described under the NMC to more complex controls proposed in a municipality's LTCP. An example of a simple control would be to raise weir heights to increase in-line storage. The model can be used to evaluate the resulting reductions in CSO volume and frequency."*

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was set up to simulate monthly CSO discharges in EPA SWMM 5.0, and it is used to estimate the frequency and volume of CSO overflows in the City of Chester and to evaluate long-term strategies for minimizing CSO overflows. The model uses data from the rain gauge located at the WRTP and is supplemented with data from a gauge at the Central Delaware Pump Station. The current model has been updated and expanded over the years to account for changes in the CSO system, but it has not been re-calibrated. Updating and additional calibration and validation of the SWMM model will occur in a subsequent task as part of the requirements of DELCORA's Consent Decree.

Monthly Reports of CSO Modeling using the SWMM are provided to the PADEP as part of DELCORA's Annual Municipal Wasteload Management Report (Chapter 94 Report), and are also provided monthly with the PADEP electronic Discharge Monitoring Report (e-DMR). For the purposes of this report, a run of the existing H&H model was performed using the typical hydrologic period established for DELCORA's CSO LTCPU. The typical hydrologic period was previously determined to be the 3-year period from 1994 – 1996, as detailed in the "Typical Hydrologic Period Report" submitted to the USEPA in November 2015. The hydrologic period from 1994 – 1996 contains a wet year (1996 with 52.1 inches), a dry year (1995 with 31.6 inches) and a year close to average conditions (1994 with 44.9 inches).

A series of monthly simulations of the existing H&H model was executed to estimate the overflow frequency, duration and volume to each of the three receiving water bodies (the Delaware River, Chester Creek and Ridley Creek) as well as the percent volume captured for treatment. The model was run in continuous mode for each month for the 1994 – 1996 period. Evaporation was not included in the simulation since it does not affect the model in a meaningful way, and may cause underreporting of CSO discharges in some cases. It is also to be noted that the snowfall recorded at the rain gauges was simulated in SWMM as rainfall and since peak runoff from snowmelt is typically lower than from rainfall, the SWMM model simulates a conservative estimate of CSO overflows.

The outputs from the H&H model run for the typical hydrologic period are summarized in Table 3-3. Based on the model results for the 1994 – 1996 typical hydrologic period, Table 3-3 indicates that:

- Only four (4) of the 25 outfalls (i.e., #012, 024, 032 and 033) are currently estimated by the model to have had less than 4-6 annual overflow events, which is a prime requirement for use of the Presumption Approach. The next lowest number of overflow events is shown to occur at CSO #020, for which the model indicates an annual average of 21 overflow events. All of the remaining outfalls are shown to have to an annual average of 25 or more overflow events.

- The response of certain regulators (i.e., #002, 003, 004, 005, 007, 008, 009, 011, 013, 015, 017, 018, 019, 022 and 025) is sensitive to even the smallest amounts of precipitation. The model indicates that these outfalls had the highest frequency of discharges.

- The Delaware River received overflows from 11 of the 25 discharge points in the CSS, which was approximately 50% of the total annual average overflow volume and accounted for approximately 49% of the overall number of discharge events.

- The Ridley Creek received overflows from 5 of the 25 discharge points in the CSS, which was approximately 12% of the total annual average overflow volume and accounted for approximately 23% of the overall number of discharge events.

- The Chester Creek received overflows from 9 of the 25 discharge points in the CSS, which was approximately 38% of the total annual average overflow volume and accounted for approximately 28% of the overall number of discharge events.

- The existing H&H model estimates that the percentage of the combined flow treated at the wastewater treatment plant was approximately 61% for the 1994 - 1996 period, which is significantly less than the 85% capture rate for treatment required for use of the Presumption Approach.

A bar chart is also included below Table 3-3 that graphically illustrates the information in the table. The chart shows the large gap that exists between the modeled number of overflow events for the typical hydrologic period, and the limit prescribed for use of the Presumption Approach of only 4-6 overflow events per year.

Table 3-3: H&H Model Results for Typical Hydrologic Period (1994 - 1996)

		Western Chester City Service Area						Central Chester City Service Area												Eastern Chester City Service Area								
		DELAWARE RIVER						DELAWARE RIVER			CHESTER CREEK									DELAWARE RIVER			RIDLEY CREEK					

Annual Overflow Frequency (Occurrence)

	Rainfall	#002	#003	#004	#005	#006	#007	#008	#009	#011	#012	#019	#020	#021	#022	#023	#024	#025	#026	#013	#014	#032	#015	#016	#017	#018	#033	Max
1/1/1994	45	80	76	44	72	0	74	76	48	50	3	93	21	43	51	30	5	65	26	54	31	2	46	32	97	93	5	97
1/1/1995	31	62	60	37	58	0	60	61	39	39	1	80	13	31	40	23	4	53	17	44	24	1	37	26	83	80	2	83
1/1/1996	52	88	83	56	83	0	84	84	57	58	1	112	28	52	59	36	5	79	32	64	38	1	56	42	115	112	3	115
Average	43	77	73	46	71	0	73	74	48	49	2	95	21	42	50	30	5	66	25	54	31	1	46	33	98	95	3	98

Typical Year Overflow Volume (MG)

	Rainfall	#002	#003	#004	#005	#006	#007	#008	#009	#011	#012	#019	#020	#021	#022	#023	#024	#025	#026	#013	#014	#032	#015	#016	#017	#018	#033	Annual Total
1/1/1994	45.0	67.0	52.9	14.6	56.7	0.0	28.7	96.9	27.1	20.7	0.2	272.5	2.5	6.5	7.6	2.5	0.5	13.3	5.8	26.1	15.4	0.1	2.4	17.9	51.0	27.6	0.4	862
1/1/1995	31.4	44.3	34.1	8.3	36.9	0.0	18.7	61.9	16.6	12.1	0.0	182.1	0.8	3.5	4.5	1.1	0.1	8.5	2.0	16.2	7.0	0.0	1.2	7.6	36.5	18.6	0.0	554
1/1/1996	52.1	78.8	62.2	16.0	67.5	0.0	33.9	112.8	30.9	23.2	0.0	318.0	1.4	6.7	8.6	2.0	0.1	15.8	3.4	30.4	13.1	0.0	2.4	14.1	62.0	32.1	0.0	988
Average	42.8	63.4	49.7	13.0	53.7	0.0	27.1	90.6	24.9	18.7	0.1	257.5	1.6	5.6	6.9	1.9	0.2	12.6	3.7	24.2	11.8	0.0	2.0	13.2	49.8	26.1	0.1	801

WWTP Treated Wet Weather Volume (Assuming max WWTP flow at 105.54 MGD, and plant DWF at 7.01 MGD)

1994	634	MG
1995	481	MG
1996	743	MG
Average	620	MG

Total Overflow

1994	862	MG
1995	554	MG
1996	988	MG
Average	801	MG

Percent of Wet Weather Flow Treated by WWTP

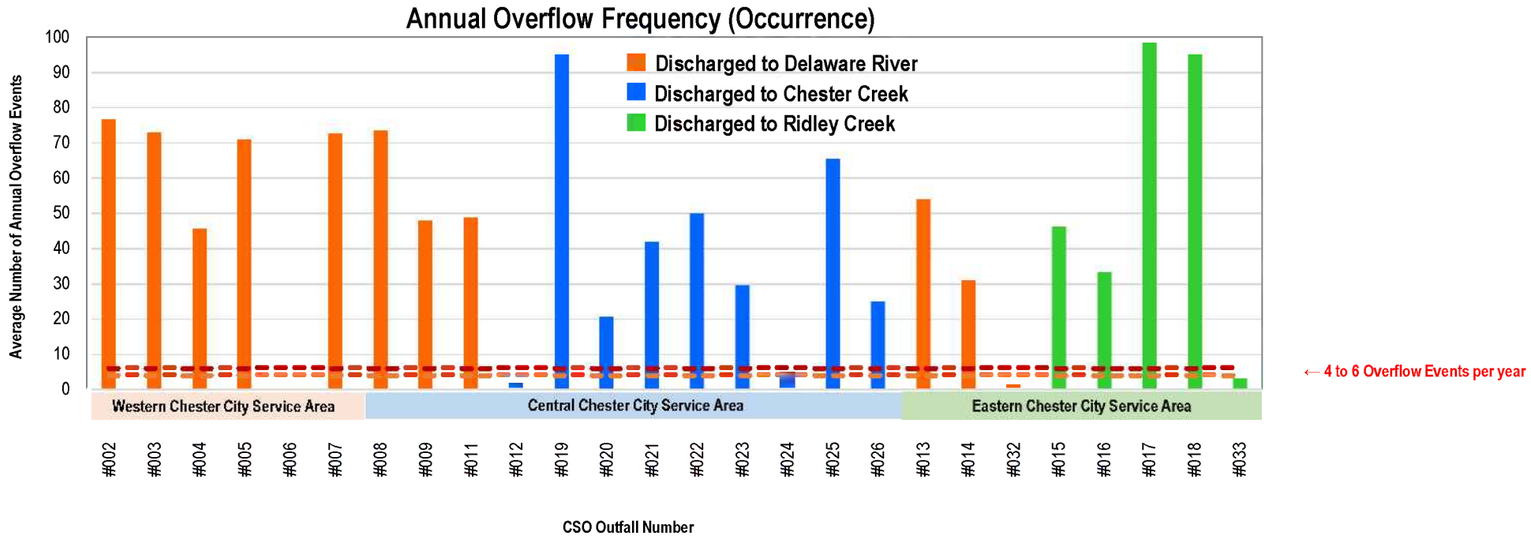
1994	42%
1995	47%
1996	43%
Average	44%

Percent of Combined Flow Treated by WWTP

1994	59%
1995	64%
1996	59%
Average	61%

Notes:

1. Modeled was test run for June, July and August, 2014, the results are in line with Weston's 2014 report.
2. The model only include the Chester City Service Area, it does not include flows from the other service areas and the Central Delaware PS.
3. Modeled max flow to the WWTP is only 86.64 MGD, less than the plant record of 105.54 MGD
4. We checked Regulator #08 set up in the model and the drawing, they are different.
5. The "Percent of Combined Flow Treated by WWTP" is estimated based on precipitation inter-event time (IET) of 12 hr.
6. CSO #006 has been separated and no longer discharges combined storm/wastewater flow.
7. CSO #010 discharges to the Delaware River through CSO #009.



Section 4 Characterization of Receiving Water Bodies

In order to select the Presumption Approach or the Demonstration Approach, it is necessary to understand the existing condition of the receiving water bodies. Use of the Presumption Approach is contingent on the municipality presenting sufficient data to make a reasonable judgment that the water quality standards in the receiving water body will presumably be met with a control plan that meets one of the three presumption criteria (see Section 2.2.1). The Demonstration Approach is appropriate where attainment of water quality standards cannot be achieved through CSO controls alone, due to the impacts of background conditions or pollution sources other than CSOs.

For the characterization of receiving water bodies, Section 2.6.2 (Receiving Water Modeling) of the USEPA's CSO Guidance Document states that:

> *"Under the CSO Control Policy, a municipality should develop an LTCP that adopts either the demonstration or the presumption approach to attainment of WQS. The demonstration approach is based on adequately demonstrating that the selected CSOs will provide for the attainment of WQS, including designated uses in the receiving water. The presumption approach does not explicitly call for analysis of receiving water impacts. The presumption approach usually involves at least screening-level models of receiving water impacts, however, because the approach will not apply if the NPDES permitting authority determines that the LTCP will not result in attainment of CWA requirements."*

In February 2016, DELCORA submitted to the USEPA its "Identification of Sensitive Areas and Pollutants of Concern Report" as a requirement of the Consent Decree. The report reviewed the impairment status of each of the three receiving water bodies and identified parameters associated with CSOs that are exceeding the water quality standards as "Pollutants of Concern".

Figure 4-1 (from the Identification of Sensitive Areas and Pollutants of Concern Report) shows the Non-Attaining and TMDL streams and river within the area impacted by DELCORA's CSO discharges, as determined from the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. The location of each of DELCORA's CSOs for each of the water bodies is shown in the figure.

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Figure 4-1

Non-Attaining and TMDL Streams/River
Within DELCORA's Service Area

Section 5 Selection of the Presumption or Demonstration Approach for Each of DELCORA's Receiving Waters

The development of an LTCPU allows for either the Presumption Approach or the Demonstration Approach to be utilized. DELCORA's approach is to establish the most reliable CSO Program that meets the Consent Decree requirements, the USEPA's CSO Policy and Guidance Document, and the applicable water quality standards.

5.1 Methodology Used in this Study

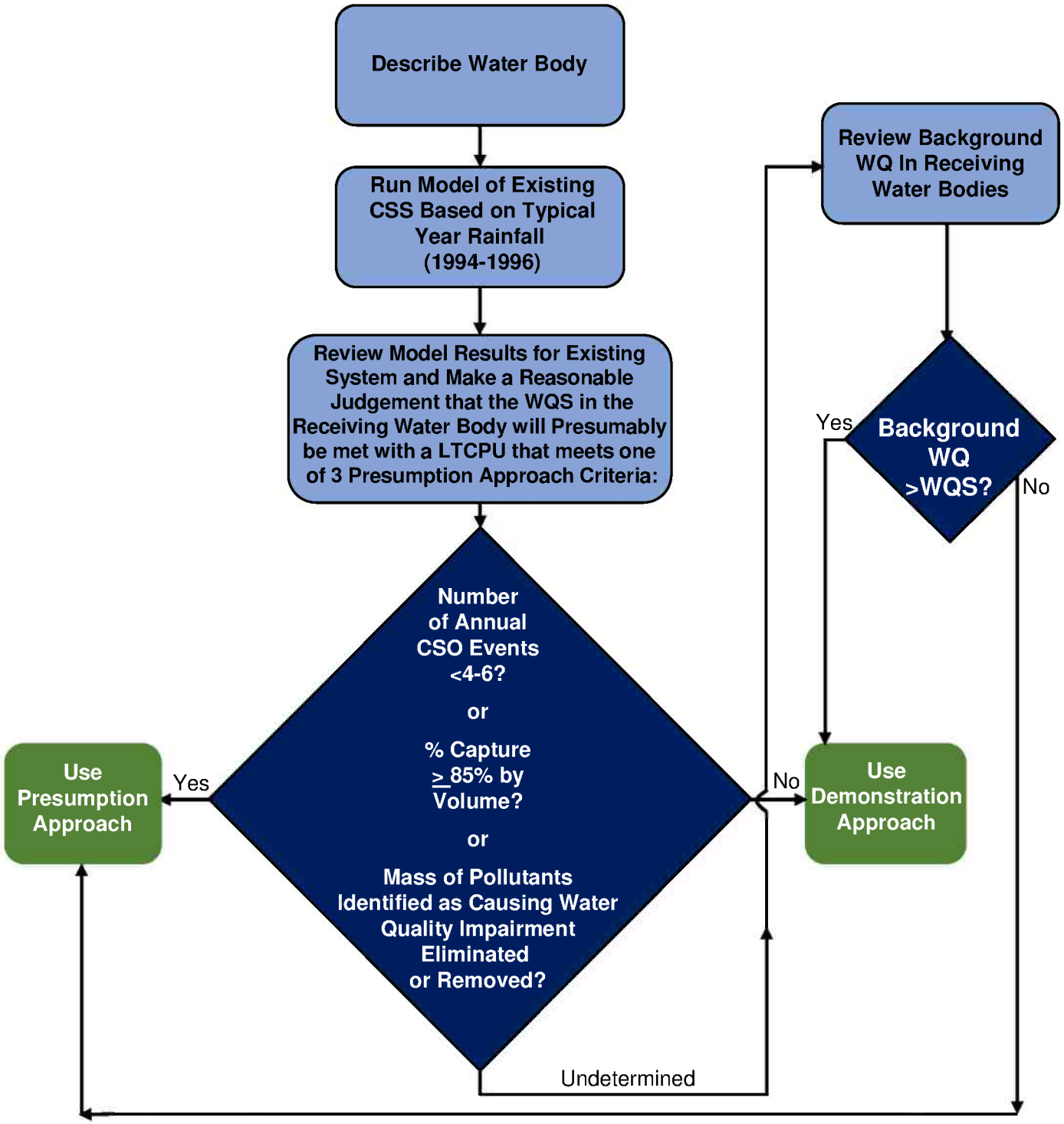
A flowchart was created to help illustrate the decision-making methodology used to assist in determining the recommended Alternatives Evaluation Approach for each of DELCORA's three receiving water bodies. This flowchart is presented in Figure 5-1.

The flowchart emphasizes two main decision making steps that lead to the recommendation of either the Demonstration or Presumption Approach, and these decision making steps are shown as dark blue diamonds. The primary decision step is to make a reasonable judgement that after all of the future CSO controls have been installed (1) will the annual average number of overflow events be less than 4 - 6 events, or (2) will the annual average percent capture for treatment of the combined wastewater be greater than or equal to 85%, or (3) for the volumes that would be eliminated or captured for treatment under item "(2)" will the mass of pollutants identified as causing water quality impairment be eliminated or removed? An answer of "Yes" to any one of these three questions is required for use of the Presumption Approach.

The results from the H&H model run for the typical hydrologic period of 1994 – 1996 were used to estimate the annual average number of overflow events per outfall, and the average percentage of the combined flow treated at the WWTP. The existing H&H model is not able to estimate if the mass of pollutants identified as causing water quality impairment will be eliminated or removed for the volumes that would be eliminated or captured for treatment, and therefore no determination can be made on that specific question at this time.

It was concluded that if the H&H model (Section 3.3) shows substantially more than 4 - 6 annual overflow events per outfall for the CSOs or if significantly less than 85% of the combined flow is shown to be captured for treatment, it will likely not be economically justifiable to install the full range of CSO control measures needed to meet the overflow frequency requirements of the Presumption Approach, and the Demonstration Approach will be favored. This determination is based on the use of Best Professional Judgement.

If it cannot be determined from the H&H model results as to whether the future CSO controls will likely be able to meet the annual number of overflow events or the percent capture rate for the Presumption Approach, then the flowchart indicates a secondary decision making step in



LEGEND

CSS = Combined Sewer System
CSO = Combined Sewer Overflow

CSO Long Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN	Figure 5-1 METHODOLOGY FLOWCHART FOR THE ALTERNATIVES EVALUATION APPROACH

which the existing water quality of the receiving water bodies is reviewed and compared to the applicable water quality standards. This determination is required since use of the Presumption Approach is contingent on the municipality presenting sufficient data to make a reasonable judgment that water quality standards will probably be met with a control plan that meets one of the three presumption criteria.

If the review of the background concentrations of those parameters typically associated with CSOs in the receiving water bodies are less than the applicable water quality standards, then the flow chart indicates that the Presumption Approach can be considered. However, if the background concentrations for those parameters are above the applicable water quality standards, then the Demonstration Approach should be used.

A review of the methodology flowchart was performed for each of the three receiving water bodies and is described in the following sub-sections.

5.1.1 Delaware River

Eleven (11) of DELCORA's 25 CSO outfalls discharge to the Delaware River. The H&H model run for the typical hydrologic period shown in Table 3-3 estimates that the Delaware River received discharges from these 11 outfalls accounting for approximately 50% of the total annual average overflow volume from the CSS, and approximately 49% of the overall number of discharge events.

Table 3-3 indicates that 10 of the 11 outfalls to the Delaware River had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSO #032 is shown to have had less than 4 – 6 annual overflows. Of the 10 CSOs that were modeled to overflow more than 4 - 6 times a year, the model estimates that all 10 of them had at least 31 annual overflow events and five of the outfalls are modeled as having had more than 71 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate to be used for the CSO discharges to the Delaware River.

5.1.2 Chester Creek

Nine (9) of DELCORA's 25 CSO outfalls discharge to the Chester Creek. The H&H model run for the typical hydrologic period of 1994 – 1996 shown in Table 3-3 estimates that the Chester Creek received discharges from these 9 outfalls accounting for approximately 38% of the total annual average overflow volume from the CSS, and approximately 28% of the overall number of discharge events.

Table 3-3 indicates that 7 of the 9 outfalls to the Chester Creek had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSOs #012 and #024 are shown to have had less than 4 – 6 overflows. Of the 7 CSOs that were modeled to overflow more than 4-6 times a year, the model estimates that all 7 of them had at least 21 or more annual overflow events and four of the outfalls are modeled as having had more than 42 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate to be used for the CSO discharges to the Chester Creek.

5.1.3 Ridley Creek

Five (5) of DELCORA's 25 CSO outfalls discharge to the Ridley Creek. The H&H model run for the typical hydrologic period of 1994 – 1996 shown in Table 3-3 estimates that the Chester Creek received discharges from these 5 outfalls accounting for approximately 12% of the total annual average overflow volume from the CSS, and approximately 23% of the overall number of discharge events.

Table 3-3 indicates that 4 of the 5 outfalls to the Ridley Creek had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSOs #033 is shown to have had less than 4 – 6 overflows. Of the four CSOs that were modeled to overflow more than 4- 6 times a year, the model estimates that all four of them had at least 33 or more annual overflow events and two of the outfalls are modeled as having had more than 95 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate for the CSO discharges to the Ridley Creek.

Section 6 Recommendations

It is recommended that the Demonstration Approach be utilized for the Delaware River, Chester Creek and Ridley Creek.

The Demonstration Approach relies on data collection and model simulation to demonstrate that the proposed LTCPU will meet applicable water quality standards and designated uses, and it provides a reliable tool to identify, evaluate and compare the selection and recommendation of the CSO control measures to be installed.

In addition to flow metering of the combined sewer system and water quality sampling of the CSOs to help refine and calibrate the H&H Model for the collection system, the Demonstration Approach requires a water quality model be developed for the Delaware River, Chester Creek and Ridley Creek. Water quality sampling of the receiving water bodies will be required to calibrate the water quality model and to identify and quantify the contributing pollutant sources in the watersheds other than CSOs.

The Demonstration Approach will be a better predictor than the Presumption Approach of actual resulting water quality at the end of the LTCPU program, and use of the Demonstration Approach will allow DELCORA to make more informed decisions regarding the long term control plan update investments that will result in compliance with the applicable water quality-based requirements.

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GREELEY AND HANSEN

Consent ORDER

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

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OCT 26 2016
BY: 2016-1211

cc: 2TCP group

OCT 13 2016

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Alternatives Evaluation Approach Report (AEAR) dated April 27, 2016. EPA understands DELCORA has chosen the "Demonstration Approach" and hereby approves the AEAR.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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APPENDIX B

Applicable WQS Master Table

- Applicable Water Quality Standards Master Table dated December 18, 2015

DELCORA CSO LTCPU - Applicable Water Quality Standards

Rev: 12-18-2015

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Alkalinity	DRBC WQRs - for Zone 4 / PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**Minimum**	**20**	20	20	---	---	---	---	---	---	---	---	---	---	20	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Alkalinity	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**120**	120		---	---	---	---	---	---	---	---	---	---	---	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Alkalinity	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**120**	120		---	---	---	---	---	---	---	---	---	---	---	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Aluminum	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**750**	---	---	750	87	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Aluminum	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**87**	---	---	750	**87**	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Aluminum	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**87**	---	---	750	**87**	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Ammonia	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**Maximum**	**$(NH_3 - N) \times (\log^{-1}[pK_T - pH] + 1)$**	---	$(NH_3 - N) \times (\log^{-1}[pK_T - pH] + 1)$	---	---	---	---	---	---	---	---	---	---	---	mg/L	pH dependent	Ammonia
Anthracene	DRBC WQRs - Table 7 / PA Code - Table 5	**Delaware River**	**Maximum**	**8,300**	---	---	---	---	---	---	8,300	40,000	---	---	8,300	---	---	µg/L		Anthracene
Anthracene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**8,300**	---	---	---	---	---	---	8,300	40,000	---	---	8,300	---	---	µg/L		Anthracene
Antimony	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**1,100**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**200**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	DRBC WQRs - Table 7 / PA Code - Table 5	**Delaware River**	**Maximum**	**5.6**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**5.6**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Arsenic (trivalent) (As III)	DRBC WQRs - Table 5 / PA Code - Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**340**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Arsenic (trivalent) (As III)	DRBC WQRs - Table 5 / PA Code - Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**150**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Arsenic (trivalent) (As III)	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**10**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Bacteria - Enterococcus (Above R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Upstream of RM 81.8**	**Maximum Geometric Average**	**88**	88	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Above R.M. 81.8)
Bacteria - Enterococcus (Below R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Downstream of RM 81.8**	**Maximum Geometric Average**	**33**	33	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Below R.M. 81.8)
Bacteria - Enterococcus	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum Geometric Average**	**88**	88	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Above R.M. 81.8)
Bacteria - Fecal Coliform (Above R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Upstream of RM 81.8**	**Maximum Geometric Average**	**770**	770	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Fecal Coliform (Above R.M. 81.8)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Bacteria - Fecal Coliform (Below R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Downstream of RM 81.8**	**Maximum Geometric Average**	**200**	200	---	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL	DRBC WQRs and PA Code PA Code for WC Critical Use agree from May 1 - Sept 30, but PA Code of 2000 CFU/100 mL from Oct. 1 - April 30 for WC exceeds that allowed by DRBC Zone 4.	Bacteria - Fecal Coliform (Below R.M. 81.8)
Bacteria - Fecal Coliform	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum Geometric Average**	**770**	770	---	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Fecal Coliform (Above R.M. 81.8)
Barium	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**21,000**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Barium	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**4,100**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Barium	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**2,400**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Benzene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**640**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**130**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**14**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**14**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.61**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**0.5**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**0.1**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.0038**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
Beryllium	DRBC WQRs - Table 7	**Delaware River**	**Maximum**	**420**							---	420	---	---				µg/L		Beryllium
Beryllium	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**420**							---	420	---	---				µg/L		Beryllium
Biological Oxygen Demand (BOD)	No Standard						---	---	---	---	---	---	---	---	---					Biological Oxygen Demand (BOD)
Bis (2-ethylhexyl) phthalate	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**4,500**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**910**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**2.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**1.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bromodichloromethane (aka Dichlorobromomethane)	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**17**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Bromodichloromethane (aka Dichlorobromomethane)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**17**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)
Bromodichloromethane (aka Dichlorobromomethane)	PA Code 25 - 93.8c, Table 5 / DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.55**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)
Butylbenzyl phthalate	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**140**	---	---	---	---			1,500	1,900	35	140	150			µg/L		Butylbenzyl phthalate
Butylbenzyl phthalate	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**35**	---	---	---	---			1,500	1,900	35	140	150			µg/L		Butylbenzyl phthalate
Cadmium	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.651*EXP(1.0166*LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.651*EXP(0.7409*LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.651*EXP(1.0166*LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.651*EXP(0.7409*LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
CBOD5	No Standard						---	---	---	---	---	---	---	---	---					CBOD5
CBOD20	No Standard						---	---	---	---	---	---	---	---	---					CBOD20
Chlorine (Total Residual Chlorine)	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**4-day Average (Chronic Maximum)**	**11**		11	---	---	---	---	---	---				19	11	µg/L		Chlorine (Total Residual Chlorine)
Chlorine (Total Residual Chlorine)	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**1-hour Average (Acute Maximum)**	**19**		19	---	---	---	---	---	---				19	11	µg/L		Chlorine (Total Residual Chlorine)
Chlorodibromomethane	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**13**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chlorodibromomethane	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**13**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chlorodibromomethane	DRBC WQRs - Table 6 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.4**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chloroform	DRBC WQRs - Tables 6 & 7 / PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**1,900**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC WQRs - Tables 6 & 7 / PA Code Table 5	**Chester Creek, Ridley Creek, Delaware River Upstream of RM 81.8**	**Chronic Maximum**	**390**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**470**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**470**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Chloroform	PA Code 25 - 93.8c, Table 5 / DRBC Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**5.7**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
COD	No Standard						---	---	---	---	---	---								COD
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.277*EXP(0.819*LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.277*EXP(0.819*LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.277*EXP(0.819*LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.277*EXP(0.819*LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**(0.819 x LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	**(0.819 x LN(hardness)+3.7256)**	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**(0.819 x LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	**(0.819 x LN(hardness)+0.6848)**	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (hexavalent) (Cr VI)	DRBC WQRs - Tables 5 & 7 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**16**	---	---	16	11	---	---	92	---	10	**16**	---	16	11	µg/L	Dissolved criteria	Chromium (hexavalent) (Cr VI)
Chromium (hexavalent) (Cr VI)	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**10**	---	---	16	11	---	---	92	---	10	16	---	16	11	µg/L	Dissolved criteria	Chromium (hexavalent) (Cr VI)
Chyrsene	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**18**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Chyrsene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**18**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Chyrsene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.0038**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Copper	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.908*EXP(0.9422*LN(hardness)-1.7)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.908*EXP(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.908*EXP(0.9422*LN(hardness)-1.7)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.908*EXP(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.960 x Exp(0.9422*LN(hardness)-1.70)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	**0.960 x Exp(0.9422*LN(hardness)-1.70)**	---	---	---	µg/L	Dissolved criteria	Copper
Copper	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.960 x Exp(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	**0.960 x Exp(0.8545*LN(hardness)-1.702)**	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Cyanide (free)	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**22**	---	---	22	5.2	---	---	140	140	5.2	22	140	22	5.2	µg/L		Cyanide (free)
Cyanide (free)	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**5.2**	---	---	22	5.2	---	---	140	140	5.2	22	140	22	5.2	µg/L		Cyanide (free)
Dieldrin	PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.24**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.056**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Dieldrin	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**0.000054**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.000054**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	DRBC WQRs - Table 6 / PA Code - Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.000052**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Diethylphthalate	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**4,000**	---	---	---	---			17,000	44,000	800	4,000	17,000			µg/L		Diethylphthalate
Diethylphthalate	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**800**	---	---	---	---			17,000	44,000	800	4,000	17,000			µg/L		Diethylphthalate
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Delaware River**	**24 hr. Average Minimum**	**3.5**	**3.5**		---	---	---	---	---	---						mg/L	**Year Round Minimum**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Delaware River**	**24 hr. Average Minimum**	**6.5**	**6.5**		---	---	---	---	---	---						mg/L	**Minimum for April 1 to June 15 and Sept. 16 to Dec. 31**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**24 hr. Average Minimum**	**3.5**	**3.5**		---	---	---	---	---	---						mg/L	**Year Round Minimum**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**24 hr. Average Minimum**	**6.5**	**6.5**		---	---	---	---	---	---						mg/L	**Minimum for April 1 to June 15 and Sept. 16 to Dec. 31**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_2$	PA Code (WWF)	**Chester Creek upstream of OF#20, & Ridley Creek from OF#18 upstream to Rt. 320**	**7-day Average**	**5.5**		5.5	---	---	---	---	---	---						mg/L		Dissolved Oxygen (DO)$_2$
Dissolved Oxygen (DO)$_2$	PA Code (WWF)	**Chester Creek upstream of OF#20, & Ridley Creek from OF#18 upstream to Rt. 320**	**Minimum**	**5.0**		5.0	---	---	---	---	---	---						mg/L		Dissolved Oxygen (DO)$_2$
Dissolved Oxygen (DO)$_3$ (Feb. 15 - July 31)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**7-day Average**	**6.0**		6.0	---	---	---	---	---	---						mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Feb. 15 - July 31)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**Minimum**	**5.0**		5.0	---	---	---	---	---	---						mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Aug. 1 - Feb. 14)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**7-day Average**	**5.5**		**5.5**												mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Aug. 1 - Feb. 14)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**Minimum**	**5.0**		**5.0**												mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Ethylbenzene	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**2,900**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**580**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	DRBC WQRs - Table 7	**Delaware River Upstream of RM 81.8**	**Maximum**	**2,100**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2,100**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Ethylbenzene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Downstream of RM 81.8	Maximum	530	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Upstream of RM 81.8	Maximum	5,300	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Maximum	5,300	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Downstream of RM 81.8	Maximum	1,100	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Hardness	No Standard	Delaware River, Chester Creek, Ridley Creek	--		--	--	---	---	---	---	---	---						mg/L as $CaCO_3$	Needed to calculate some of the metal concentrations	Hardness
Iron (Fe)	PA Code (WWF, MF, TSF)	Delaware River, Chester Creek, Ridley Creek	30-day Average	1.5		1.5	---	---	---	---	---	---						mg/L as total recoverable	Iron as total recoverable	Iron $(Fe)_{(1)}$
Iron (Fe)	PA Code (WWF, MF, TSF)	Delaware River, Chester Creek, Ridley Creek	Maximum	0.3		0.3	---	---	---	---	---	---				---	1.0	mg/L as dissolved	Iron as dissolved	Iron $(Fe)_{(2)}$
Lead	DRBC WQRs - Table 5	Delaware River	Acute Maximum	38	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Delaware River	Chronic Maximum	5.4	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Acute Maximum	38	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Chronic Maximum	5.4	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Mercury (Hg)	PA Code Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	1.4	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	PA Code Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	0.77	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Maximum	0.051	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7	Delaware River Upstream of RM 81.8	Maximum	0.051	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7 / PA Code Table 5	Delaware River Downstream of RM 81.8	Maximum	0.05	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	12,000	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	2,400	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	DRBC WQRs - Table 6	Delaware River Upstream of RM 81.8	Maximum	590	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Methylene chloride (Dichloromethane)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**590**	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**4.6**	---	---	---	---	---	590	---	260,000	2,400	12,000	**4.6**			µg/L		Methylene chloride (Dichloromethane)
Molybdenum	No Standard						---	---	---	---	---	---								Molybdenum
MTBE	No Standard						---	---	---	---	---	---								MTBE
Naphthalene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**140**			---	---	---	---	---	---	43	140	---			µg/L		Naphthalene
Naphthalene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**43**			---	---	---	---	---	---	**43**	140	---			µg/L		Naphthalene
Nickel	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.998 x Exp(0.846 x LN(hardness)+2.255)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	**0.998 x Exp(0.846 x LN(hardness)+2.255)**	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.997 x Exp(0.846 x LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	**0.997 x Exp(0.846 x LN(hardness)+0.0584)**	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.846*EXP(0.846*LN(hardness)+2.255)**	---	---	**0.846*EXP(0.846*LN(hardness)+2.255)**	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Delaware River Upstream of RM 81.8**	**Acute Maximum**	**0.846*EXP(0.846*LN(hardness)+2.255)**	---	---	**0.846*EXP(0.846*LN(hardness)+2.255)**	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Delaware River Upstream of RM 81.8**	**Chronic Maximum**	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 7	**Delaware River Downstream of RM 81.8**	**Maximum**	**500**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nitrate	No Standard						---	---	---	---	---	---								Nitrate
Nitrite	No Standard						---	---	---	---	---	---								Nitrite
Nitrate + Nitrate	No Standard																			Nitrate + Nitrate
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**0.51**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.51**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.005**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
Oil and Grease	No Standard						---	---	---	---	---	---								Oil and Grease
Osmotic Pressure (OP)	**PA Code (WWF, MF, TSF)**	**Delaware River, Chester Creek, Ridley Creek**	**Maximum**	**50**		50	---	---	---	---	---	---						milliosmoles/kg		Osmotic Pressure (OP)
PCBs (Total)	DRBC WQRs - Table 5 / PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.014**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
PCBs (Total)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.000016**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
PCBs (Total)	DRBC WQRs - Table 6	**Delaware River**	**Maximum**	**0.000016**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
pH$_{(1)}$	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**8.5**	8.5		---	---	---	---	---	---				---	6.5 - 9	--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH$_{(1)}$
pH$_{(1)}$	DRBC WQRs - for Zone 4	**Delaware River**	**Minimum**	**6.5**	6.5		---	---	---	---	---	---						--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH$_{(1)}$

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
pH(1)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**8.5**	8.5		---	---	---	---	---	---				---	6.5 - 9	--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH(1)
pH(1)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Minimum**	**6.5**	6.5		---	---	---	---	---	---						--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH(1)
pH(2)	PA Code (WWF, MF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Maximum**	**9.0**		9.0	---	---	---	---	---	---						--	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	pH(2)
pH(2)	PA Code (WWF, MF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Minimum**	**6.0**		6.0	---	---	---	---	---	---						--	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	pH(2)
Phenanthrene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**5**			---	---	---	---	---	---	1	5	---			µg/L		Phenanthrene
Phenanthrene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**1**			---	---	---	---	---	---	1	5	---			µg/L		Phenanthrene
Phenols	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**0.02**	0.02		---	---	---	---	---	---	---	---	10.4			mg/L		Phenols
Phenols	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.02**	0.02		---	---	---	---	---	---	---	---	10.4			mg/L		Phenols
Phosphate	No Standard						---	---	---	---	---	---								Phosphate
Pyrene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**4,000**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Pyrene	DRBC WQRs - Table 7	**Delaware River Upstream of RM 81.8**	**Maximum**	**4,000**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Pyrene	DRBC WQRs - Table 7 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**830**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Radioactivity - alpha emitters	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**3**	3		---	---	---	---	---	---						pc/L		Radioactivity - alpha emitters
Radioactivity - beta emitters	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**1,000**	1,000		---	---	---	---	---	---						pc/L		Radioactivity - beta emitters
Radioactivity - alpha emitters	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**3**	3		---	---	---	---	---	---						pc/L		Radioactivity - alpha emitters
Radioactivity - beta emitters	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**1,000**	1,000		---	---	---	---	---	---						pc/L		Radioactivity - beta emitters
Selenium (Se)	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**20**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Selenium (Se)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**20**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Selenium (Se)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**4.6**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Silver (Ag)	DRBC WQRs - Tables 5 & 7 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**0.85*EXP(1.72*LN(hardness)-6.59)**	---	---	0.85*EXP(1.72*LN(hardness)-6.59)	NA	---	---	170	40,000	---	0.850 x Exp(1.72 x LN(hardness) - 6.590)	---	3.2	---	µg/L	Dissolved criteria	Silver (Ag)
Sulfide	No Standard						---	---	---	---	---	---								Sulfide
Synthetic Detergents (B)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum 30-day Average**	**1.0**	1.0		---	---	---	---	---	---						mg/L		Synthetic Detergents (B)
Synthetic Detergents (B)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum 30-day Average**	**1.0**	1.0		---	---	---	---	---	---						mg/L		Synthetic Detergents (B)
Temperature (A) (1)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**30**	30		---	---	---	---	---	---						°C		Temperature (A)
Temperature (A) (1)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**2.8 Deg above 24-hr gradient during the 1961-66 period**	2.8 Deg above 24-hr gradient during the 1961-66 period		---	---	---	---	---	---						°C		Temperature (A)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Temperature [A] [1]	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**30**	30		---	---	---	---	---	---						°C		Temperature [A]
Temperature [A] [1]	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2.8 Deg above 24-hr gradient during the 1961-66 period**	2.8 Deg above 24-hr gradient during the 1961-66 period		---	---	---	---	---	---						°C		Temperature [A]
Temperature [2]	PA Code (WWF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Maximum**	**Varies - see table on pg. 93-21 & 93-22**		Varies - see table on pg. 93-21 & 93-22	---	---	---	---	---	---						°F	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	Temperature
Tetrachloroethene/ Tetrachloroethylene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**700**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**140**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Delaware River Upstream of R.M. 81.8**	**Maximum**	**3.3**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**3.3**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Delaware River Downstream of R.M. 81.8**	**Maximum**	**0.69**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Thallium	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**65**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**13**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Delaware River Upstream of R.M. 81.8**	**Maximum**	**0.47**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.47**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Delaware River Downstream of R.M. 81.8**	**Maximum**	**0.24**							0.24	0.47	13	**65**				µg/L		**Thallium**
Threshold Odor Number	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**24 at 60 °C**	24 at 60 °C		---	---	---	---	---	---						--		**Threshold Odor Number**
Threshold Odor Number	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**24 at 60 °C**	24 at 60 °C		---	---	---	---	---	---						--		**Threshold Odor Number**
Toluene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**1,700**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Toluene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**330**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Toluene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**1,300**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Total Dissolved Solids (TDS)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**133% of background**	133% of background		---	---	---	---	---	---						mg/L		**Total Dissolved Solids (TDS)**
Total Dissolved Solids (TDS)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**133% of background**	133% of background		---	---	---	---	---	---						mg/L		**Total Dissolved Solids (TDS)**
TKN	No Standard						---	---	---	---	---	---								**TKN**
Total Organic Carbon (TOC)	No Standard						---	---	---	---	---	---								**Total Organic Carbon (TOC)**
Total Organic Halides (T.O.X.)	No Standard						---	---	---	---	---	---								**Total Organic Halides (T.O.X.)**
Total Nitrogen	No Standard						---	---	---	---	---	---								**Total Nitrogen**
Total Petroleum Hydrocarbon (TPH)	No Standard																			**Total Petroleum Hydrocarbon (TPH)**

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Total Phosphorus	No Standard						---	---	---	---	---	---								Total Phosphorus
Total Suspended Solids (TSS)	No Standard						---	---	---	---	---	---								Total Suspended Solids (TSS)
Turbidity (C)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum 30-day Average**	**40**	40		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**150**	150		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum 30-day Average**	**40**	40		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**150**	150		---	---	---	---	---	---						NTU		Turbidity (C)
Xylenes (total)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**1,100**			---	---	---	---	---	---	210	1,100	70,000			µg/L		Xylenes (total)
Xylenes (total)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**210**			---	---	---	---	---	---	210	1,100	70,000			µg/L		Xylenes (total)
Zinc	DRBC WQRs - Tables 5 & 7	**Delaware River**	**Acute Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Delaware River**	**Chronic Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.978 x Exp(0.8473 x LN(hardness) + 0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	**0.978 x Exp(0.8473 x LN(hardness) + 0.884)**	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.986 x Exp(0.8473 x LN(hardness) + 0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	**0.986 x Exp(0.8473 x LN(hardness) + 0.884)**	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc

(A) Temperature shall not exceed 5 °F (2.8 °C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or a maximum of 86 °F (30.0 °C) - whichever is less.

(B) Using M.B.A.S assay, with a maximum 30-day average of 1.0 mg/L.

(C) Unless exceeded due to natural conditions.

NOTES:

DRBC standards in their WQRs are referred to as "Stream Quality Objectives". DRBC's Stream Quality Objectives have primacy over the PA Code standards for the Delaware River.

PA CODE refers to the standards as "Water Quality Standards".

Ridley Creek is "TSF & MF" Critical Use from Rt. 320 Bridge upstream to the Media Water Intake. Ridley Creek is "WWF & MF" downstream from the Rt. 320 Bridge to mouth.

Chester Creek has a "TSF" Critical Use designation as well, but this is well upstream of the CSO discharge furthest upstream on Chester Creek and does not apply for this analysis.

APPENDIX C

ID of Sensitive Areas & POCs Report

- DELCORA Sensitive Areas and POC Report dated February 2016 (Revised May 2016)
- USEPA Approval of the Sensitive Areas and POC Report dated October 13, 2016

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Identification of Sensitive Areas and Pollutants of Concern Report (Final)

February 2016
(May 2016)

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Identification of Sensitive Areas and Pollutants of Concern Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	2/9/16 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	2/9/16 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	2/3/16 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
1	5/17/16	Greeley and Hansen	• Updated Sections ES-3 and ES-4 to reflect changes in the report. • Updated Section 1.1, second paragraph. • Updated Sections 1.3.1, revised text reading 13.3 to be 20 MGD. • Clarified Sections 1.3.2, and 2.1.2 • Updated Table 2-1 and Section 2.3.1.2 to address USEPA comment. • Revised Sections 2.3.2, 2.3.4, 2.3.4.2, 2.3.5.1 to address USEPA comment on sensitive areas. • Updated Figure 2-1 • Revised Sections 2.4, 2.4.1, 2.4.2 to address USEPA comments. • Revised Section 3.7 to address USEPA comments. • Updated Section 3.7.2 • Updated Attachment A and Added Attachment K

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Executive Summary

ES-1 Background

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal authority originally organized under the Pennsylvania Municipal Authorities Act of 1945 (P.L. 382), as amended and supplemented, pursuant to action taken by the Delaware County Council on October 20, 1971. Under County of Delaware Ordinance 2002-1, the term of existence of DELCORA was extended to January 15, 2052.

DELCORA is in the process of developing a Long Term Control Plan (LTCP) Update for the Combined Sewer System (CSS) as part of a Consent Decree entered with the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP). DELCORA's Combined Sewer System is comprised of a sewer that accepts stormwater and sanitary wastewater which is treated at DELCORA's Western Regional Treatment Plant WRTP. As part of this comprehensive effort, DELCORA is to submit a report to the USEPA and PADEP that identifies all Sensitive Areas and Pollutants of Concern (POCs) that are impacted by Combined Sewer Overflows (CSOs) and are within the Model Area for each of its receiving waters. DELCORA is also to identify any additional areas that have been determined by DELCORA as being appropriate for prioritization.

The purpose of this report is to meet the requirement in the Consent Decree for the submission of a report that identifies the Sensitive Areas and Pollutants of Concern that are impacted by DELCORA's CSOs.

ES-2 Consent Decree Requirements

The Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania on August 17, 2015, and was approved by the Federal District Court on November 10, 2015. The Consent Decree requires DELCORA to complete and submit a revised and updated LTCP to the USEPA and the PADEP for review and approval. Consent Decree Paragraph V.A.11 (Identification of Sensitive Areas and Pollutants of Concern) requires that within six (6) months after the Date of Lodging, DELCORA shall submit a report that identifies all Sensitive Areas and Pollutants of Concern that are impacted by CSOs and are within the Model Area for each of its receiving waters. The receiving water bodies impacted by DELCORA's CSOs include the Delaware River, Chester Creek and Ridley Creek.

For the Identification of Sensitive Areas, Section V.A.11 of the Consent Decree specifically states:

> *"For each of its Receiving Waters, DELCORA shall contact appropriate agencies, access available data sources, and collect additional data as necessary to identify Sensitive*

Areas. DELCORA shall fully document all such contacts and the associated responses, and all additional investigations carried out to identify Sensitive Areas. DELCORA shall also identify any additional areas that, while not Sensitive Areas, have been identified by DELCORA as being appropriate for prioritization ("Priority Areas")." Additionally, *"For each of its Receiving Waters, DELCORA shall conduct community outreach and appropriate studies to determine whether and to what extent primary contact recreation is occurring in each Receiving Water, and shall fully document its outreach and study methods, and its findings."*

For the Identification of Pollutants of Concern, Section V.A.11 of the Consent Decree specifically states:

"For each of its Receiving Waters, DELCORA shall review existing water quality data and recent PADEP CWA § 303(d) listings to identify POCs. Even if a water body has not been formally listed as out of compliance with its water quality standards and designated uses, if available data indicate such impairment exists and such impairment involves pollutants associated with CSOs, DELCORA shall consider the related pollutants to be POCs."

ES-3 Sensitive Areas Summary

A comprehensive review of online databases, correspondence with regulatory agencies and local environmental organizations and review of responses to the public survey was conducted to identify potential Sensitive Areas within the combined sewer system portion of the collection system.

Outstanding National Resource Waters (ONRW) are maintained and protected by Tier 3 of the USEPA's Antidegradation Policy which can be accessed through the Agency's web portal. Only waters of "exceptional ecological significance" qualify as ONRWs, and States and Tribes determine whether or not a water body will be classified as such. In Chapter 93 of the Pennsylvania Code, it is stated that a water body will be classified as having Exceptional Value (EV) if it is considered by the Commonwealth of Pennsylvania to be an ONRW. No Outstanding National Resource Waters were located within the project boundaries.

The goal of the National Marine Sanctuaries Act (Title 16, Chapter 32, Section 1431 last amended in November 2000) is to identify and designate as National Marine Sanctuaries (NMS) areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System. The Office of National Marine Sanctuaries (ONMS) is the trustee of all national marine sanctuaries and as such, it currently recognizes fourteen (14) national marine sanctuaries, none of which are located within DELCORA's service area. Therefore, none of DELCORA's receiving waters, the Delaware River, Chester Creek or Ridley Creek, are considered to be a National Marine Sanctuary.

There are no commercial shellfish harvesters that operate within the study area. The Partnership for the Delaware Estuary reported shellfish areas well downstream of the most southern outfall in DELCORA's system. The uppermost shellfish harvesting area is approximately 32 miles outside the project boundaries. No shellfish beds are located within the project boundaries.

There are numerous drinking water intakes in this geographical area but none are located on the Delaware River downstream in close proximity to DELCORA's CSOs. There are no drinking water intakes located along Chester Creek or Ridley Creek in proximity to DELCORA's service area. Therefore, the Sensitive Area criteria for Drinking Water Intakes does not apply to the Chester or Ridley Creeks.

While the US Fish and Wildlife Service identified several Endangered or Threatened species which potentially could live in the project area, critical habitat was found for Atlantic Sturgeon only. The habitat for year-of-young Atlantic Sturgeon downstream of CSO #002 in the Delaware River meets the Sensitive Area criteria for Endangered or Threatened species. The Atlantic Sturgeon is listed as a threatened species by the US Fish and Wildlife Service with documented habitat in the Delaware River downstream approximately one-half mile downstream of DELCORA's most southern outfall. Therefore, the habitat for year-of-young Atlantic Sturgeon is considered a sensitive area.

The northern reaches of Ridley Creek within DELCORA's service area are designated as Approved Trout Waters and Trout Stocked Streams. The portion of the approved trout waters from CSO #033 downstream to Chestnut Street is considered a Priority Area because of this special environmental use.

The boat launch located between CSO #007 and #008 along the Delaware River is located within the portion of the waterbody rated for primary contact and may be impacted by CSO discharge. The boat launch is considered a Priority Area.

ES-4 Pollutants of Concern Summary

A comprehensive review of existing receiving water quality data was conducted to identify the Pollutants of Concern and this review was performed in accordance with the requirements of the Consent Decree and the CSO Guidance Manual. This review included on-line USEPA STORET data from the Years 2010-2015, results of sampling performed during the preparation of DELCORA's 1999 LTCP and additional CSO sampling. A parameter associated with CSO discharges was considered to be a POC when more than 10% of the total samples reviewed indicated an exceedance of the applicable water quality standard. A secondary category called Parameters of Potential Concern (POPC) was established for those parameters associated with CSO discharges where 2 to 10% of the total samples reviewed indicated an exceedance of the applicable water quality standard.

The specific parameters identified by DELCORA as POCs in each of the receiving water bodies are listed below.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria

- For the upper Delaware River (Upstream of R.M. 81.8)
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria

- For the Chester Creek
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria

- For the Ridley Creek
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria

The identified POCs for DELCORA's receiving water bodies have been listed and discussed in detail in Section 3.7. No POCP (Parameters of Potential Concern) were identified.

Section 1 Introduction

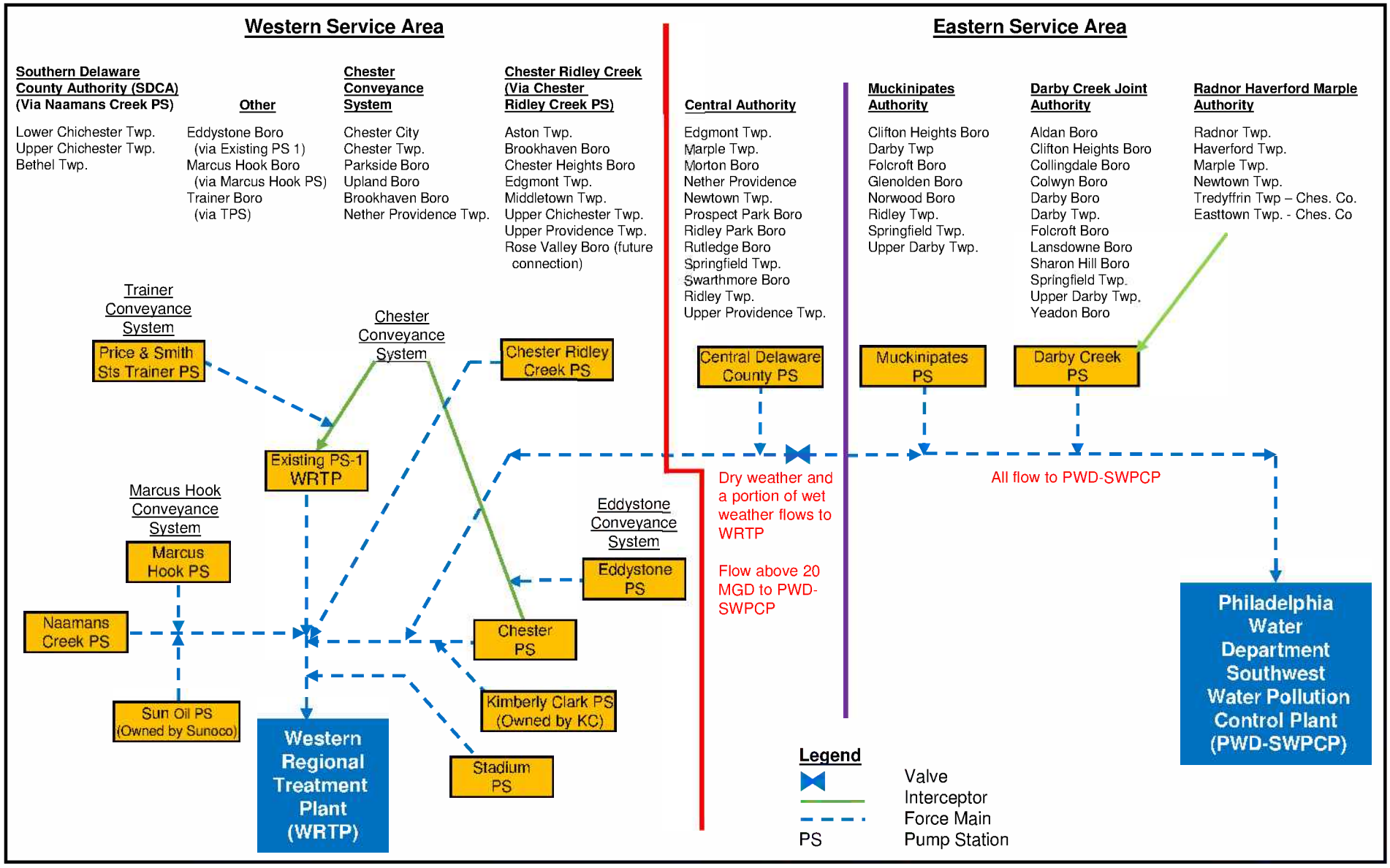
1.1 Background of DELCORA's Facilities

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA, as shown on Figure 1-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

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WESTON SOLUTIONS
Restoring Resource Efficiency

Figure 1-1
DELCORA'S CONVEYANCE SYSTEM

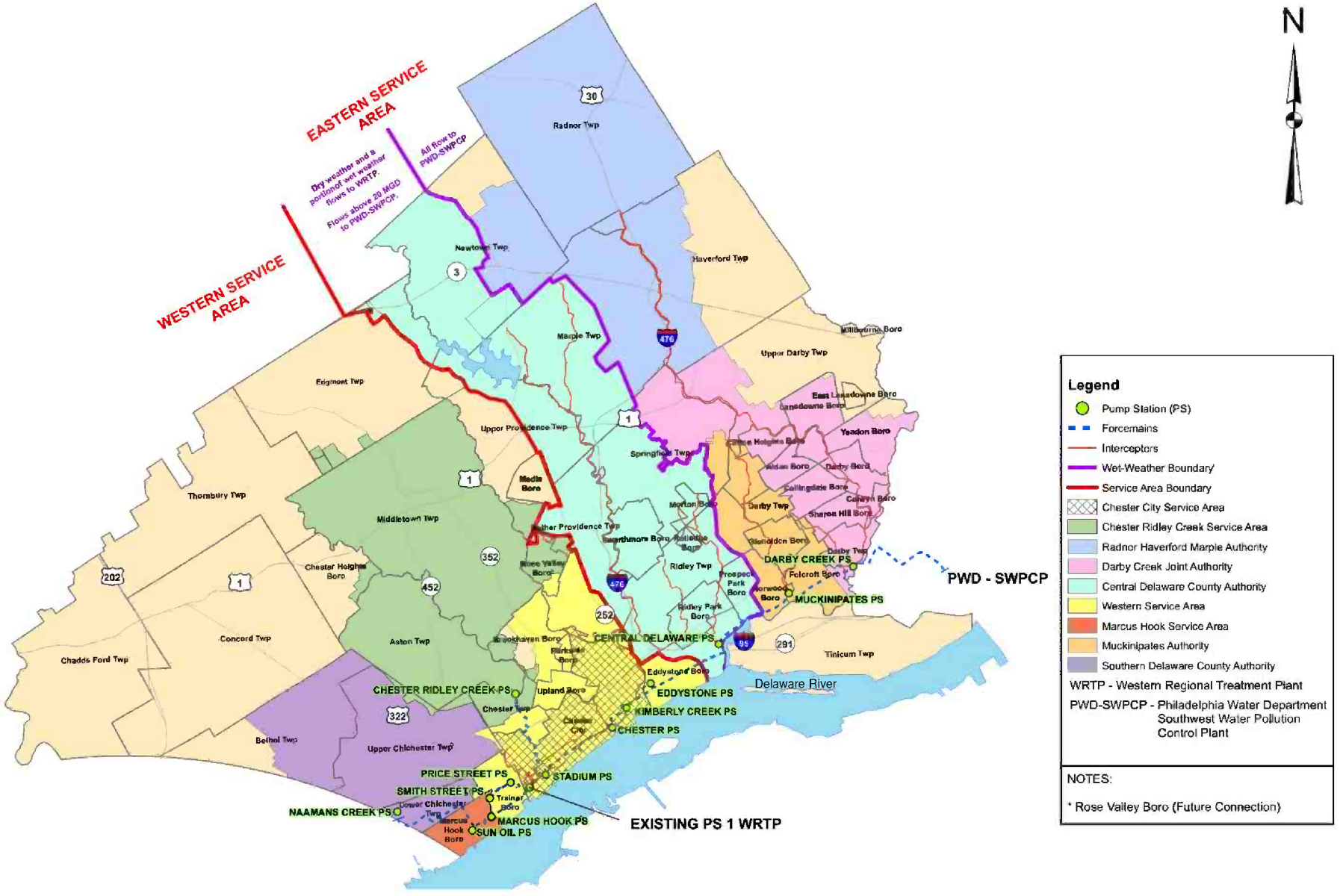

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Figure 1-2
DELCORA'S SERVICE AREA

Part C – Other Requirements, Section V – Combined Sewer Overflows of the NPDES Permit details DELCORA's responsibilities with respect to the CSO system including reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum to the LTCP until the updated LTCP is approved.

1.2 Consent Decree

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraph V.A.11 (Identification of Sensitive Areas and Pollutants of Concern) requires that within six (6) months after the Date of Lodging, DELCORA shall submit a report to the USEPA and PADEP that identifies all Sensitive Areas and Pollutants of Concern that are impacted by CSOs and are within the Model Area for each of its receiving waters. Details of the Consent Decree requirements for Sensitive Areas and POCs are respectively found in Sections 1.2 and 3.1.

1.3 CSO System Description

1.3.1 DELCORA Facilities

DELCORA's Western service area wastewater is treated at the WRTP located at 3201 W. Front Street in Chester, Pennsylvania. The WRTP treats all wastewater from Southern Delaware County Authority, Marcus Hook Borough, Trainer Borough, Upland Borough, Parkside Borough, Eddystone Borough, Chester Township and the City of Chester as well as a portion of the wastewater from Brookhaven Borough and Nether Providence Township. The City of Chester CSO system is described in detail in Section 1.3.2.

One of the facilities in the City of Chester is the 40-MGD Chester Pump Station and the 48-inch-diameter, PCCP force main that runs to the WRTP. DELCORA has completed construction of a 54-inch-diameter ductile iron force main to replace the existing force main. In 2002, DELCORA completed a force main that connects the Central Delaware Pump Station via a 3.4-mile, 24-inch ductile iron force main to the Chester Force Main. This connection allows DELCORA to send up to 27 MGD of flow from the CDPS to the WRTP, however, DELCORA's operating policy limits this flow to 20 MGD, with flows above this point to be directed to PWD SWPCP. Figure 1-1 shows the interconnections in DELCORA's system. The left side of the figure indicates the Western service area and the right side indicates the Eastern service area. This interconnectivity coupled with the legal agreements DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates.

1.3.2 City of Chester CSO System

As noted in Section 1.1, the combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The Chester CSO system contains 26 permitted outfalls as listed in Table 1-1, and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. However, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. Figure 1-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility.

Table 1-1: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River(2)	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W

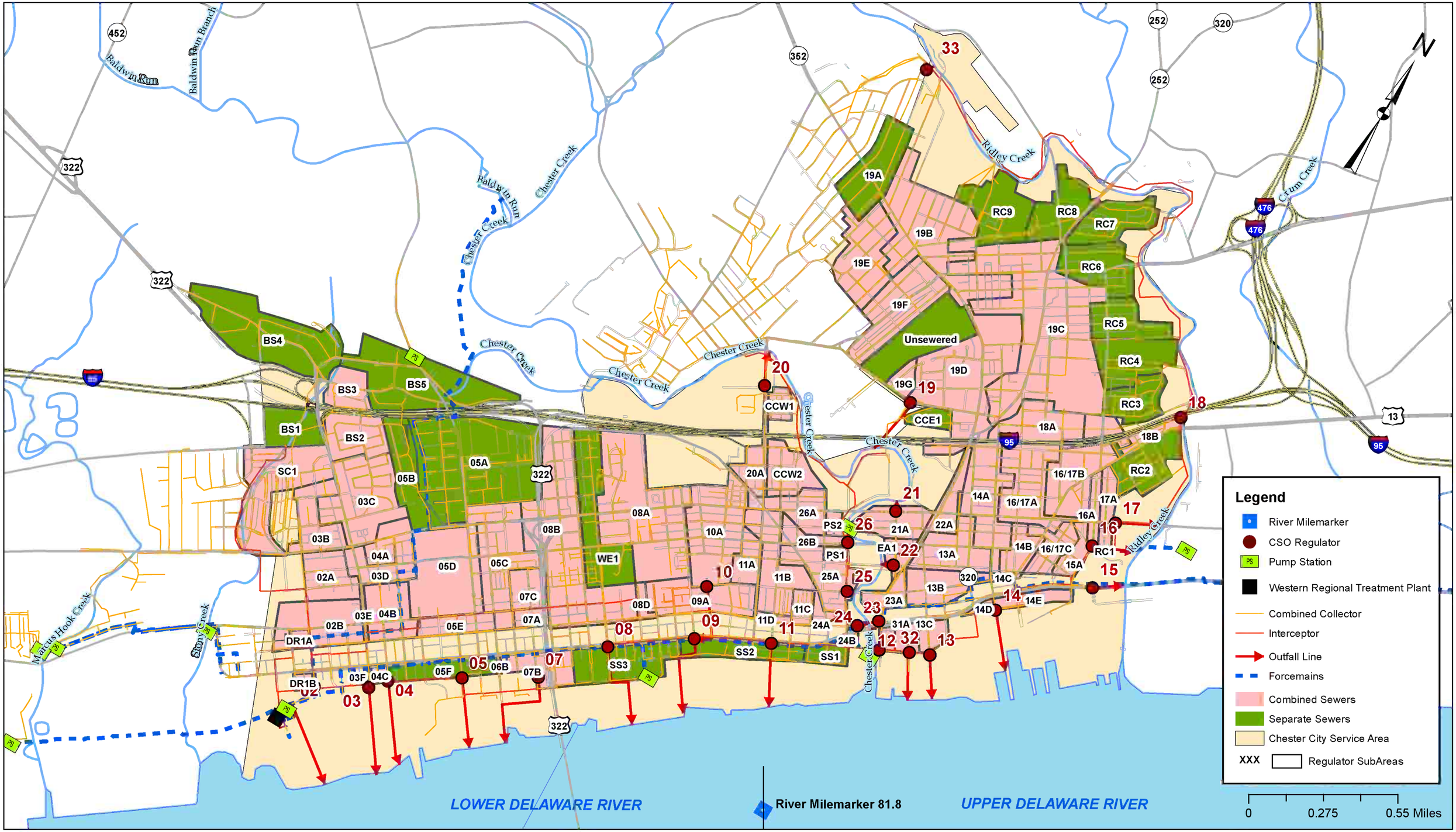
Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W
Ridley Creek(2)	033	Elkington Boulevard and Ridley Creek	39°52'22"N	75°22'29"W

Notes:

(1) CSO #010 discharges to the Delaware River through CSO #009.

(2) No mechanical regulator used for this outfall.

Figure 1-3 also provides a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 1-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.



CSO Long Term Control Plan Update
Delaware County Regional Water Quality Control Authority

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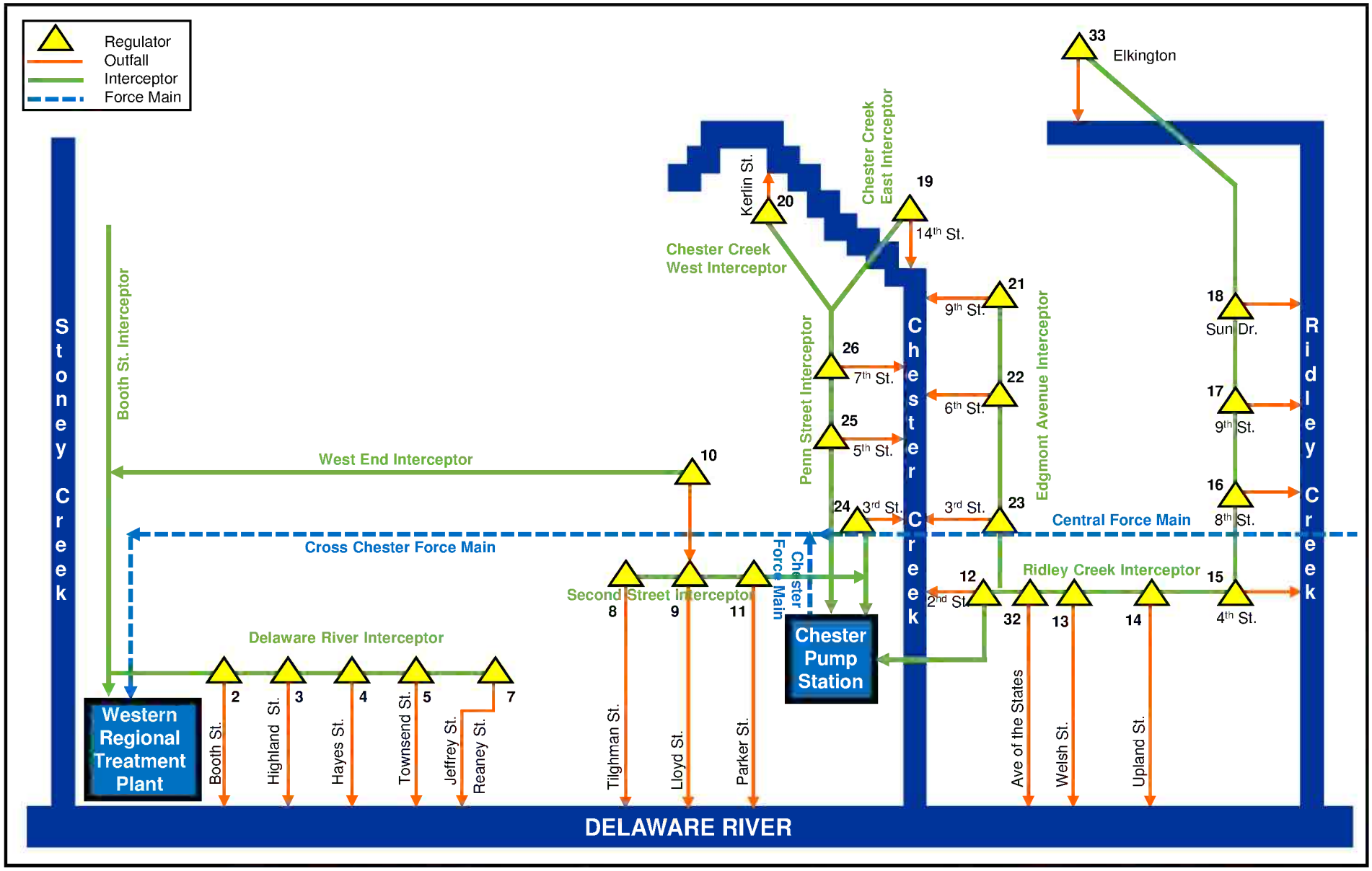
Identification of Sensitive Areas and Pollutants of Concern Report

Figure 1-3
Location of Regulators and Combined Sewer Outfalls With Drainage Areas



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

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Figure 1-4
SCHEMATIC OF CHESTER CSO SYSTEM

Section 2 Identification of Sensitive Areas

2.1 Regulatory Requirements

2.1.1 Consent Decree Requirements

For the Identification of Sensitive Areas, Section V.A.11 of the Consent Decree states:

> *"For each of its Receiving Waters, DELCORA shall contact appropriate agencies, access available data sources, and collect additional data as necessary to identify Sensitive Areas. DELCORA shall fully document all such contacts and the associated responses, and all additional investigations carried out to identify Sensitive Areas. DELCORA shall also identify any additional areas that, while not Sensitive Areas, have been identified by DELCORA as being appropriate for prioritization ("Priority Areas")."*
>
> Additionally, *"For each of its Receiving Waters, DELCORA shall conduct community outreach and appropriate studies to determine whether and to what extent primary contact recreation is occurring in each Receiving Water, and shall fully document its outreach and study methods, and its findings."*

2.1.2 Requirements of the USEPA's CSO Control Policy and Sensitive Areas Definition

The USEPA's CSO Control Policy (Federal Register 59 [April 19, 1994]: 18688-18698) "expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas" (Section II.C.3). The CSO Control Policy states the six (6) criteria for defining an area as a "Sensitive Area" include:

1. Designated Outstanding National Resource Waters
2. National Marine Sanctuaries
3. Waters with threatened or endangered species and their habitat
4. Waters with primary contact recreation
5. Public drinking water intakes or their designated protected areas
6. Shellfish beds

The CSO Control Policy states that if Sensitive Areas are present and impacted, the LTCP should include provisions to:

- Prohibit new or significantly increased overflows
- Eliminate or relocate overflows wherever physically possible and economically achievable

- Treat overflows where necessary
- Where elimination or treatment is not achievable, reassess impacts each permit cycle

Sensitive Areas should be considered prior to the evaluation of CSO control alternatives. This allows a CSO community to identify and estimate costs for controls that could eliminate or relocate CSOs from Sensitive Areas where pollutant loadings pose a high environmental or public health risk and where control efforts should be focused. The cost of these controls can then be considered, along with the community's financial capability, to evaluate cost-effective controls for all of the receiving waters.

2.2 Priority Areas Definition

The term "Priority Areas" is not specifically defined by the USEPA in the Consent Decree nor in the CSO Control Policy or Guidance Document. For the purposes of this report, the term "Priority Areas" is defined as follows:

> *"Areas having some environmental significance but not to the level of "sensitive areas" as defined in the federal CSO Control Policy. These priority areas may include: public access areas (i.e., near marinas, schools, playgrounds, parks, or athletic fields); or use of shallow streams for recreational activity, with something less than full contact (i.e., wading)".*

In compliance with the Consent Decree, DELCORA conducted community outreach in order to determine whether and to what extent primary contact recreation is occurring in each Receiving Water. In order to cover DELCORA's large service area, a public survey was deemed to be the most comprehensive method to actively solicit community outreach. Multiple regulatory agencies and environmental organizations were also contacted.

2.3 Assessment of Sensitive and Priority Areas

The six criteria for Sensitive Areas identified in the CSO policy were evaluated for the Delaware River, Chester Creek and Ridley Creek within DELCORA's service area including reaches upstream of the CSOs. Special consideration was given to areas downstream and within the tidal influence of DELCORA's CSOs as any potential Sensitive Areas within hydraulic proximity to outfalls that may be impacted by their discharge.

2.3.1 Methodology

In order to develop a comprehensive understanding of the presence of designated Sensitive Areas within the study area, multiple strategies were used to complete these investigations including searching online data resources, sending letters to regulatory agencies and environmental organizations, and conducting a public survey. The goal of this multi-faceted approach was to

gain a thorough understanding of the presence of sensitive and priority areas to support the development of future CSO control alternatives.

2.3.1.1 Letters with Regulatory Agencies

Letters were drafted and issued to key regulatory agencies at the federal and state levels, and environmental organizations at the state and local levels. Contacts were identified based on their governance over the three waterbodies of concern including the Delaware River, Chester Creek and Ridley Creek, or their local involvement with those associated watersheds. Agencies in New Jersey and Delaware were also contacted to further understand the surrounding environment even though the study area is limited to the boundaries of the Commonwealth of Pennsylvania. Table 2-1 lists the agencies which received requests for information. Follow-up telephone calls were made to all agencies that had not responded by November 30, 2015.

Table 2-1: Letters Issued to Agencies and Organizations

Agency	Contact	Title	Date Sent	Response Date
U.S. Fish and Wildlife Agency	Robert Anderson	Fish & Wildlife Biologist	10/29/2015	11/2/2015
U.S. Fish and Wildlife - John Heinz NWR Birds	Brendalee Phillips	Wildlife Biologist	10/29/2015	No Comments
PA DEP	Jennifer Fields	Clean Water Section Program Manager	10/29/2015	11/17/15 - phone call
Delaware River Basin Commission (DRBC)	Steve Tambini	Executive Director	10/29/2015	No Comments
PA Game Commission	Patti Barber	Endangered Bird Biologist	10/29/2015	12/29/2015 – phone call
PA Game Commission	Ian Gregg	Wildlife Biologist	10/29/2015	No Response
PA Environmental Council	Carol F. McCabe, Esq.	Chair	10/29/2015	No Response
Chester Ridley Crum Watersheds Association	Brian Byrnes	Executive Director	10/29/2015	11/23/15 – phone call

Agency	Contact	Title	Date Sent	Response Date
New Jersey Department of Environmental Protection (NJDEP)	David Chanda	Director Fish and Wildlife	10/29/2015	No Response
Delaware Department of Natural Resources and Environmental Control (DNREC)	Matt Fisher	Director Fish and Wildlife	10/29/2015	11/30/2015
PA Fish and Boat Commission (PFBC)	John Buzzar, Kathy Gipe and Greg Murphy	Fisheries Biologists	10/29/2015	12/22/15; follow-up 3/11/16 and 5/2/16
Partnership for the Delaware Estuary (PDE)	Dr. Danielle Kreeger	Science Director	10/29/2015	11/25/2015

Each letter requested information related to all six Sensitive Area criteria with the exception of the letter to the U.S. Fish and Wildlife Service, which was tailored based on telephone conversations held prior to issuance of the letter. Copies of the letters issued requesting information and responses are included in Attachment A.

2.3.1.2 Online Database Searches

An abundance of information is available online regarding the Delaware River, Chester Creek, and Ridley Creek waterbodies. The following entities and on-line databases were searched for information related to Sensitive Areas and Priority Areas within the study area boundary:

- National Oceanic and Atmospheric Administration (NOAA)
  - NOAA 2014 Environmental Sensitivity Index Maps
- United States Environmental Protection Agency
- Pennsylvania Department of Environmental Protection
- Office of National Marine Sanctuaries
- John Heinz National Wildlife Refuge
- Chester Creek Rails-to-Trails Project
- Ridley Creek State Park
- Pennsylvania Department of Conservation and Natural Resources (PA DCNR)

The results of these searches were used to determine the presence of Sensitive Areas and/or Priority Areas located within the study area boundaries.

2.3.1.3 Public Survey

DELCORA prepared a public survey requesting information from local residents specifically about how the public is using the waterbodies within the CSS. Furthermore, the public survey also asked for the frequency that the residents are using the waterbody and within what time of the year they use the waterbody. Respondents were also provided an opportunity to leave comments in an open-ended format. The survey was mailed to approximately 14,000 customers within DELCORA's service area. The individuals contacted had the option to complete a hard copy of the survey or to complete the survey online. In addition to the 14,000 customers that received a hard copy of the survey, all members of the public (not just the individuals that received a copy of the survey) had the ability to complete the survey online at DELCORA's website. A copy of the survey, survey map, and the Public Survey Tally Sheet is included as Attachment B. A summary of the responses received by the residents in the Public Survey is included in Table 2-2.

Table 2-2: River and Creeks Use Survey Summary

Rivers and Creek Use Survey Summary						
	Delaware River		Chester River		Ridley Creek	
Activities	Percent Use per Year	Percent Never Used	Percent Use per Year	Percent Never Used	Percent Use per Year	Percent Never Used
Fishing Bank/Boat	1.28%	98.72%	1.53%	98.47%	0.55%	99.45%
Fishing from Wading	0.25%	99.75%	0.84%	99.16%	0.51%	99.49%
Rowing/Canoeing	0.05%	99.95%	0.02%	99.98%	0.02%	99.98%
Motor Boating	0.55%	99.45%	0.02%	99.98%	0.02%	99.98%
Kayaking	0.05%	99.95%	0.03%	99.97%	0.02%	99.98%
Jet Skiing	0.25%	99.75%	0.01%	99.99%	0.01%	99.99%
Water Skiing	0.01%	99.99%	0.00%	100.00%	0.00%	100.00%
Swimming	0.01%	99.99%	0.03%	99.97%	0.04%	99.96%
Wading	0.24%	99.76%	0.09%	99.91%	0.26%	99.74%
Other	0.01%	99.99%	0.01%	99.99%	0.01%	99.99%

2.3.2 Outstanding National Resource Waters

Outstanding National Resource Waters (ONRW) are maintained and protected by Tier 3 of the USEPA's Antidegradation Policy which can be accessed through the Agency's web portal at http://www.epa.gov/sites/production/files/2014-10/documents/diamond-outstanding-memo.pdf. Only waters of "exceptional ecological significance" qualify as ONRWs, and States and Tribes determine whether or not a water body will be classified as such.

In Chapter 93 of the Pennsylvania Code, it is stated that a water body will be classified as having Exceptional Value (EV) if it is considered by the Commonwealth of Pennsylvania to be an

ONRW. Chapter 93 of the PA Code lists water bodies alongside their protected water uses. Neither the Delaware River, Chester Creek nor Ridley Creek are listed as being of Exceptional Value. Therefore, none of DELCORA's receiving waters, the Delaware River, Chester Creek or Ridley Creek, are considered to be an ONRW.

2.3.3 National Marine Sanctuaries

The goal of the National Marine Sanctuaries Act (Title 16, Chapter 32, Section 1431 last amended in November 2000) is to identify and designate as National Marine Sanctuaries (NMS) areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System. Receiving this designation results in the conservation and management of these special habitats, support of the natural biological communities through protection and restoration, enhances the public's awareness, understanding and appreciation for the marine sanctuary, and supports the vitality of these communities through research and Federal, State and Local government collaboration.

In order for a marine environment to be designated a National Marine Sanctuary, the United States Secretary of Commerce will determine if any of the following criteria apply:

"Criteria 1
The area's natural resources and ecological qualities are of special significance and contribute to: biological productivity or diversity; maintenance or enhancement of ecosystem structure and function; maintenance of ecologically or commercially important species or species assemblages, or both; or maintenance or enhancement of connectivity to other ecologically significant resources.

Criteria 2
The area contains submerged maritime heritage resources of special historical, cultural, or archaeological significance, that: individually or collectively are consistent with the criteria of eligibility for listing on the National Register of Historic Places; have met or which would meet the criteria for designation as a National Historic Landmark; or have special or sacred meaning to the indigenous people of the region or nation.

Criteria 3
The area supports present and potential economic uses, such as: tourism; commercial and recreational fishing; subsistence and traditional uses; diving; and other recreational uses that depend on conservation and management of the area's resources.

Criteria 4
The publically-derived benefits of the area, such as aesthetic value, public recreation, and access to places depend on conservation and management of the area's resources."

The above criteria for National Marine Sanctuaries was taken directly from the Sanctuary Nomination Process Guide which can be found at http://www.nominate.noaa.gov/guide.html#document.

The Office of National Marine Sanctuaries (ONMS) is the trustee of all national marine sanctuaries and as such, it currently recognizes fourteen (14) national marine sanctuaries, none of which are located within DELCORA's service area. Therefore, none of DELCORA's receiving waters, the Delaware River, Chester Creek or Ridley Creek, are considered to be a National Marine Sanctuary.

2.3.4 Threatened or Endangered Species Criterion

The Federal CSO Policy states "waters with threatened or endangered species and their habitat" are considered a Sensitive Area. The U.S. Fish and Wildlife Service and PA Fish and Boat Commission were contacted and the NOAA Environmental Sensitivity Index maps reviewed to identify any threatened or endangered species with habitat within the project boundaries. Threatened and endangered species that could potentially occur within the project study area are listed in Table 2-3 below. A copy of the letters received from the U.S. Fish and Wildlife Service and PA Fish and Boat Commission can be found in Attachment A to this report.

Table 2-3: Federally-Listed Threatened and Endangered Species

Species	Status
Bog Turtle	Threatened
Eastern Redbelly Turtle	Threatened
Indiana Bat	Endangered
Northern Long-Eared Bat	Endangered
Atlantic Sturgeon	Threatened
Shortnose Sturgeon	Endangered

These species could potentially use the Delaware River, Chester Creek or Ridley Creek as habitat. However, the U.S. Fish and Wildlife Service stated that no critical habitat has been designated for any of the threated and endangered listed species in the Delaware River, Chester and Ridley Creeks as of November 2015.

The NOAA Environmental Sensitivity Index Maps for the project area, ESI-18 and ESI-19, were then reviewed to locate specific habitat for the above listed species. These NOAA maps are included as Attachment K. No habitat was found for the Bog Turtle, Indiana Bat, or Northern Long-Eared Bat within the project boundaries. The NOAA ESI maps do indicate the Shortnose Sturgeon concentrations are "medium" from April through October, and "high" November through March in the Delaware River. However, the NOAA ESI maps generically state this migratory species is present in the Delaware River and does not include any specific portion of the project area as being a nursery, spawning or year-of-young habitat for the species.

The Eastern Redbelly Turtle habitat is located within the Heinz National Wildlife Refuge which enters the Delaware River approximately 2 miles upstream of the northern most CSO outfall. The Refuge is not directly on the Delaware River and outside the project boundaries.

Atlantic Sturgeon habitat is shown on NOAA map ESI-18 spanning the Pennsylvania/Delaware border. High concentrations of year-of-young Atlantic Sturgeon has been documented in this area. The most northern portion of the Atlantic Sturgeon habitat, as shown on Figure 2-1, is one-half mile from DELCORA's most down steam CSO #002. The criteria for a Sensitive Area is met because both a threatened species and its habitat are identified.

In the previously submitted 2012 DELCORA LTCP report, tidal flats were identified as a Sensitive Area meeting the criteria of critical habitat for threatened or endangered species. However, the current request for information from the U.S. Fish and Wildlife Service on threatened or endangered species and their habitat present within the project boundaries found that no critical habitat has been identified. The response from the U.S. Fish and Wildlife Service stating the same can be found in Attachment A. Therefore, the most current information is used in this report and the tidal flats are no longer considered a Sensitive Area.

2.3.4.1 Bald and Golden Eagle

Bald eagles are known to nest in the vicinity of the project area. While the bald eagle has been removed from the Federal list of threatened and endangered species, the bald eagle along with the golden eagle continues to be protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act (MBTA). These Acts prohibit anyone to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, disturb, or otherwise harm eagles, their nests, or their eggs". Under the BGEPA, "disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: (1) injury to an eagle; (2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. Since the Bald Eagle has been removed from the Federal list of threatened and endangered species, the Sensitive Area criteria for Threatened or Endangered Species does not apply to the project study area. However, it is acknowledged that these species require special consideration. During the development of CSO abatement alternatives, the project will be evaluated for project size, location and layout in order to comply with the BGEPA and MBTA.

2.3.4.2 Special Considerations

The northern reaches of Ridley Creek within DELCORA's service area are designated as Approved Trout Waters and Trout Stocked Streams. The portion approved for stocking trout begins at Brookhaven Road upstream of CSO #033 and ends downstream of CSO #033 at Chestnut Street in Chester City as shown on Figure 2-1. The portion of the approved trout waters from CSO #033 downstream to Chestnut Street is considered a Priority Area because of

N

SPRING RUN

SPRING RUN

NAAMAN CREEK

BALDWIN RUN

CHESTER CREEK

RIDLEY CREEK BRANCH

RIDLEY CREEK

RIDLEY CREEK

CRUM CREEK

MARCUS HOOK CREEK

STONY CREEK

Priority Area 1: Approved Trout Waters

Priority Area 2: Boat Launch

Sensitive Area: Atlantic Sturgeon

LOWER DELAWARE RIVER
(primary contact recreation)

UPPER DELAWARE RIVER
(recreation/secondary contact)

River Milemarker 81.8

Chester Island

02 03 04 05 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 32 33

491 95 13 322 352 252 320 291 476

PS

0 0.5 1 Miles

Legend

- River Milemarker
- CSO Regulator
- Boat Launch Ramp
- Combined Sewer Outfall
- PS Pump Station
- Western Regional Treatment Plant
- Upper Tidal Limit
- Trout Stocked Streams
- Approved Trout Waters
- Sensitive Area
- Priority Areas
- Chester City Service Area

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this special environmental use and the need to meet water quality standards to continue to support trout stocking. Additionally, the public is provided an opportunity to use Ridley Creek for recreational purposes and that may include wading which further meets the criteria of a Priority Area.

2.3.5 Primary Contact Recreation Criterion

Primary contact is defined as an activity where people come directly in contact with the waterbody, such as at bathing beaches. The Upper Delaware River (defined as the portion of the river upstream of River Mile 81.8), Chester Creek and Ridley Creek are all designated for secondary contact and are not suitable for direct contact with the waterbody. The Lower Delaware River (downstream of River Mile 81.8), is rated for primary contact. Special water quality standards are used for water contact areas in order to protect the public from being exposed to waterborne diseases. The study area is located in a densely populated urban area with a mix of recreational uses including boating, fishing, hiking, and other uses by the public.

2.3.5.1 Delaware River

The Delaware River is designated as suitable for Water Contact (WC) Recreation below River Mile (R.M.) 81.8 (between CSO #009 and #011). It is to be noted that this stretch (Zone 4) of the Delaware River is not listed in the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report (PADEP, 2014) (a.k.a. the "303(d) list") as impaired for its WC use, and it has not been reported as impaired or not meeting designated uses from coliform bacteria or any other parameter commonly associated with CSOs or municipal wastewater treatment plant discharges. There are no designated bathing beaches or approved swimming facilities along the Delaware River within the project area boundaries.

There is one boat launch owned by the Chester Economic Development Authority located along the Delaware River within the project study area boundaries as shown on Figure 2-1. This boat launch is located between CSO #007 and #008 and may be impacted by CSO discharges. Additionally, this boat ramp is located within the portion of the waterbody rated for primary contact. Therefore, it was determined that this location does not qualify as a Sensitive Area because it is neither impaired, failing to meet the associated water quality standards, the public is not provided with access to the waterbody and is not using it for primary contact recreation activities according to the public survey. It is however considered a Priority Area because it provides the public with direct access to the Delaware River in a portion rated for primary contact. The Priority Area at the boat launch is shown in Figure 2-1 to extend for a total length of 500 feet along the shoreline; or 250 feet upstream and 250 feet downstream from the location of the boat launch. The Priority Area around the boat launch is also shown to extend into the river 250 feet from the shoreline. There are no defining boundaries for priority areas, however, a buffer zone of 250 feet around the boat launch includes the area one block upstream and one block downstream of the boat launch.

2.3.5.2 Chester Creek and Ridley Creek

There are no identified boat launch ramps, boat docks, or designated bathing beaches within Chester or Ridley Creek within the project area boundaries. Results of the public survey indicate the public is not using Chester Creek or Ridley Creek for primary contact activities. Of all the activities listed, fishing was the most frequently identified use of the waterbodies which does not qualify as primary contact. Of the over 460 respondents only a few reported using the waterbodies for boating, wading or swimming. It was therefore concluded these waterbodies are not considered a Sensitive Area for primary contact.

As mentioned above, the approved trout waters of Ridley Creek are being considered a Priority Area. In addition to its environmental significance as approved trout waters, they provide the public with wading access to the water for recreational fishing activities. This further supports this section of Ridley Creek being considered a Priority Area worthy of special consideration.

2.3.6 Drinking Water Intakes

Several drinking water providers are located within the study area. The majority of Delaware County is served by Aqua Pennsylvania. Chester Water Authority serves portions of western Delaware County in Thornbury Township, Chester Heights Borough, Chadds Ford Township, Concord Township, Bethel Township, Aston Township, Upper Chichester, Lower Chichester, Trainer, Brookhaven, Parkside, Upland, Chester Township, and Chester City. All drinking water intakes for both Aqua Pennsylvania and the Chester Water Authority are upstream of the CSOs and are not affected by their discharges as they are located on tributaries of the Delaware River.

Upstream of DELCORA's service area (and upstream of Center City Philadelphia), the Delaware River is still tidal and the Philadelphia's Water Department's Baxter Water Treatment Plant is located alongside the tidal portion of the river. DELCORA's most upstream CSO on the Delaware, CSO #014, is over 26 miles downstream of this drinking water intake.

Downstream of DELCORA's service area and located in the State of Delaware, United Water customers receive most of their water from the Stanton Water Treatment Plant, which is capable of treating 30 million gallons of water per day. The Stanton Plant draws water from the White Clay and Red Clay Creeks which are tributary to the Christiana River, itself a tributary to the Delaware River. DELCORA's most downstream CSO, CSO #002, is over 10 miles upstream of the confluence of the Delaware and Christiana Rivers. The Stanton's plant drinking water intake is several miles upstream of this location.

Due to the large distances of the drinking water intakes noted above to DELCORA's CSOs, the Sensitive Area criteria for Drinking Water Intakes on the Delaware River does not apply to the areas associated with DELCORA's CSO discharges.

There are no drinking water intakes located along Chester Creek or Ridley Creek in proximity to DELCORA's service area. Therefore, the Sensitive Area criteria for Drinking Water Intakes does not apply to the Chester or Ridley Creeks.

2.3.7 Shellfish Beds

There are no commercial shellfish harvesters that operate within the study area. The Partnership for the Delaware Estuary reported shellfish areas well downstream of the most southern outfall in DELCORA's system. Shellfish consumption as a DRBC designated use, only applies to DRBC WQM Zone 6. The DRBC's 2014 Delaware River and Bay Water Quality Assessment presents a map that shows the approved shellfish harvesting areas in the Delaware Bay, and this map is re-presented in this report as Figure 2-2. The uppermost shellfish harvesting area is approximately 32 miles downstream from DELCORA's closest CSO discharge (CSO #002). The influence of tidal mixing and dilution coupled with the 32 mile separation between the most downstream discharge point and beginning of the shellfish harvest zone result in the CSO discharge having a negligible impact on the shellfish beds. Therefore, the Sensitive Area criteria for Shellfish Beds does not apply to the areas associated with DELCORA's CSO discharges.

2.4 Summary of Sensitive and Priority Areas

A comprehensive review of online databases, correspondence with regulatory agencies and local environmental organizations, and responses to the public survey was conducted to identify potential Sensitive Areas and Priority Areas within the CSS portion of the collection system.

2.4.1 Summary of Sensitive Areas

The habitat for year-of-young Atlantic Sturgeon downstream of CSO #002 in the Delaware River meets the Sensitive Area criteria for Endangered or Threatened species. The Atlantic Sturgeon is listed as a threatened species by the US Fish and Wildlife Service with documented habitat in the Delaware River downstream approximately one-half mile downstream of DELCORA's most southern outfall.

There are no Outstanding National Resource Waters nor National Marine Sanctuaries within the project area. Shellfish beds are located well downstream of the CSO locations and are outside the project boundaries. There are numerous drinking water intakes in the geographical area but none are located in close proximity downstream of DELCORA's CSOs on the Delaware River. No drinking water intake locations were found that meet the criteria of a Sensitive Area.

Figure 2-2: Shellfish Harvesting Areas in Zone 6 of the Delaware River

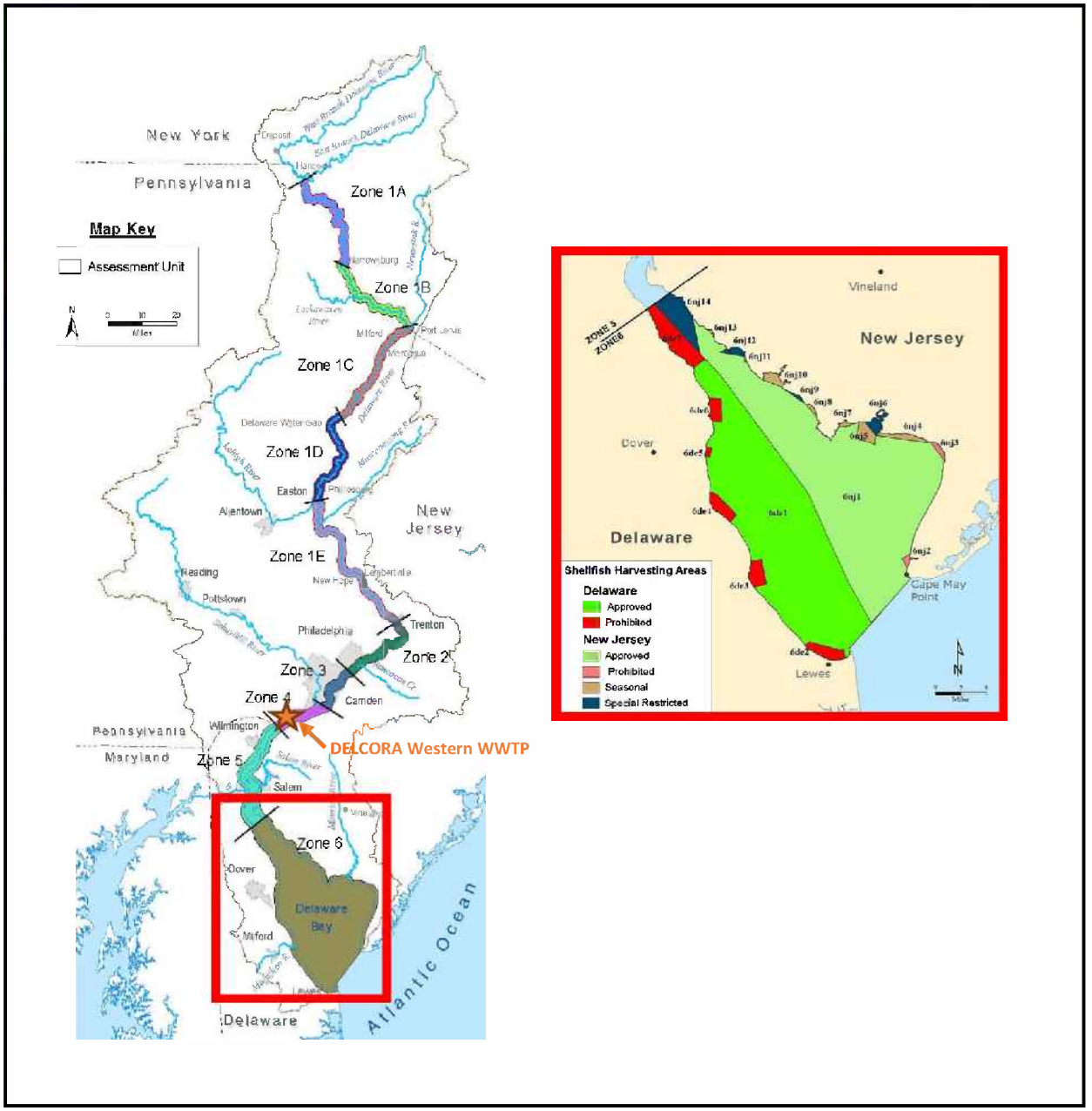

*Image courtesy of the Delaware River Basin Commission

2.4.2 Summary of Priority Areas

Priority Areas include areas having some environmental significance but not to the level of "Sensitive Areas" as defined in the federal CSO Control Policy. Two Priority Areas were identified:

- Approved trout waters in Ridley Creek,
- Chester Economic Development Authority's boat launch in Chester City.

The northern reaches of Ridley Creek within DELCORA's service area are designated as Approved Trout Waters and Trout Stocked Streams. The portion of the approved trout waters from CSO #033 downstream to Chestnut Street is considered a Priority Area because of this special environmental use.

The boat launch located between CSO #007 and #008 along the Delaware River is located within the portion of the waterbody rated for primary contact. The boat launch is considered a Priority Area due to its location to CSO #007 and #008.

Section 3 Pollutants of Concern

3.1 Regulatory Requirements

3.1.1 Consent Decree Requirements

For the Identification of Pollutants of Concern, Section V.A.11 of the Consent Decree specifically states:

> *"For each of its Receiving Waters, DELCORA shall review existing water quality data and recent PADEP CWA § 303(d) listings to identify POCs. Even if a water body has not been formally listed as out of compliance with its water quality standards and designated uses, if available data indicate such impairment exists and such impairment involves pollutants associated with CSOs, DELCORA shall consider the related pollutants to be POCs."*

3.1.2 Requirements of the USEPA's CSO Guidance Document

Section 2.5.3.3 of the USEPA's CSO Guidance document states that to assess the impacts of wet weather runoff, the water quality of the receiving waters should be understood for normal dry weather periods. The water quality data that is collected during dry weather conditions provides a basis for comparing the data collected during wet weather conditions. The CSO Guidance Document says:

> *"Receiving water monitoring should include identified parameters of concern. These parameters typically include those previously identified for combined sewage and CSO monitoring.*
>
> - *pH*
> - *BOD*
> - *TDS*
> - *TSS*
> - *Nutrients*
> - *Metals*
> - *Indicator bacteria*
>
> *Knowledge of the site-specific water quality concerns could expand the list to include dissolved oxygen, toxics, biological assessment, and sediment."*

3.2 Receiving Water Use Designations and General Water Quality Standards

Information about the applicable water quality standards (WQS) and designated uses for the three receiving water bodies impacted by DELCORA's CSOs were obtained from the PADEP's 2014 Integrated Water Quality Monitoring and Assessment Report (or "303(d) list"), the Pennsylvania Code, the Delaware River Basin Commission's (DRBC's) Water Quality Regulations (WQRs) and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment.

3.2.1 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report (303(d) list)

The primary source of information about the causes of impairment, and the Total Maximum Daily Load (TMDL) status of the water bodies (if any) is the 2014 PA Integrated Water Quality Monitoring and Assessment Report (PA Integrated Report), which satisfies Pennsylvania's requirement of both Section 303(d) and 305(b) of the Clean Water Act (CWA). The PA Integrated Report lists all impaired surface waters within Pennsylvania that are not attaining designated and existing uses, even after appropriate and required pollution control technologies have been applied. A TMDL is designed to reduce pollutant loads to impaired waters and enable these waters to meet water quality standards.

The Integrated Report uses a five-part categorization (lists) of water according to their use attainment status. The categories represent varying levels of use attainment, ranging from Category 1, where all designated water uses are met to Category 5, where impairment by pollutants required the development of a TMDL to correct. Each segment of the waterbody is placed into one of these five categories.

The PADEP's website explains the categories as follows:

- *"Category 1: Waters attaining all designated uses.*
- *Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses maybe unknown because data are insufficient to categorize a water body consistent with the states' listing methodology or may be impaired.*
- *Category 3: Waters for which there are insufficient or no data and information to determine, consistent with the state's listing methodology, if designated uses are met.*
- *Category 4: Waters impaired for one or more designated use but not needing a TMDL. States may place these waters in one of the following three subcategories:*
    - *Category 4A: TMDL is approved.*
    - *Category 4B: Expected to meet all designated uses within a reasonable timeframe (three years).*
    - *Category 4C: Not impaired by a pollutant.*

- *Category 5: Waters impaired for one or more designated uses by any pollutant and requiring the development of a TMDL. Category five includes waters shown to be impaired as the result of biological assessment used to evaluate aquatic life even if the specific pollutant is not known unless the state can demonstrate that non-pollutant stressors cause impairment or that no pollutant(s) causes or contribute to the impairment.*"

The Category 5 list constitutes the Section 303(d) list that the USEPA will approve or disapprove under the CWA. For the purposes of the determination of Pollutants of Concern, Categories 4A and 5 are the relevant categories as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters. All of the lists are sorted by an 8-digit Hydrologic Unit Code (HUC) that is particular for the water body of interest. For DELCORA's drainage area, the HUC for the Lower Delaware River (02040202) was used for searching the data in the PA Integrated Report for all three of DELCORA's receiving water bodies.

3.2.2 PA Code Chapter 25 §93.9g

The primary source of information for the Critical Use Designation for each section of the three receiving water bodies is Chapter 25 §93.9g – Drainage List from the Pennsylvania Code. The relevant Critical Use Designations for DELCORA's receiving water bodies include Warm Water Fishes (WWF), Migratory Fishes (MF), Trout Stocking (TSF), and Water Contact Sports/Recreation (WC).

- The "WWF" designation indicates the maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
- The "MF" designation indicates the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters.
- The "TSF" designation indicates maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
- The "WC" designation indicates the use of the water for swimming and related activities.

3.2.3 DRBC's Water Quality Regulations and PA Code Chapter 25 §93.7

The applicable water quality standards for the three receiving water bodies were found in the Delaware River Basin Commission's Water Quality Regulations, and in Water Quality Criteria lists found in Chapter 25 §93.7 and §93.8c of the Pennsylvania Code. For the Delaware River, the water quality standards are dictated by the DRBC's WQRs that have primacy over the standards in the PA Code. The water quality standards in the PA Code apply to the non-tidal

portions of the Chester Creek and Ridley Creek, and to the Delaware River if there is no standard listed for a particular parameter in the DRBC's WQRs.

3.2.4 DRBC's 2014 Delaware River and Bay Water Quality Assessment

The DRBC's 2014 Delaware River and Bay Water Quality Assessment (2014 Assessment) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commissions' Water Quality Regulations for the period October 1, 2008 through September 30, 2013. The 2014 Assessment involves the comparison of key water quality parameters with the applicable DRBC water quality regulations. The states of Pennsylvania, New Jersey, Delaware and New York consider the DRBC's Assessment report as part of their determinations as to whether sections of the Delaware River should be listed on the state 303(d) list for a certain pollutant.

3.2.5 Delaware River

3.2.5.1 303(d) List Designation

The 2014 PA Integrated Water Quality and Assessment Report ("the 303(d) List") lists a 61.02 mile segment of the Lower Delaware River in Category 4A as having an approved TMDL for polychlorinated biphenyls (PCBs) from an unknown source related to its fish consumption use. The USEPA approved a TMDL for PCBs for Zone 2 through Zones 5 in 2003, and a second PCB TMDL was approved for Zone 6 in 2006. The TMDLs for PCBs encompass the Delaware River Estuary and stretch from the mouth of the Delaware River upstream to the Trenton, NJ /Morrisville, PA Bridge. The segment of the Delaware River having an approved TMDL for PCBs is shown in yellow in the map in Figure 3-1, which was derived from the PADEP's eMapPA website. Attachment C presents an excerpt from the 2014 PA Integrated Water Quality Monitoring and Assessment Report, and includes the applicable pages for the Delaware River.

Consequently, the impacts of DELCORA's CSO discharges on the level of PCBs within the Delaware River was evaluated further and is discussed herein.

3.2.5.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code

The Critical Uses for the Delaware River in the area of DELCORA's CSO discharges are designated in Chapter 25 §93.9 of the PA Code. All stretches of the Delaware River in this area are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). Additionally the Delaware River has a Water Contact (WC) designation downstream of River Mile 81.8, which is located directly adjacent to the City of Chester between CSO #009 and #011.

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Figure 3-1
Non-Attaining and TMDL Streams/River
Within DELCORA's Service Area

For WC-designated waters, Chapter 25 §93.7 of the PA Code establishes the following as the water quality criterion for fecal coliform bacteria:

- **Fecal Coliform** – A geometric mean of 200 colonies per 100 mL during the swimming season (May 1 through September 30) based on a minimum of five samples collected during a 30-day period. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 colonies/100 mL based on a minimum of five samples collected during a 30-day period. There are no fecal coliform bacteria criteria for the Delaware River or tributaries that are not designated as WC waters or for Potable Water Supply (PWS).

For WWF and MF waters the WWF designation is the more restrictive of the two, and Chapter 25 §93.7 of the PA Code establishes the following additional standards for WWF waters:

- **Dissolved Oxygen** – The minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 5.5 mg/L
- **Alkalinity** – A minimum of 20 mg/L as $CaCO_3$, except where naturally occurring conditions are less
- **Ammonia Nitrogen** – the maximum total ammonia nitrogen concentration (in mg/L) at all times shall be the numerical value given by un-ionized ammonia nitrogen (NH_3-N) x ($\log^{-1}[pK_T\text{-}pH] + 1$)
- **Iron** – 30-day average 1.5 mg/L as total recoverable
- **pH** – From 6.0 to 9.0 inclusive
- **Temperature** – A table is included within Chapter 25 §93.7 for maximum water temperatures in the receiving water body at various times of the year
- **Total Residual Chlorine** – Four-day average 0.011 mg/L; 1-hour average 0.019 mg/L

3.2.5.3 Designated Zone and Water Quality Regulations from the DRBC

Chapter 25 §93.9 of the PA Code lists the DRBC regulations for Water Quality Zone 4 as exceptions to PA Code's specific water quality criteria. The DRBC's water quality regulations have primacy over the standards in the PA Code for the Delaware River.

The DRBC defines Zone 4 as that part of the Delaware River extending from R.M. 78.8 to R.M. 95.0, the Pennsylvania-Delaware state boundary line to the upstream side of the Philadelphia Navy Yard, including the tidal portions of the tributaries thereof. The DRBC states that the quality of Zone 4 waters shall be maintained in a safe and satisfactory condition for the following uses:

- Industrial water supplies after reasonable treatment
- Maintenance of resident fish and other aquatic life

- Passage of anadromous fish
- Wildlife
- Recreation - secondary contact above R.M. 81.8
- Recreation (all water-contact sports) below R.M. 81.8
- Navigation

The DRBC's Stream Quality Objectives for Zone 4 are as follows:

1. **Dissolved Oxygen**
   - 24-hour average concentration shall not be less than 3.5 mg/L.
   - During the periods from April 1 to June 15, and September 16 to December 31, the DO shall not have a seasonal average less than 6.5 mg/L.

2. **Temperature** shall not exceed:
   - 5°F (2.8°C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or
   - A maximum of 86°F (30.0°C), whichever is less.

   (NOTE: The DRBC's 2014 Delaware River and Bay Water Quality Assessment states that *"atmospheric temperatures and meteorological conditions are strong drivers of water temperature. DRBC previously demonstrated that water temperatures are strongly liked to air temperatures, and that a notable increase in air temperatures is observable between the temperature gradient period (1961-1966) and the current period. At present, we* [i.e., DRBC] *lack the tools to determine which portion of the exceedance is attributable to potentially controllable anthropogenic thermal inputs, and which portion is due to metrological drivers beyond our control".*

3. **pH** between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions.

4. **Phenols** maximum 0.02 mg/l, unless exceeded due to natural conditions.

5. **Threshold Odor Number** not to exceed 24 at 60°C.

6. **Synthetic Detergents.** (M.B.A.S.). Maximum 30- day average 1.0 mg/L.

7. **Radioactivity**
   - Alpha emitters - maximum 3 pc/L (picocuries per liter);
   - Beta emitters - maximum 1,000 pc/L.

8. **Bacteria**
   - **Fecal Coliform**
     - Above R.M. 81.8: maximum geometric average 770 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 200 per 100 milliliters
   - **Enterococcus**
     - Above R.M. 81.8: maximum geometric average 88 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 33 per 100 milliliters

9. **Total Dissolved Solids** not to exceed 133% of background.
(NOTE: The background TDS concentration is at present undefined, according to the DRBC's 2014 Delaware River and Bay Water Quality Assessment.)

10. **Turbidity** unless exceeded due to natural conditions.
    - Maximum 30-day average 40 units (NTU)
    - Maximum 150 NTU

11. **Alkalinity** between 20 and 120 mg/L.

12. **Toxic Pollutants**
    - Applicable criteria to protect the taste and odor of ingested water and fish are presented in the DRBC's WQRs Table 4.
    - Applicable freshwater stream quality objectives for the protection of aquatic life are presented in the DRBC's WQRs Table 5.
    - Applicable freshwater stream quality objectives for the protection of human health are presented in the DRBC's WQRs Tables 6 and 7.

3.2.5.4 DRBC Evaluation of Use Attainment Status

Table 3-1 presents a summary of Table 23 from the DRBC's 2014 Delaware River and Bay Water Quality Assessment for Zone 4 of the Delaware River. Zone 4 is the portion of the Delaware River directly impacted by DELCORA's CSO discharges and it extends from R.M. 95.0 to R.M. 78.8, the Pennsylvania-Delaware state line including the tidal portions of the tributaries thereof. The extent of Zone 4 can be seen in Figure 2-2.

Table 3-1: Summary of the 2014 DRBC Integrated Assessment for Zone 4 of the Delaware River

Zone	Designated Use			
	Aquatic Life	Drinking Water	Recreation	Fish Consumption
4	NS	N/A	S	NS

Notes:
N/A - Not applicable
NS - The Designated Use is not supported
S - The Designated Use is supported

3.2.5.4.1 Water Contact Recreation

Table 3-1 shows that the designated use for Water Contact Recreation is being attained for the Delaware River below R.M. 81.8.

3.2.5.4.2 Aquatic Life

Table 3-1 shows that the designated use for Aquatic Life is not being attained. According to the DRBC's Assessment report, "*the composite aquatic life assessment for 2014 yields a result of "Not Supporting" for all assessment units* (or zones). *It is important to note, however, that this result is largely driven by the requirement to categorize as not meeting criteria any assessment unit* (or zone) *with 1 exceedance plus 1 confirmatory exceedance.*"

The DRBC's Assessment Report also states: "*Data showed multiple exceedances of aluminum acute and chronic freshwater objectives for the support of aquatic life in Zone 4. Of 35 surface water samples tested for aluminum in Zone 4 during the assessment period, 34 exceeded the chronic criterion and 8 exceeded the acute criterion at 21PA_WQX-WQN0182 near Marcus Hook, PA. No exceedances of aluminum were reported in Zones 2, 3, 5 and 6.*" As part of the Recommendations for Future Action at the end of the report, the DRBC states that the "*exceedances of aluminum criteria in Zone 4 warrant further attention*".

3.2.5.4.3 Fish Consumption

Table 3-1 shows that the designated use for Fish Consumption is not being attained. The DRBC's 2014 Delaware River and Bay Water Quality Assessment report states that their assessment criterion for fish consumption is based on the presence of fish consumption advisories from the four Basin states for the mainstem of the Delaware River. If a fish consumption advisory is present, this resulted in the DRBC making an assessment of "not supporting the designated use".

The Assessment report states that the violation criteria for PCBs is also supported by the presence of measureable concentrations of PCBs in the river that exceeded the surface water quality standard. Twenty-two mainstem channel sites were sampled for PCBs in 2012, from

Biles Channel near Trenton, NJ to the ocean boundary between Cape May and Lewis. It was found that all of the samples exceeded the current PCB water quality criteria of 16 µg/L for the protection of human health from carcinogenic effects.

The 2016 Commonwealth of Pennsylvania Fish Consumption Advisories for Zones 2, 3, and 4 of the Delaware River (Trenton, NJ/Morrisville, PA Bridge to PA/DE border) are as shown below in Table 3-2. These advisories identify PCBs as a pollutant of concern in fish tissue.

Table 3-2: PA Fish Consumption Advisory Summary for PCBs in the Delaware River

Fish Species	Meal Frequency	Contaminant
White Perch	1 meal/month	PCB
Flathead Catfish	1 meal/month	PCB
Channel Catfish	1 meal/month	PCB
Striped Bass: over 28 inches in length	1 meal/month	PCB
Carp	6 meals/year	PCB
American Eel	Do Not Eat	PCB

3.2.6 Chester Creek

3.2.6.1 303(d) List Designation

Chester Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its recreational use due to pathogens, and for not meeting its aquatic life use due to siltation. "Pathogens" were listed in 2006 for three segments totaling 0.94 miles, and a TMDL is anticipated in 2019. The source for the pathogens is listed as "unknown", and these three stream segments are all well upstream of DELCORA's service area. Therefore it appears that the noted impairment of the Chester Creek due to pathogens is not related to DELCORA' CSO discharges.

"Siltation" was listed in 2014 for four segments of the creek totaling 18.41 miles, and a TMDL is anticipated in 2027. The source for the siltation was identified as "urban runoff/storm sewers". The majority of Chester Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located upstream of DELCORA's service area and are shown in red in the map in Figure 3-1. However, one of DELCORA's CSO outfalls does discharge to the furthest downstream segment of the Chester Creek that is impaired by siltation, which is Outfall #020 near Kerlin Street and Finland Drive. Siltation is measured by the water quality parameter Turbidity with units of Nephelometric Turbidity Units (NTU). The impacts of DELCORA's CSO discharges on the levels of Turbidity within the impaired sections of the Chester Creek have been evaluated further and are discussed herein.

Category 4A lists a 0.81-mile segment of Chester Creek at its mouth that does not meet its designated use for fish consumption due to PCBs from an unknown source, and for which a TMDL for PCBs was issued in 2006. This is shown in yellow in the map in Figure 3-1, and is related to the TMDL for PCBs in the Delaware River Estuary. As a consequence, the impacts of DELCORA's CSO discharges on the level of PCBs within the section of the Chester Creek for which there is an approved TMDL for PCBs has been evaluated further and is discussed herein.

Attachment C presents an excerpt from the 2014 PA Integrated Water Quality Monitoring and Assessment Report, and includes the applicable pages for the Chester Creek. It is to be noted that the Integrated Report also identifies an approved TMDL for the protection of two segments of the creek for aquatic life, but after consultation with staff in the Clean Water Section of the PADEP's Southeast Regional Office it was determined that those two stream segments were listed in the Integrated Monitoring Report in error.

3.2.6.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code

The Critical Uses for the Chester Creek in the area of DELCORA's CSO discharges are designated in Chapter 25 §93.9 of the PA Code. All stretches of the Chester Creek in this area are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). The same specific water quality criteria apply to the WWF and MF Critical Use designations for Chester Creek as was listed previously for the Delaware River in Section 3.2.5.2.

3.2.7 Ridley Creek

3.2.7.1 303(d) List Designation:

Ridley Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its aquatic life use due to siltation. The "Siltation" was listed in 2012 for five segments totaling 26.76 miles, and a TMDL is anticipated in 2025. The source for the siltation was identified as "unknown" or from "urban runoff/storm sewers".

In actuality, it appears that the majority of Ridley Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located well upstream of DELCORA's service area and are shown in red in the map in Figure 3-1. However, all of Ridley Creek within DELCORA's service area is shown as impaired for aquatic life due to siltation. Attachment C presents an excerpt from the 2014 PA Integrated Water Quality Monitoring and Assessment Report, and includes the applicable pages for the Ridley Creek.

Siltation is measured by the water quality parameter Turbidity, and consequently the impacts of DELCORA's CSO discharges on the levels of Turbidity within the impaired sections of the Ridley Creek have been evaluated further and are discussed herein.

3.2.7.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code:

The Critical Uses for the Ridley Creek in the area of DELCORA's CSO discharges are designated in Chapter 25 §93.9 of the PA Code. All stretches of the Ridley Creek in this area are designated as Warm Water Fishes (WWF) (maintenance only), Migratory Fishes (MF) (passage only), or Trout Stocking (TSF). The TSF stretch only applies in the sections of the Ridley Creek upstream of the Chestnut Street bridge crossing.

The same specific water quality criteria apply to the WWF and MF Critical Use designations for Ridley Creek as was listed previously for the Delaware River in Section 3.2.5.2, except for the parameters of Dissolved Oxygen and Temperature – which are more stringent because of the high oxygen needs of trout.

Specifically, for TSF waters Chapter 25 §93.7 of the PA Code establishes the following additional standards:

- **Dissolved Oxygen** – For the period February 15 to July 31 of any year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 6.0 mg/L. For the remainder of the year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 5.5 mg/L.
- **Temperature** – A separate table is included within Chapter 25 §93.7 for maximum water temperatures in the receiving water body at various times of the year for TSF waters.

3.3 Approach for the Identification of the Applicable Water Quality Standards

For the Delaware River and the tidal portions of its tributaries, the DRBC's Water Quality Regulations are the prime source for the water quality standards, and the PA Code Chapter 93 WQS for the designated use serves as a secondary source. The DRBC's regulations have primacy over the PA Code for the Delaware River and the tidal portions of its tributaries. For the non-tidal portions of the Chester Creek and Ridley Creek, the specific designated use for the water body in the PA Code serves as the prime source of the WQS. If a parameter is not listed in the DRBC's Water Quality Regulations or in the PA Code, then there is not a WQS for that parameter that applies to the Delaware River, Chester Creek or Ridley Creeks.

A conservative approach was taken in the identification of the applicable WQS, such that the more stringent standard was used where the standards from the DRBC's Water Quality Regulations and the PA Code overlapped. The methodology for identifying the applicable WQS was complicated by the fact that the WQS vary for the three receiving water bodies and can also vary within the same water body depending on where the sample was taken.

Attachment D in the List of Attachments contains the master table that was developed to determine the applicable water quality standards for the expanded list of Parameters Considered for the Delaware River downstream of R.M. 81.8, the Delaware River upstream of R.M. 81.8,

the Chester Creek and Ridley Creek within the area impacted by DELCORA's CSO discharges. The specific methodology for identification of the applicable water quality standards is described in greater detail below.

In order to determine WQS for metals, an average hardness value of 84 mg/l (as $CaCO_3$) was used for the Delaware River based on an average of the hardness values obtained from the USEPA's Storage and Retrieval Data Repository (STORET) study data from the Years 2010-2015 for this portion of the Delaware River. Due to unavailable hardness data on STORET for the Chester and Ridley Creeks, an average hardness value of 74 mg/l (as $CaCO_3$) was used for the Chester and Ridley Creeks based on guidance in the DRBC Water Quality Regulations, Section 4.20.05, Paragraph A.2.

3.3.1 Delaware River Downstream of R.M. 81.8 (Water Contact Use Designation)

The "lower" Delaware River downstream of R.M. 81.8 has a Water Contact designated use. Therefore, there is stricter criteria for the lower Delaware River below R.M. 81.8 than there is for the "upper" Delaware River upstream of R.M. 81.8 that does not have the Water Contact use designation.

The following bullets describe the approach that was used for the identification of the applicable water quality standards on the Delaware River downstream of R.M. 81.8:

- The basis for determining the WQRs was to first look to the DRBC's WQRs in Section 3.30.4 for Zone 4.
- If there were no listings for a parameter in Section 3.30.4, we next referred to the "Human Health Criteria" in 25 PA Code Ch. 93 WQS, 93.8c, Table 5 as the primary water quality standard, unless a more restrictive standard was listed in the PA Code that applies to the Delaware River. The Human Health Criteria includes probable modes of exposure such as, but not limited to ingestion from drinking water and fish consumption, inhalation and dermal absorption and is the most appropriate for protecting human health from water contact or immersion.
- If there were no Human Health Criteria listed in Table 5 of the PA Code, we referred to the standards in the DRBC WQRs Tables 6 and 7 and used the more restrictive standard for Fish and Water Ingestion. These tables are respectfully titled "Stream Quality Objectives for Carcinogens" and "Stream Quality Objectives for Systemic Toxicants".

3.3.2 Delaware River Upstream of R.M. 81.8 (WWF and MF Use Designation)

The following bullets describe the approach that was used for the identification of the applicable water quality standards on the Delaware River upstream of R.M. 81.8:

- The basis for determining the WQRs was to first look to the DRBC's WQRs in Section 3.30.4 for Zone 4.
- If there was no listing for a parameter in Section 3.30.4, we next referred to the DRBC's WQRs Table 5 "Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life" and used both the Acute and Chronic standards. If none was listed, we referred to DRBC Tables 6 and 7, and used the listed standard that is the next less restrictive than the Primary Contact standard that was used above for the Water Contact portion of the Delaware River. We used the Fish Ingestion Only criteria, not the Fish and Water Ingestion criteria for the Upper Delaware.
- If there is no DRBC standard listed for the parameter, we used the 25 PA Code Ch. 93 WQS Table 3 – "Specific Water Quality Criteria" for the particular Critical Use Designation of the water body and also the 25 PA Code Ch. 93 WQS Table 5 "Fish and Aquatic Life Criteria" (for both Acute and Chronic) as the source of the water quality standard – these tables are complimentary and do not overlap.

3.3.3 Chester Creek and Ridley Creek (TSF, WWF and MF Use Designations)

The following bullets describe the approach that was used for the identification of the applicable water quality standards on the Chester and Ridley Creeks:

- For the tidal portions of the creeks, we used as the basis the DRBC's WQRs in Section 3.30.4 for Zone 4. The DRBC regulations that were applied were for the Delaware River upstream of R.M. 81.8, since both creeks discharge to the Delaware River upstream of R.M. 81.8.
- For the non-tidal portions of the creeks, we used the 25 PA Code Ch. 93 WQS Table 3 – "Specific Water Quality Criteria" for the particular Critical Use Designation of the water body and also the 25 PA Code Ch. 93 WQS Table 5 "Fish and Aquatic Life Criteria" (for both Acute and Chronic) as the source of the water quality standard – these tables are complimentary and do not overlap.

3.4 Sampling of Select CSO Outfalls

3.4.1 Historical Sampling of Select CSO Outfalls

Under the current permit (NPDES Permit No. PA 0027103, Amendment 1, dated December 17, 2013), DELCORA is required to conduct on-going monitoring of its CSO outfalls at the following three locations within thirty (30) minutes of a rainfall:

- 2nd and Dock Streets Pump Station (wet well) (Chester Pump Station-CPS)
- CSO Outfall #018 – Sun Drive and Hancock Street
- CSO Outfall #019 – 14th Street and Crozer Hospital

The NPDES permit requires that the three (3) above locations be monitored for the five (5) parameters, sample type and at the frequency specified in Table 3-3 below. The grab samples are to be collected within the first 30 minutes of the discharge.

Table 3-3: Permit-Specified CSO Monitoring Program Parameters, Sample Type and Frequency

Parameter	Sample Type	Measurement Frequency
Biological Oxygen Demand (BOD_5)	Grab (mg/l)	Annual
Ammonia	Grab (mg/l)	Annual
Total Suspended Solids (TSS)	Grab (mg/l)	Annual
Phosphorus	Grab (mg/l)	Annual
Fecal Coliform	Grab (#/ 100 ml)	Annual

DELCORA annually obtains CSO water quality samples in conformance with the NPDES permit requirements. The permit required CSO sampling results for the most recent three years (2012, 2013 and 2014) are contained in Attachment E and summarized in Table 3-4. Analyses for the consideration of these 5 parameters as a Pollutant of Concern are included within Sections 3.7 and 3.8.

Table 3-4: Summary of NPDES Permit-Required CSO Samples (2012-2014)

Sample Location	Parameters				
	BOD5 (mg/L)	Ammonia (mg/L)	TSS (mg/L)	Phosphorus (mg/L)	Fecal Coliform (#/100 mL)
2012 Samples					
2nd & Dock Streets (Chester Pump Station) (wet well) 10/29/2012	35	2.18	106	0.823	>600,000
Sun Drive & Hancock Street (CSO #018) 10/29/2012	28	1.79	47	0.813	>600,000
14th Street & Crozer Hospital (CSO #019) 10/29/2012	21	0.81	48	0.499	>600,000
2013 Samples					
2nd & Dock Streets (Chester Pump Station) (wet well) 11/27/2013	65	2.1	204	1.32	>200,000
Sun Drive & Hancock Street (CSO #018) 11/27/2013	13	0.2	40	0.35	150,000

Sample Location	Parameters				
	BOD5 (mg/L)	Ammonia (mg/L)	TSS (mg/L)	Phosphorus (mg/L)	Fecal Coliform (#/100 mL)
14th Street & Crozer Hospital (CSO #019) 11/27/2013	40	0.9	163	1.21	190,000
2014 Samples					
2nd & Dock Streets (Chester Pump Station) (wet well) 09/25/2014	100	6.72	134	1.6	811,000
Sun Drive & Hancock Street (CSO #018) 09/25/2014	42.5	1.88	56	0.55	169,000
14th Street & Crozer Hospital (CSO #019) 09/25/2014	39.5	3.26	45	0.78	430,000

3.4.2 Additional Sampling of CSO Outfalls

Additional sampling was undertaken at the three monitored CSOs by DELCORA on November 19th and December 1st, 2015 for a much longer list of parameters than is required by the NPDES permit. The sampling results were used to confirm the actual parameters prevalent in DELCORA's CSO discharges.

Attachment F in the List of Attachments includes the laboratory data for the additional sampling of the CSOs. Wet weather samples were collected primarily to analyze for the parameters thought to have been present at the plant influent due to the industrial wastewater discharged at that location (see Section 3.6.1). These wet weather samples were also intended to capture those parameters due to the first flush during a wet weather overflow event. The wet weather samples were collected when the minimum rainfall was 0.5" with a high intensity, and the samples were collected within 30 minutes from the beginning of a wet weather overflow event as required by the NPDES permit.

Figure 3-2 presents a map that shows the locations that were used for DELCORA's sampling of the combined sewer system, select CSOs, for the historical sampling of the Chester and Ridley Creeks, and for the USEPA's STORET Database monitoring stations on the receiving water bodies.

3.5 Sampling of Receiving Waters

3.5.1 USEPA'S STORET Database

The USEPA's STORET database was used as the primary source for existing water quality data for all three receiving water bodies. Data was extracted using the appropriate hydrologic unit code for the Lower Delaware River, and all monitoring stations associated with the three receiving bodies within the area of DELCORA's CSO discharges were selected for gathering of water quality data. The water quality data was first extracted from STORET for the period of September 1, 2014 through September 1, 2015. The water quality data for this period was evaluated against the applicable water quality standards. The parameters (during this period) that were found to be exceeding the water quality standards and/or were found to be associated with CSO discharges (as "detects" through the additional CSO sampling) were considered for further evaluation. The water quality data of these particular parameters was then extracted from STORET for a five year period ranging from September 1, 2010 through September 1, 2015 and evaluated against the applicable water quality standards. This five-year STORET data was used to confirm the presence of these parameters and to calculate the total number of observations as well as exceedance percentages in the receiving bodies. The evaluation of the STORET data is discussed in detail under Section 3.7 and 3.8.

Table 3-5 shows a list of the STORET monitoring stations that were used, along with their station identification numbers. There were a total of two stations that belong to Delaware River Basin Commission on the Delaware River and three station that belong to Pennsylvania Department of Environmental Protection on the Delaware River, Chester Creek and Ridley Creek. Figure 3-2 shows the locations of the STORET database monitoring stations with their respective identification numbers.

The parameters that were searched within the STORET database from the monitoring stations in Table 3-5 were based on the expanded list of the Parameters Considered discussed in Section 3.6 of this report. Once the data from the USEPA STORET database was extracted, each parameter was sorted based on its characteristic name and station identification number.

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Figure 3-2
Sampling Locations
2010 - 2015

Table 3-5: Water Quality Monitoring Stations Used from USEPA's STORET Database

Station Name	Station Identification Number	Agency	Period of Record	Latitude	Longitude
Marcus Hook (R.M. 78.1)	332049	DRBC	9/1/2014 – 9/1/2015	39.798611	-75.430111
Eddystone (R.M. 84.0)	892062	DRBC	9/1/2014 – 9/1/2015	39.849139	-75.329628
Chester Creek	DRBC422094	PADEP	9/1/2014 – 9/1/2015	39.8447	-75.36
Ridley Creek	DRBC422120	PADEP	9/1/2014 – 9/1/2015	39.8533	-75.3461
Delaware River	WQN0182	PADEP	9/1/2014 – 9/1/2015	39,8069	-75.4064

3.5.2 Historical Sampling of Chester and Ridley Creeks

The USEPA's STORET Database only has data for one monitoring station each for both the Chester and Ridley Creeks, and those stations are each located near the mouths of the creeks. In order to supplement the receiving water data for the Chester and Ridley Creeks and to obtain representative samples of the water quality in the creeks upstream of DELCORA's CSO discharge locations, DELCORA took its own water quality samples for the Chester and Ridley Creeks on five dates in 2010. Two samples were obtained during a storm event on October 14, 2010, including a sample taken at the beginning of the storm and a second sample taken after a minimum of 0.45 inch of rain had fallen.

In addition to the parameters listed in Table 3-3 for DELCORA's NPDES permit-specified CSO monitoring program, the following in-situ field measurements were also collected during the 2010 sampling:

- Temperature
- pH
- Conductivity
- Dissolved Oxygen (DO)

Besides being specified in DELCORA's NPDES permit, the parameters in Table 3-5 are indicative of the presence of wastewater. Dissolved Oxygen can also be used to indicate a water body that is being stressed and may inhibit natural biological activity.

The sampling plan for the collection of the 2010 water quality samples from the Chester and Ridley Creeks specified collection during dry weather and during storm events in order to examine the impacts of CSO discharges on the water bodies. Discrete samples of receiving water collected for laboratory analyses were specified at four locations along the Chester and Ridley Creeks. The dry- and wet-weather water quality sampling locations that were used are listed below in Table 3-6, and are shown on the map in Figure 3-2. The data from the 2010 historical receiving water quality sampling is presented in Attachment G.

Table 3-6: Receiving Water Body Sample Locations for Chester and Ridley Creeks

Sample Location Name as Shown in Figure 3-2	Sample Collection Location	Latitude	Longitude	Closest Upstream CSO	Closest Downstream CSO	Nearest Access Road or Address
Ridley Creek 1 (RC1)	Upstream Chester Park Drive crossing of Ridley Creek	39°52'23.83"N	75°22'30.82"W	None	33	Chester Park Drive
Ridley Creek 3 (RC3)	Downstream East 2nd Street Bridge crossing of Ridley Creek	39°51'12.58"N	75°20'47.13"W	15	None	Old East 2nd Street
Chester Creek 1 (CC1)	Upstream Kerlin Street crossing of Chester Creek	39°51'20.76"N	75°22'36.02"W	None	20	1556 Kerlin Street
Chester Creek 3 (CC3)	Downstream 2nd Street Bridge crossing of Chester Creek	39°50'41.08"N	75°21'36.15"W	023, 024	12	Adjacent to Chester Pump Station

The sampling locations were carefully selected to provide an upstream (or background) sample above the furthest upstream CSO discharges on each creek to compare against a sample from a downstream location that is impacted by the CSO discharges.

3.6 Methodology for Identification of the Parameters Considered

For the identification of the POCs, DELCORA took an inclusive approach to determine that all relevant water quality parameters were appropriately considered and evaluated. The first step was to develop a comprehensive list of the overall "Parameters Considered", which was then further evaluated and refined to determine the list of the applicable POCs. Development of the list of Parameters Considered was meant to cast a wide net as the first step towards identifying any parameters that might possibly be of concern.

3.6.1 Development of the Parameters Considered List

The initial list of the Parameters Considered was compiled from six (6) primary reference sources from the USEPA, PADEP and the DRBC. The Parameters Considered list initially consisted of those specific parameters listed in the USEPA's CSO Guidance Document (as noted in Section 3.1.2). Additional parameters were added from the parameters requiring sampling per DELCORA's NPDES permit, from the PA Code's specific water quality criteria for DELCORA's three receiving water bodies, from the DRBC's Water Quality Regulations for Zone 4 of the Delaware River, from the 2014 PA Integrated Water Quality Monitoring and Assessment Report (a.k.a. "303(d) List"), and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment report. Attachment H provides the full version of the table used to develop the initial Parameters Considered list and includes the reference source for each of the parameters noted.

Table 3-7 provides a summary of the initial Parameters Considered list that was developed by compiling the parameters listed in each of the six primary reference sources noted above.

Table 3-7: Initial List of Parameters Considered

Bacteria - Enterococcus	Nutrients
Bacteria - Fecal Coliform	Oil and Grease
Alkalinity	PCBs (Fish Consumption)
Aluminum (Aquatic Life)	pH
Ammonia	Phenols
Biological Oxygen Demand (BOD)	Phosphorus
Cadmium	Radioactivity - alpha emitters
CBOD20	Radioactivity - beta emitters
CBOD5	Synthetic Detergents
Chlorine	Temperature
Chlorodibromomethane	Threshold Odor Number (TON)

Copper	Total Kjeldahl Nitrogen (TKN)
Cyanide	Total Dissolved Solids (TDS)
Dichlorobromomethane	Total Phosphorus
Dissolved Oxygen	Total Residual Chlorine (TRC)
Iron	Total Suspended Solids (TSS)
Lead	Toxics
Metals	Turbidity
Nitrate	Zinc
Nitrite	

As shown in the table in Attachment H and as noted in Section 3.1.2, the USEPA's CSO Guidance Document lists "Metals", "Nutrients", and "Toxics" as parameters of concern but does not provide any further definition of the individual parameters in these three categories. Tables 3-8, 3-9, and 3-10 below list the specific parameters that were added onto the initial Parameters Considered list for Nutrients, Metals, and Toxics and the reference source stating the reason for the inclusion of each of the parameters.

Table 3-8: Nutrients Included in the Initial List of Parameters Considered

Parameter (Nutrients)	Reference Source
Ammonia	NPDES Permit Required Sampling for CSO Discharges
Nitrate	NPDES Permit Required Sampling for Outfall #001
Nitrite	NPDES Permit Required Sampling for Outfall #001
Phosphate	Implied by EPA CSO Guidance for LTCP
TKN	NPDES Permit Required Sampling for Outfall #001
Total Nitrogen	Implied by EPA CSO Guidance for LTCP
Total Phosphorus	NPDES Permit Required Sampling for CSO Discharges

Table 3-9: Metals Included in the Initial List of Parameters Considered

Parameter (Metals)	Reference Source
Aluminum (Al)	Listed in DRBC WQRs Table 5
Arsenic (trivalent) (As III)	Listed in DRBC WQRs Table 5
Cadmium (Cd)	Listed in DRBC WQRs Table 5
Chromium (trivalent) (Cr III)	Listed in DRBC WQRs Table 5
Chromium (hexavalent) (Cr VI)	Listed in DRBC WQRs Table 5
Copper (Cu)	Listed in DRBC WQRs Table 5
Iron (Fe)	PA Code for TSF, WWF, and MF Critical Use
Lead (Pb)	Listed in DRBC WQRs Table 5
Mercury (Hg)	Listed in DRBC WQRs Table 5
Nickel (Ni)	Listed in DRBC WQRs Table 5
Selenium (Se)	Listed in DRBC WQRs Table 5
Silver (Ag)	Listed in DRBC WQRs Table 5
Zinc (Zn)	Listed in DRBC WQRs Table 5

Table 3-10: Toxics Included in the Initial List of Parameters Considered

Parameter (Toxics)	Reference Source
Phenols	Required by DRBC Zone 4 WQRs
Chlorodibromomethane	NPDES Permit Required Sampling for Outfall #001
Cyanide	NPDES Permit Required Sampling for Outfall #001
Dichlorobromomethane	NPDES Permit Required Sampling for Outfall #001

Once the initial list of Parameters Considered was developed, additional parameters were added onto the list if they had been detected during the historical sampling data of the influent to the WRTP (WRTP data), and in the existing CSO monitoring data (as required by the NPDES permit). One year's worth of DELCORA's plant influent historical sampling data from September 1, 2014 through September 1, 2015 was collected and analyzed to identify additional Parameters Considered.

It is important to state that that the historical sampling data noted above for the influent to the WRTP also included industrial wastewater from DELCORA's forty-five (45) Significant Industrial Users (SIUs). The industrial wastewater from forty-three (43) of DELCORA's SIUs is trucked directly to the WRTP and is discharged downstream of all CSOs into the combined sewer flow prior to the plant's influent sampling location. Consequently, the historical sampling data for the influent to the plant detected twenty-eight (28) industrial-type chemicals from these SIUs that are not normally associated with sanitary sewage or combined sewer overflows. Since the trucked-in industrial wastewater is discharged directly to the WRTP, it is not able to migrate back into the combined sewer system and, therefore, this industrial wastewater cannot be

discharged from any of DELCORA's CSOs. However, as part of the due diligence to address all possible POCs, the 28 industrial chemicals that were detected in the historical sampling of the plant influent were added onto an expanded list of Parameters Considered.

DELCORA actively maintains an Industrial Pretreatment program, and all of its industrial users are controlled by the sewer use regulations, Resolution No. 91-03, "The DELCORA Standards, Rules and Regulations," and the Local Limits, Resolution No. 95-11. In addition, all Significant and/or Categorical Industrial Users are further controlled by a permit, which is issued for not more than four (4) years. Each SIU is reviewed to determine how its wastewater is conveyed to the treatment plant. The only two (2) SIUs that discharge into the CSS, are commercial laundries with relatively benign wastewater compared to some of the truly industrial facilities that truck their wastewater to the WRTP. All of the parameters that are required to be analyzed by these commercial laundries in their wastewater based on their permit requirements were confirmed to be on the expanded list of the Parameters Considered. The two SIUs that discharge directly into DELCORA's combined sewer system are listed in Table 3-11 below.

Table 3-11: Industrial Users Discharging into DELCORA's Combined Sewer System

ID No	Permit #	Industry	Activity	Site Address	Discharge Route
W1	1DE-01-02	Ace Linen Service, Inc.	Laundry Service	3120 W. 6th St., Chester, PA 19013	Flows to Booth St. Interceptor to Delaware Interceptor to WRTP
W32	1DE-01-12	Delco Linen	Laundry Service	2626 W. 4th St., Chester, PA 19013	To 36-inch brick sewer on 4th St., to 48-inch brick sewer on Townsend St., to CSO Regulator #005, to Delaware River Interceptor, to WRTP

To help eliminate from the expanded list of the Parameters Considered the industrial chemicals that were detected as a result of the SIUs discharging to the WRTP, it was determined that additional wet weather sampling at the CSOs was required as noted in Section 3.4.2. The purpose of the additional sampling was to verify and confirm that the industrial-type chemicals not normally associated with CSOs that were detected in the historical sampling of the plant influent were in fact actually from the trucked-in industrial wastewater and not a part of the normal flow within the CSS that might overflow at a CSO. The CSO sampling results were used to screen non-detected parameters from the list of the Parameters Considered.

Review of the November 19th and December 1st, 2015 additional sampling results allows for shortening of the list of the Parameters Considered as possible POCs by screening those parameters that were introduced from the historical sampling of the plant influent that included the trucked-in industrial wastewater. The additional sampling results more accurately reflect the actual characteristics of the wastewater discharged at the CSOs, than does the historical data at the plant influent since the trucked-in industrial wastewater only goes into the plant and does not enter into the CSS. Therefore, if a parameter on the expanded Parameters Considered list was

not detected in the November and December 2015 wet weather sampling of the CSOs, those parameters were not considered further as POCs.

3.7 Methodology for Identification of the Pollutants of Concern List

Once the Parameters Considered list was narrowed using the November/December 2015 additional sampling results at the CSOs, the parameters remaining on the narrowed list of Parameters Considered were further evaluated to determine if they are Pollutants of Concern, or Parameters of Potential Concern (POPC). A parameter is considered a "Pollutant of Concern" for a water body if more than 10% of the samples exceeded the applicable water quality standard. This criteria is based on guidance provided by the USEPA, which recommends a "greater than 10% exceedance percentage" for determining that waters only partially meet their designated use for aquatic life support. A parameter is considered a "Parameter of Potential Concern" if 2 – 10% of the samples exceeded the water quality standard.

Water quality data for the parameters on the narrowed Parameters Considered list were collected from the STORET data repository for the one-year period from September 1, 2014 to September 1, 2015, from the water quality monitoring stations on each of the three receiving water bodies as noted in Section 3.5.1.

The segments of the Delaware River, Chester Creek and Ridley Creek have unique water quality standards that apply to them depending on the regulating authority, their designated uses, and the specific location within the waterbody. The maximum concentrations detected for each of the Parameters Considered were compared against the applicable surface water quality standards to determine which parameters were exceeding their standards. Attachment I in the List of Attachments provides a table with the final Parameters Considered list for each of the three receiving water bodies for which there is a water quality standard. The Delaware River was broken down into two tables; one for the Delaware River upstream of R.M 81.8 ("upper Delaware") and one for the Delaware River downstream of R.M 81.8 ("lower Delaware") based on the Water Contact Recreation designated use for the Delaware River below R.M. 81.8 and the more stringent requirements associated with primary contact.

The receiving stream water quality data from the USEPA STORET data warehouse was compared against the applicable WQS to check for exceedances. Both the acute and chronic conditions for the Parameters Considered were compared to the WQS, where applicable, to determine if there were exceedances. In addition to listing the Parameters Considered for each receiving water body, the table in Attachment I list the applicable water quality standards for each of the receiving water bodies, and identifies those parameters were the STORET sample data exceeded the water quality standards.

A flowchart was created to help illustrate the decision-making methodology used for developing the Pollutants of Concern list. The flowchart represents the process used for answering five (5) screening questions about the Parameters Considered in order to determine if a parameter is to be

considered a Pollutant of Concern, a Parameter of Potential Concern, or neither. The 5 screening questions for each Parameter Considered are:

1. Does a Water Quality Standard Exist for the parameter?
2. Do the available data indicate impairment exists and the impairment involves pollutants associated with CSOs?
3. Do greater than 10% of the samples for the receiving water body exceed the WQS?
4. Do 2% - 10% of the samples for the receiving water body exceed the WQS?
5. Was the parameter detected in the additional sampling of the CSOs?

Figure 3-3 presents the Methodology Flowchart used for developing the list of POCs and POPCs, and the following subsections provide additional details about the methodology used to answer the 5 screening questions.

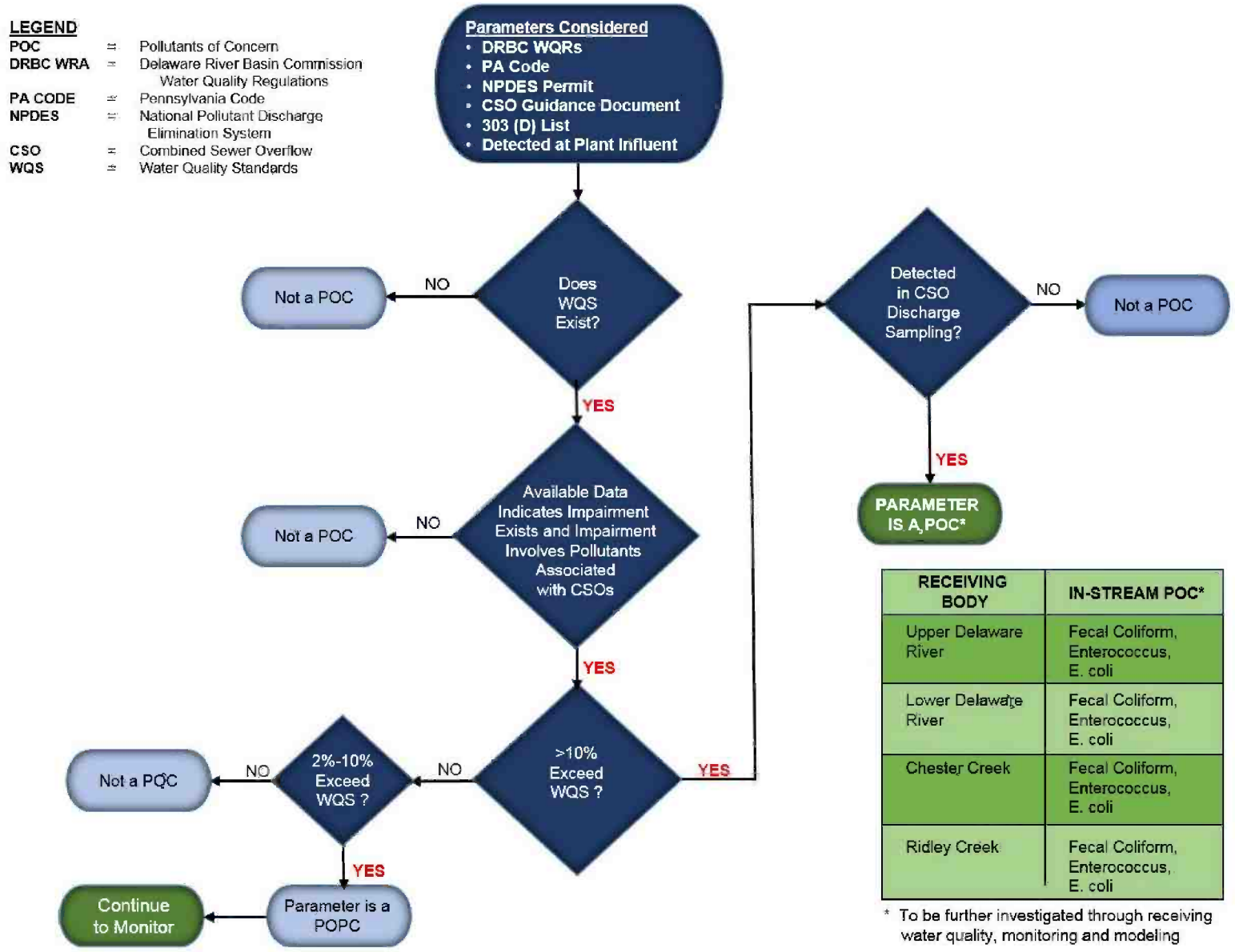
3.7.1 Screening of Parameters with No Water Quality Standard

The Methodology Flowchart for POC and POPC Determination shows that the first step is to determine if a Parameter Considered has an applicable PA State or DRBC water quality standard. If a parameter does not have an applicable water quality standard, there is no standard to exceed. Therefore, those parameters without a water quality standard are not considered further as a POC or a POPC. These include many of the Parameters Considered.

As noted previously in Section 3.1.2, the USEPA's CSO Guidance document states that receiving water monitoring should include identified parameters of concern and these typically include those previously identified for combined sewage and CSO monitoring:

- pH
- BOD
- TDS
- TSS
- Nutrients
- Metals
- Indicator bacteria

A number of the above listed parameters were screened as not a POC or POPC because they do not have an applicable surface water quality standard for the Delaware River, Chester Creek, or Ridley Creek. These include the parameters of BOD/CBOD, TDS and TSS, and the nutrients nitrate, nitrite, phosphorus, and TKN.



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

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Figure 3-3
METHODOLOGY FLOWCHART FOR POC AND POPC DETERMINATION

The table of the final Parameters Considered in Attachment I shows in gray-highlighting those Parameters Considered that were screened-out as not being a POC because they do not have an applicable water quality standard. Of the 76 Parameters Considered, 25 were removed from further consideration because they do not have an applicable water quality standard.

3.7.2 Screening of Parameters Causing Impairment and that are Associated with CSOs

For the 51 Parameters Considered that do have an applicable water quality standard, the Methodology Flowchart shows that the second screening decision is to determine if existing water quality data indicate impairment of the receiving water bodies exists and the impairment involves pollutants associated with CSOs. The inclusion of this determination comes directly from the requirements of the Consent Decree as noted in Section 3.1.1.

"Impairment" of a receiving water body is "indicated" to exist in one of two ways. First, the receiving water body is considered impaired for a particular parameter if the parameter appears in the 2014 PA Integrated Water Quality & Assessment Report (303(d) List). The PA Integrated Report identifies surface water bodies that are not attaining their designated and existing uses as "impaired".

Secondly, for the purpose of this report, a receiving water body is also considered impaired for a parameter if any of the available sampling data for that parameter in the water body shows that there had been an exceedance of the applicable water quality standard. Those parameters that showed exceedances of the WQS and that may be associated with CSOs were evaluated further to determine if they should be considered as a POC.

The 2014 PA Integrated Water Quality & Assessment Report shows the Delaware River to be impaired for Fish Consumption by PCBs from an unknown source, and there is a PCB TMDL on the Delaware River stretching far upstream to Trenton, NJ. While the Delaware River is impaired from PCBs, the PCBs are not normally associated with CSOs. Given this reason, and the fact that the PCB impairment begins well upstream of DELCORA's service area – PCBs were screened as not being a POC. Furthermore, the additional CSO sampling results from November/December 2015 in Attachment I show that PCBs were found to be at a lower concentration than the Reporting Detection Limit (RDL). For this additional reason it was determined that PCBs are not associated with DELCORA's CSO discharges.

For the Chester Creek and Ridley Creeks, the 2014 PA Integrated Water Quality & Assessment Report shows that both of the creeks are impaired for Aquatic Life from siltation, with Urban Runoff/Storm Sewers identified as the source. The impairment of the Chester Creek and Ridley Creek by siltation primarily occurs upstream of DELCORA's service area as shown in Figure 3-1. The term "Siltation" is not defined in the 2014 PA Integrated Water Quality & Assessment Report, but through various sources could be defined as:

"the pollution of water by fine particulate terrestrial clastic material, with a particle size dominated by silt or clay. It refers both to the increased concentration of suspended sediments, and to the increased accumulation (temporary or permanent) of fine sediments on bottoms where they are undesirable. Siltation is most often caused by soil erosion or sediment spill."

There is not a water quality standard for "siltation", however, siltation can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. For this reason "Turbidity" was reviewed further as a surrogate for siltation to determine if it might be considered as a POC. Per available USEPA STORET data, the Turbidity concentrations on all of the three receiving water bodies were found to be below the WQS (see Attachment I) and therefore siltation was screened-out as not being a POC.

3.7.3 Screening of Parameters where > 10% of Observations Exceed WQS

The concentrations of those Parameters Considered that were detected within the receiving water bodies from USEPA's STORET data for the years 2010 - 2015 were compared to the applicable water quality standards to determine if a Parameter Considered should be viewed as a Pollutant of Concern.

If 10% or more of the total number of samples for a Parameter Considered listed in Attachment I exceeded the WQS, then the parameter was further evaluated to see if it was detected in the CSO discharges.

If 2% - 10% of the total number of samples for a Parameter Considered exceeded the WQS, then the parameter was considered a Parameter of Potential Concern. The concentrations of the Parameters of Potential Concern will continued to be monitored over time, and re-evaluated should the monitoring show their concentrations to increase over time.

Per the flowchart, if 2% - 10% of the total number of samples for a Parameter Considered do not exceed the WQS, then the parameter was not considered to be a POC or POPC.

3.7.4 Screening of Parameters Not Detected at CSO Discharges

The Methodology Flowchart shows that additional analysis is required for those parameters that exceeded the water quality standards for the receiving water bodies in more than 10% of the samples. For those parameters, the concentration of the parameter detected in the November/December 2015 sampling of the CSO discharges was reviewed.

If the parameter was "Not Detected (ND)" or was below the Reporting Detection Limit (see Attachment F) in the November/December 2015 CSO sampling results, it indicates that the parameter was not observed in DELCORA's CSO discharges. In this case, the parameter is not considered to be a POC. In this manner, the industrial-type chemicals that had been originally

detected in the historic sampling results from the influent to the WRTP were able to be removed from further consideration as a POC or POPC.

If the parameter was detected within the November/December 2015 CSO sampling results, it indicates that the parameter was in DELCORA's CSO discharge. In these cases the parameter is considered as a POC, and is to be further investigated through additional receiving water quality monitoring and modeling.

3.8 Discussion of the Pollutants of Concern and Parameters of Potential Concern

The Parameters Considered shown in Attachment I were analyzed against the WQS. The parameters that exceeded the WQS in the receiving bodies are shown in the summary table in Attachment J. The summary table also provides information on the number of observations for each parameter as well as the total number of exceedances for each parameter in all the receiving water bodies from 2010 to 2015. The POCs are shown in red highlight within the table, and POPCs are shown in yellow highlight.

The following discussion of the individual parameters is focused only on those parameters shown in the tables in Attachments I and J to be either a POC or a POPC.

3.8.1 Fecal Coliform Bacteria

Fecal coliform bacteria are the most common microbiological contaminants of natural waters, and are used to indicate contamination by human pathogens. Fecal coliform live in the digestive tracks of warm-blooded animals, including humans, and are excreted in the feces. The DRBC collects fecal coliform bacteria data at Stations 332049 and 892062 on the Delaware River. Additionally, DELCORA sampled the Chester and Ridley Creeks in 2010 for fecal coliform concentrations. The 2010 receiving water sampling results for the Chester and Ridley Creeks are presented in Attachment G.

There are no PA Code, Chapter 93 fecal coliform bacteria water quality standards for streams designated WWF, MF or TSF with no other qualifiers. However, the DRBC's Delaware River Zone 4 has a Stream Quality Objective for fecal coliform of no more than 770 CFU/100 mL for the section upstream of R.M. 81.8, which includes the tidal portions of the Chester and Ridley Creeks, and 200 CFU/100 mL for the section of the river downstream of R.M. 81.8. The tidal extent on Chester Creek and Ridley Creek is shown on Figure 3-1. Compliance with the DRBC Stream Quality Objectives for fecal coliform bacteria is based on a geometric average of samples taken at such frequency and location as to permit valid interpretation.

Of the six samples taken by DELCORA in 2010 on the Ridley Creek at RC1 (upstream) and RC3 (downstream), four show exceedances of the Stream Quality Objective for fecal coliform. These values indicate that the Ridley Creek was not meeting the DRBC Stream Quality Objective, however, more sampling is recommended to further confirm these results.

Of the six samples taken by DELCORA on the Chester Creek at CC1 (upstream) and CC3 (downstream), four show exceedances of the Stream Quality Objective for fecal coliform. These values indicate that the Chester Creek was also not meeting the DRBC WQS at that time, however as with the Ridley Creek, more sampling is recommended to further confirm these results.

The table in Attachment I shows that the available data indicates that there were no exceedances observed of fecal coliform in the Delaware River.

Given that more than 10% of the fecal coliform samples for both the Ridley and Chester Creeks exceeded the WQS, fecal coliform should be considered as a POC for the two creeks. However, although the existing data for the Delaware River has demonstrated that there were no exceedances observed of fecal coliform, since fecal coliform is a primary pollutant typically associated with CSO discharges it has been decided to also include it as a POC for the Delaware River in the interest of minimizing potential impacts to human health and the environment.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the upper Delaware River (Upstream of R.M. 81.8)
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the Chester Creek
  - Fecal Coliform considered to be a Pollutant of Concern.
- For the Ridley Creek
  - Fecal Coliform considered to be a Pollutant of Concern.

3.8.2 Enterococcus Bacteria

Enterococcus is a second bacteria genus that also resides in the digestive system of humans and animals, and that is used to indicate the presence of human pathogens. They have been long recognized as important human pathogens and are becoming increasingly so.

Unlike fecal coliform, the DRBC does not collect enterococcus bacteria data at Stations 332049 and 892062 on the Delaware River, and DELCORA did not collect samples for enterococcus bacteria in 2010 as it did for fecal coliform. Enterococcus are used as an indicator bacteria for marine waters.

As with fecal coliform, there are no PA Code, Chapter 93 water quality standards for enterococcus bacteria for streams designated WWF, MF or TSF with no other qualifiers. However, the DRBC's Delaware River Zone 4 has a WQS for enterococcus bacteria of no more

than 88 CFU/100 mL for the section upstream of R.M. 81.8, which includes tidal portions of the Chester and Ridley Creeks, and 33 CFU/100 mL for the section of the river downstream of R.M. 81.8. Compliance with the DRBC WQS for enterococcus bacteria is based on a geometric average of samples taken at such frequency and location as to permit valid interpretation.

Very little existing data was available for enterococcus bacteria concentrations in the Delaware River, Chester Creek and Ridley Creek in the area of DELCORA's CSO discharges. However, enterococcus bacteria and fecal coliform bacteria are similar to each other, they are both produced in the human digestive tract, and are both considered to be parameters typically associated with CSOs. For this reason it was decided to also include enterococcus bacteria as a POC at the same locations identified for fecal coliform bacteria, which includes all three of DELCORA's receiving water bodies.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - Enterococcus considered to be a Pollutant of Concern.
- For the upper Delaware River (Upstream of R.M. 81.8)
  - Enterococcus considered to be a Pollutant of Concern.
- For the Chester Creek
  - Enterococcus considered to be a Pollutant of Concern.
- For the Ridley Creek
  - Enterococcus considered to be a Pollutant of Concern.

3.8.3 Escherichia Coli Bacteria

Escherichia coli (also known as E. coli) is a facultative anaerobic, rod-shaped bacterium of the genus *Escherichia* that is commonly found in the lower intestine of warm-blooded organisms. E. coli is expelled into the environment within fecal matter. Fecal material can enter the environment from many sources including wastewater treatment plants, CSO discharges, livestock or poultry manure, sanitary landfills, septic systems, sewage sludge, pets and wildlife.

E. coli was not listed as an initial Parameter Considered because it is listed in the applicable reference sources from the PA Code or DRBC. However, in consultation with the PADEP it is understood that Enterococcus bacteria could be replaced with E. coli in future regulations (on the anticipation that national standards for E. coli will be adopted in Pennsylvania) and therefore E. coli is included as a POC for all the receiving water bodies.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - E. coli considered to be a Pollutant of Concern.

- For the upper Delaware River (Upstream of R.M. 81.8)
  - E. coli considered to be a Pollutant of Concern.

- For the Chester Creek
  - E. coli considered to be a Pollutant of Concern.

- For the Ridley Creek
  - E. coli considered to be a Pollutant of Concern.

3.8.4 Metals

During the data analysis, it was detected that some metal concentrations, in the receiving water bodies, exceeded the water quality standards. These metals include Aluminum, Copper, Iron, Lead, and Mercury. The appropriate control measures for metals from CSO discharges are the continued implementation of and compliance with the Nine Minimum Controls (NMCs) as required by DELCORA's NPDES permit.

The NPDES permit requires DELCORA to submit an annual report each year to the PADEP, with appropriate documentation demonstrating the continued implantation of and compliance with the NMC required on a system wide basis.

Additionally, the USEPA's guidance document *Guidance for Nine Minimum Controls* states;

> *"…municipalities should immediately implement best available technology economically achievable (BAT) or best conventional pollutant control technology (BCT). At a minimum, BAT/BCT should include the nine minimum controls, which are determined on a best professional judgement (BPJ) basis by the NPDES permitting authority".*

For the removal of metals, the most applicable Nine Minimum Controls include the maximum use of the collection system for storage, the review and modification of pretreatment requirements to ensure that CSO impacts are minimized, maximization of flow to the POTW for treatment and pollution prevention programs (such as street sweeping) to reduce these contaminants in the CSOs.

Therefore, metals are not considered to be POCs.

3.9 Summary for Pollutants of Concern

In the effort to identify Pollutants of Concerns related to its CSO discharges, DELCORA has reviewed the 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) List), the historic sampling data for the influent to the Western Regional Treatment Plant, the USEPA's STORET Data repository, historic water quality sampling data from the Chester and

Ridley Creeks, and additional sampling results from the CSOs from November and December of 2015.

Three (3) POCs were determined. These include Fecal Coliform bacteria, Enterococcus bacteria and E. coli bacteria. These three POCs are parameters typically associated with CSO discharges. The list of POCs is summarized in Table 3-12 with their respective exceedance percentage (%) for each of the receiving water bodies. The concentrations of these identified POCs in the Delaware River, Chester Creek and Ridley Creek will be further investigated through receiving water quality monitoring and modeling.

No Parameters of Potential Concern were identified at this time.

Table 3-12: List of Pollutants of Concern (POC)

No.	Upper Delaware River		Lower Delaware River		Chester Creek		Ridley Creek	
Pollutants of Concern (>10% of observed samples exceed WQS)								
1	Fecal Coliform[b]	100%	Fecal Coliform[b]	100%	Fecal Coliform[a],[b]	100%	Fecal Coliform[a],[b]	100%
2	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%
3	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%

[a] Based on historical sampling conducted in 2010 upstream and downstream of CSO outfalls only on Chester and Ridley Creeks.

[b] Fecal Coliform and Enterococcus are listed as POCs due to both being parameters typically associated with CSOs.

[c] DRBC regulations are available for Enterococcus and it is typically associated with CSOs and therefore it is included as a POC. However, in consultation with PADEP Enterococcus could be replaced with E. coli bacteria in the future (based on the anticipation that national standards on E. coli will be adopted in Pennsylvania) and therefore E.coli is also included as a POC.

Section 4 References

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ATTACHMENT A

Letters with Regulatory Agencies Regarding Sensitive Areas

DELCORA CSO LTCP
Sensitive Areas Contact Sheet

No.	Sensitive Area Item	Contact	Title	Agency	Street	City	State	Zip	Phone Number	Date Sent	Response Date
1	Endangered Species	Robert Anderson	Fish & Wildlife Biologist	US Fish and Wildlife Agency	110 Radnor Road, Suite 101	State College	PA	16801-7987	814-237-4090 x7447	10/28/2015	11/2/2015
2	Threatened and Endangered Birds	Brendalee Phillips	Wildlife Biologist	US Fish and Wildlife - John Heinz NWR Birds	8601 Lindbergh Blvd.	Philadelphia	PA	19153	215-365-3118 x119	10/29/2015	No Comments
3		Jennifer Fields	Program Manager jefields@pa.gov	PA DEP	2 East Main Street	Norristown	PA	19401	484-250-5192	10/29/2015	11/17/15 - phone call
4		Steve Tambini	Executive Director	Delaware River Basin Commission (DRBC)	25 State Police Drive	West Trenton	NJ	08628-0360	609-883-9500 x203	10/29/2015	No Comments
5	Threatened and Endangered Birds	Patti Barber	Endangered Bird Biologist	PA Game Commission	2001 Elmerton Ave	Harrisburg	PA	17110-9797	717-303-4482	10/29/2015	12/31/15 return call
6	Threatened and Endangered Birds	Ian Gregg	Wildlife Biologist	PA Game Commission	2001 Elmerton Ave	Harrisburg	PA	17110-9797	814-422-8239	10/29/2015	No Response
7		Carol F. McCabe, Esq.	Chair	PA Environmental Council	1315 Walnut Street, Suite 532	Philadelphia	PA	19107	215-545-4570	10/29/2015	No Response
8	Primary Contact Areas	Brian Byrnes	Executive Director	Chester Ridley Crum Watersheds Association	P.O. Box 227	Gradyville	PA	19039	610-359-1440	10/29/2015	11/23/15 - called
9		David Chanda	Director Fish and Wildlife	New Jersey Department of Environmental Protection (NJDEP)	P.O. Box 420 501 E State Street, 3rd Floor	Trenton	NJ	08625	609-292-9410	10/29/2015	No Response
10	Atlantic and Shortnose Sturgeon, river herring, shad	Matt Fisher	Director Fish and Wildlife	Delaware Department of Natural Resources and Environmental Control (DNREC)	89 Kings Highway	Dover	DE	19901	302-735-8663	10/29/2015	11/30/2015
11	Delaware River and tributaries	John Buzzar Kathy Gipe	Fisheries Biologist	PA Fish and Boat Commission (PFBC)	1601 Elmerton Ave	Harrisburg	PA	17110	717-705-7800 610-847-5983 814-359-5186	10/29/2015	12/22/2015 Follow up 3/11/16 and 5/2/16
12	Freshwater Mussels	Dr. Danielle Kreeger	Science Director	Patnership for the Delaware Estuary (PDE)	110 S Poplar Street, Suite 202	Wilmington	DE	19801	302-655-4990 x 104	10/29/2015	11/25/2015

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October 29, 2015

Carol F. McCabe, Esquire
PA Environmental Council
1315 Walnut Street
Suite 532
Philadelphia, PA 19107

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Ms. McCabe:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

Sensitive Areas are defined by the United States Environmental Protection Agency (USEPA) Federal Register Combined Sewer Overflow (CSO) Control Policy and the US EPA Guidance for Long Term Control Plan as follows:

- Outstanding National Resource Waters (ONRW)
- National Marine Sanctuaries
- Waters with threatened or endangered species and their habitat
- Waters with primary contact recreation (i.e. beaches, boat ramps, boat launches, etc.)
- Public drinking water intakes or their designated protection areas
- Shellfish beds

USEPA requirements indicate that sensitive areas are given the highest priority during the development of technical alternatives.

This letter is being submitted to your agency as a formal request for information that your agency may have on sensitive areas within Delaware County, PA. Specifically, we are interested in sensitive areas located within the area of study as shown in GREEN on the attached map. If portions of the study area meet the above sensitive area criteria, we request that you provide the following information:

- Complete list of identified Sensitive Areas;
- Narrative description of how the sensitive area criteria listed above applies to the study area;
- Map of specific locations within our study area identifying the specific sensitive areas; and
- Any additional information you deem appropriate.

DELCORA is under a Consent Decree to submit this study to USEPA in February 2016. In order to meet project milestones, we respectfully request you provide a response within 30 days of receipt of this letter, no later than November 23, 2015. We appreciate your cooperation and assistance in completing this study. Should you need any additional information, please feel free to contact me at (215) 553-7919 or Julia Spicher at (215) 553-7926.

Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
Michael Hope, Greeley and Hansen
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October 29, 2015

Ms. Patti Barber
PA Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Ms. Barber:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

Sensitive Areas are defined by the United States Environmental Protection Agency (USEPA) Federal Register Combined Sewer Overflow (CSO) Control Policy and the US EPA Guidance for Long Term Control Plan as follows:

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- Shellfish beds

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Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
Michael Hope, Greeley and Hansen
Julia Spicher, Greeley and Hansen

GREELEY AND HANSEN

1700 Market Street, Suite 2130
Philadelphia, Pennsylvania 19103
p 215 563 3460
f 215 563 1139
www.greeley-hansen.com

October 29, 2015

Ms. Jennifer Fields
Pennsylvania Department of Environmental
Protection
2 East Main Street
Norristown, PA 19401

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Ms. Fields:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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Greeley and Hansen LLC

Marlene Finizio
Project Manager

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October 29, 2015

Mr. Ian Gregg
PA Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Gregg:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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October 29, 2015

Mr. Steven Tambini
Executive Director
Delaware River Basin Commission
25 State Police Drive
West Trenton, NJ 08628-0360

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Tambini:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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Marlene Finizio
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October 29, 2015

Ms. Brendalee Phillips
US Fish and Wildlife - John Heinz
NWR Birds
8601 Lindbergh Boulevard
Philadelphia, PA 19153

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Ms. Phillips:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
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Julia Spicher, Greeley and Hansen

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
110 Radnor Road, Suite 101
State College, Pennsylvania 16801-4850

November 2, 2015

Marlene Finizio
Greeley and Hansen LLC
1700 Market Street, Suite 2130
Philadelphia, PA 19103

RE: USFWS Project #2016-0026
PNDI Large Project

Dear Ms. Finizio:

This responds to your letter received on October 9, 2015, requesting information about federally listed and proposed endangered and threatened species within the area affected by the development of a Long Term Control Plan for the Delaware County Regional Authority. The project area is located in Delaware County, Pennsylvania. The following comments are provided pursuant to the Endangered Species Act of 1973 (Act, 87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), the Migratory Bird Treaty Act (MBTA, 16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat. 755, as amended), and the Bald and Golden Eagle Protection Act (BGEPA, 16 U.S.C. 668-668d).

Federally Listed Species

There are a number of federally listed species that are either known to occur, or have the potential to occur, in the proposed study area. We describe general information about these species, but without more specific project information and locations are not able to provide additional information regarding potential avoidance or conservation measures. We fully support your planning efforts and desires to protect sensitive areas and overall water quality. Let us know how we can be of additional assistance.

No critical habitat has been designated for any of the below listed species, at this time.

Bog turtle

The project is within the known range of the bog turtle (*Clemmys muhlenbergii*), a species that is federally listed as threatened. Bog turtles inhabit shallow, spring-fed fens, sphagnum bogs, swamps, marshy meadows, and pastures characterized by soft, muddy bottoms; clear, cool, slow-flowing water, often forming a network of rivulets; high humidity; and an open canopy. Bog

turtles usually occur in small, discrete populations occupying suitable wetland habitat dispersed along a watershed. The occupied "intermediate successional stage" wetland habitat is usually a mosaic of micro-habitats ranging from dry pockets, to areas that are saturated with water, to areas that are periodically flooded. Some wetlands occupied by bog turtles are located in agricultural areas and are subject to grazing by livestock. More information on this species can be found at: http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=C048

Indiana bat

The project area is within the range of the federally endangered Indiana bat (*Myotis sodalis*). Indiana bats hibernate in caves and abandoned mines during the winter months (November through March), and use a variety of forested upland and wetland habitats during the spring, summer, and fall. Indiana bats usually roost in dead or living trees with exfoliating bark, crevices or cavities. Female Indiana bats form nursery colonies under the exfoliating bark of dead or living trees, such as shagbark hickory, black birch, red oak, white oak, and sugar maple, in upland or riparian areas. More information on this species can be found at: http://www.fws.gov/MIDWEST/endangered/mammals/inba/index.html

Northern long-eared bat

The project is within the known range of the northern long-eared bat (*Myotis septentrionalis*), a species that is federally listed as threatened. Northern long-eared bats hibernate in caves and abandoned mines during the winter months, and use a variety of forested upland and wetland habitats during the spring, summer, and fall. More information on this species can be found at: http://www.fws.gov/midwest/endangered/mammals/nlba/index.html

Atlantic sturgeon

The project is within the known range of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), a species that is federally listed as threatened. The Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish. Adult sturgeon spawn in freshwater in the spring and early summer and migrate into "estuarine" and marine waters where they spend most of their lives. The Atlantic sturgeon is under the jurisdiction of the National Marine Fisheries Service (NMFS). Please contact NMFS regarding this species or visit their website at: http://www.nmfs.noaa.gov/pr/species/fish/atlanticsturgeon.htm#status

Shortnose sturgeon

The project is within the known range of the Shortnose sturgeon (*Acipenser brevirostrum*), a species that is federally listed as endangered. The shortnose sturgeon is the smallest of the three sturgeon species that occur in eastern North America. The shortnose sturgeon is anadromous, living mainly in the slower moving riverine waters or nearshore marine waters, and migrating periodically into faster moving fresh water areas to spawn. The shortnose sturgeon is under the jurisdiction of the NMFS. Please contact NMFS regarding this species or visit their website at: http://www.nmfs.noaa.gov/pr/species/fish/shortnosesturgeon.htm

In cases where adverse effects to federally listed species cannot be avoided, further consultation with the Service would be necessary to avoid potential violations of section 9 (prohibiting "take" of listed species) and/or section 7 (requiring federal agencies to consult) of the Endangered Species Act. Information about the section 7 and section 10 consultation processes (for federal and non-federal actions, respectively) can be obtained by contacting this office or accessing the Service's Endangered Species Home Page (http://endangered.fws.gov).

Bald and golden eagles

Bald eagles (*Haliaeetus leucocephalus*) are known to nest in the vicinity of the project area. While the bald eagle has been removed from the Federal list of threatened and endangered species (August 8, 2007; 72 FR 37346), the bald eagle along with the golden eagle (*Aquila chrysaetos*) continues to be protected under the BGEPA and MBTA. Both the BGEPA and the

MBTA prohibit take as defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, disturb, or otherwise harm eagles, their nests, or their eggs." Under the BGEPA, "disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: (1) injury to an eagle; (2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

We recommend that you evaluate the project type, size, location and layout in light of the National *Bald Eagle Management Guidelines* to determine whether or not bald eagles might be disturbed as a direct or indirect result of this project. If it appears that disturbance may occur, we recommend that you consider modifying your project consistent with the Guidelines. These guidelines, as well as additional eagle information, are available at http://www.fws.gov/northeast/EcologicalServices/eagle.html To assist you in making a decision regarding impacts to bald eagles, a screening form can be found at http://www.fws.gov/northeast/pafo/bald_eagle.html.

Migratory Birds

The Service is the principal Federal agency charged with protecting and enhancing populations and habitat of migratory bird species. The MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the MBTA has no provision for authorizing incidental take, the Service recognizes that some birds may be killed even if all reasonable measures to avoid take are implemented.

The potential exists for avian mortality if there is habitat destruction and alteration within the project boundaries. Site-specific factors that should be considered in project siting to avoid and minimize the risk to birds include avian abundance; the quality, quantity and type of habitat; geographic location; type and extent of bird use (e.g. breeding, foraging, migrating, etc.); and landscape features. Please review the enclosed information for general recommendations for avoiding and minimizing impacts to migratory birds within and around the project area. Please

be aware that since these are general guidelines, some of them may not be applicable to the current project design or they may have already been included in the project design.

The project area is located in the vicinity of the Important Bird Area (IBA) known as Upper Ridley-Crum Creek. IBAs are designated by the Pennsylvania Ornithological Technical Committee. They are the most critical regions in the Commonwealth for conserving bird diversity and abundance, and are the primary focus of Audubon Pennsylvania's conservation efforts. To find out more information about this IBA, including which bird species breed there, visit: http://netapp.audubon.org/IBA/State/US-PA

Please contact Brian Scofield of my staff at 814-234-4090 if you have any questions or require further assistance regarding this matter.

Sincerely,

Lora L. Zimmerman
Field Office Supervisor

Enclosure

Adaptive Management Practices for Conserving Migratory Birds

The Fish and Wildlife Service is the principal Federal agency charged with protecting and enhancing populations and habitat of migratory bird species. The Migratory Bird Treaty Act (MBTA, 16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat. 755, as amended) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. While the MBTA has no provision for authorizing incidental take, the Service recognizes that some birds may be killed even if all reasonable measures to avoid take are implemented. Unless the take is authorized, it is not possible to absolve individuals, companies or agencies from liability (even if they implement avian mortality avoidance or similar conservation measures). However, the Office of Law Enforcement focuses on those individuals, companies, or agencies that take migratory birds with disregard for their actions and the law.

The potential exists for avian mortality from habitat destruction and alteration within the project boundaries. Site-specific factors that should be considered in project siting to avoid and minimize the risk to birds include avian abundance; the quality, quantity and type of habitat; geographic location; type and extent of bird use (*e.g.* breeding, foraging, migrating, etc.); and landscape features.

We offer the following recommendations to avoid and minimize impacts to migratory birds within and around the project area:

1. Where disturbance is necessary, clear natural or semi-natural habitats (*e.g.*, forests, woodlots, reverting fields, shrubby areas) and perform maintenance activities (*e.g.*, mowing) between September 1 and March 31, which is outside the nesting season for most native bird species. Without undertaking specific analysis of breeding species and their respective nesting seasons on the project site, implementation of this seasonal restriction will avoid take of most breeding birds, their nests, and their young (*i.e.*, eggs, hatchlings, fledglings).

2. Minimize land and vegetation disturbance during project design and construction. To reduce habitat fragmentation, co-locate roads, fences, lay down areas, staging areas, and other infrastructure in or immediately adjacent to already-disturbed areas (*e.g.*, existing roads, pipelines, agricultural fields) and cluster development features (*e.g.*, buildings, roads) as opposed to distributing them throughout land parcels. Where this is not possible, minimize roads, fences, and other infrastructure.

3. Avoid permanent habitat alterations in areas where birds are highly concentrated. Examples of high concentration areas for birds are wetlands, State or Federal refuges, Audubon Important Bird Areas, private duck clubs, staging areas, rookeries, leks, roosts, and riparian areas. Avoid establishing sizable structures along known bird migration pathways or known daily movement flyways (*e.g.,* between roosting and feeding areas).

4. To conserve area-sensitive species, avoid fragmenting large, contiguous tracts of wildlife habitat, especially if habitat cannot be fully restored after construction. Maintain

contiguous habitat corridors to facilitate wildlife dispersal. Where practicable, concentrate construction activities, infrastructure, and man-made structures (*e.g.*, buildings, cell towers, roads, parking lots) on lands already altered or cultivated, and away from areas of intact and healthy native habitats. If not feasible, select fragmented or degraded habitats over relatively intact areas.

5. Develop a habitat restoration plan for the proposed site that avoids or minimizes negative impacts to birds, and that creates functional habitat for a variety of bird species. Use only plant species that are native to the local area for revegetation of the project area.

If you have any questions regarding these measures, please contact Lora Zimmerman of the Pennsylvania Field Office located in State College, PA at 814-234-4090.

GREELEY AND HANSEN

1700 Market Street, Suite 2130
Philadelphia, Pennsylvania 19103
p 215 563 3460
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www.greeley-hansen.com

October 29, 2015

Mr. Brian Byrnes
Executive Director
Chester Ridley Crum Watersheds Association
38 Bishop Hollow Road
Newtown Square, PA 19073

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Byrnes:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
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October 29, 2015

Ms. Danielle Kreeger
Partnership for the Delaware Estuary
110 S. Poplar Street
Suite 202
Wilmington, DE 19801

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Ms. Kreeger:

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Greeley and Hansen LLC

Marlene Finizio
Project Manager

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Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
Michael Hope, Greeley and Hansen
Julia Spicher, Greeley and Hansen

Finizio, Marlene

From: Spicher, Julia
Sent: Friday, January 15, 2016 3:25 PM
To: Finizio, Marlene
Subject: FW: Sensitive Areas Study
Attachments: Sensitive Areas Study.docx

From: Kurt Cheng [mailto:kcheng@delawareestuary.org]
Sent: Tuesday, November 24, 2015 4:34 PM
To: Spicher, Julia <jspicher@greeley-hansen.com>
Cc: Danielle Kreeger <DKreeger@delawareestuary.org>
Subject: Sensitive Areas Study

Hi Julia,

On behalf of Dr. Danielle Kreeger, please find attached the sensitive areas study document. Let me know if you have any questions.

Thanks,

Kurt

--
Kurt Cheng
Shellfish Specialist

Partnership for the Delaware Estuary
110 South Poplar Street, Suite 202
Wilmington, DE 19801

302-655-4990 x107

www.delawareestuary.org

Sensitive Areas Study

Partnership for the Delaware Estuary has identified sensitive areas within the study area which are listed and described below along with a visual representation on the provided map. Additional information on the study area is also presented.

Sensitive Areas

- **Ridley Creek watershed**
- **Schuylkill River watershed**
- **Darby Creek mouth / John Heinz National Wildlife Refuge at Tinicum**

Ridley Creek watershed

Ridley Creek begins north of Delaware County and flows through the county and into the Delaware River. Healthy freshwater mussel populations comprised of the Eastern elliptio (*Elliptio complanata*) exist throughout the creek which warrants protection. Additionally, there are long term freshwater mussel monitoring studies within the creek. Therefore, the Ridley Creek watershed should be considered a sensitive area.

Schuylkill River watershed

The northeast section of Delaware County drains into the Schuylkill River which flows just east of the county. Freshwater mussel beds have been qualitatively identified and quantitatively surveyed within the Schuylkill River and include multiple species including the eastern elliptio, the alewife floater (*Anodonta implicata*), and the tidewater mucket (*Leptodea ochracea*). Surveys have also identified juvenile mussels in the river indicating the population is successfully reproducing.

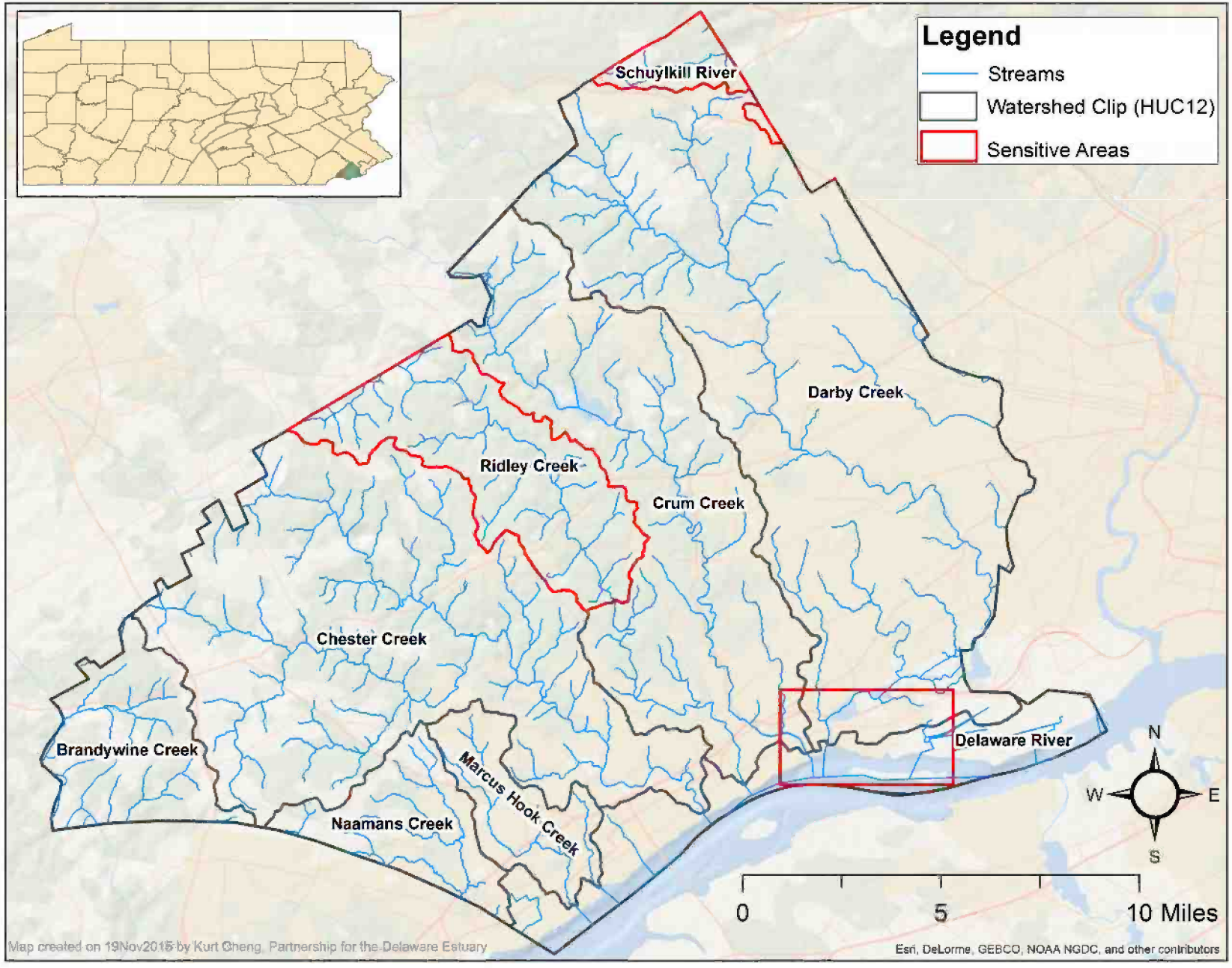
Darby Creek mouth / John Heinz National Wildlife Refuge at Tinicum

Access to Darby Creek is made possible via the Ridley Township Municipal Marina where boaters may access the Delaware River as well as the John Heinz National Wildlife Refuge at Tinicum. As well as serving as a primary contact for recreation, freshwater mussel surveys at the mouth of Darby Creek have yielded positive detections of the eastern elliptio and the alewife floater.

Although a few sensitive areas have been described above, it should be noted that Partnership for the Delaware Estuary and other organizations has only surveyed a portion of all streams in Delaware County. Historical data and museum records indicate that multiple species of freshwater mussels were found in Chester and Crum Creeks (Ortmann 1919). It is possible that additional freshwater mussel beds still exist in some streams that have not been properly surveyed. Attention should be paid to areas with hydrological connectivity to downstream sites that support freshwater mussels. In example, although outside of the highlighted study area, freshwater mussel populations as well as beds of submerged aquatic vegetation between Pennsylvania's coast and Little Tinicum Island may be impacted from waters draining the Darby Creek watershed.

Ortmann, A.E. 1919. A monograph of the naiades of Pennsylvania. Part III: Systematic account of the genera and species. Memoirs of the Carnegie Museum 8(1): xvi -385 + 21 plates.

Sensitive Areas in Delaware County, PA November 2015



GREELEY AND HANSEN

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October 29, 2015

Mr. John Buzzar
PA Fish and Boat Commission
1601 Elmerton Avenue
Harrisburg, PA 17110

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Buzzar:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

Sensitive Areas are defined by the United States Environmental Protection Agency (USEPA) Federal Register Combined Sewer Overflow (CSO) Control Policy and the US EPA Guidance for Long Term Control Plan as follows:

- Outstanding National Resource Waters (ONRW)
- National Marine Sanctuaries
- Waters with threatened or endangered species and their habitat
- Waters with primary contact recreation (i.e. beaches, boat ramps, boat launches, etc.)
- Public drinking water intakes or their designated protection areas
- Shellfish beds

USEPA requirements indicate that sensitive areas are given the highest priority during the development of technical alternatives.

This letter is being submitted to your agency as a formal request for information that your agency may have on sensitive areas within Delaware County, PA. Specifically, we are interested in sensitive areas located within the area of study as shown in GREEN on the attached map. If portions of the study area meet the above sensitive area criteria, we request that you provide the following information:

- Complete list of identified Sensitive Areas;
- Narrative description of how the sensitive area criteria listed above applies to the study area;
- Map of specific locations within our study area identifying the specific sensitive areas; and
- Any additional information you deem appropriate.

DELCORA is under a Consent Decree to submit this study to USEPA in February 2016. In order to meet project milestones, we respectfully request you provide a response within 30 days of receipt of this letter, no later than November 23, 2015. We appreciate your cooperation and assistance in completing this study. Should you need any additional information, please feel free to contact me at (215) 553-7919 or Julia Spicher at (215) 553-7926.

Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
Michael Hope, Greeley and Hansen
Julia Spicher, Greeley and Hansen

Pennsylvania Fish & Boat Commission
established 1866

Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823
814-359-5237

December 22, 2015

IN REPLY REFER TO
SIR# 45340

Greeley & Hansen
Marlene Finizio
1700 Market Street
Philadelphia, Pennsylvania 19103

RE: Species Impact Review (SIR) – Rare, Candidate, Threatened and Endangered Species
PNDI Search No.
Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Delaware County

Dear Ms. Finizio:

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search "potential conflict" or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish & Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish & Boat Code (Chapter 75), or the Wildlife Code.

Based on records maintained in the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files, the following rare or protected species are known from the vicinity of the project site:

Common Name (Scientific Name, PA Status)
Atlantic Sturgeon (*Acipenser oxyrinchus*, Endangered)
Shortnose Sturgeon (*Acipenser brevirostrum*, Endangered)
Eastern Redbelly Turtle (*Pseudemys rubriventris*, Threatened)

The Shortnose and Atlantic Sturgeon, which are listed by both Pennsylvania and the U.S. Fish and Wildlife Service/National Marine Fisheries Service, occur in the Delaware River. They are especially vulnerable to physical (dredging, rip-rap, etc.) and chemical (pH, dissolved oxygen, temperature, heavy metals, and organic contaminants) changes to the aquatic environment. Although the mobile adults of these protected fish species may be capable of moving from the project area, their spawning grounds (including eggs, larvae, and immature fish) are vulnerable to burial, crushing by equipment, and siltation

from construction projects. In-stream activities during their spawning period may also disrupt the adults' reproductive behavior. Both Atlantic Sturgeon and Shortnose Sturgeon adults and juveniles may also forage and migrate through the proposed project area and could be adversely impacted by the proposed project.

The Eastern Redbelly Turtle is one of Pennsylvania's largest native aquatic turtles. This turtle species is known to inhabit relatively large, deep streams, rivers, ponds, lakes, and marshes with permanent water and ample basking sites. Redbelly turtles are documented in the Delaware River, Darby Creek, Crum Creek, Ridley Creek, and Chester Creek within the project area. They can be found in deep, slow water habitats in the creeks, as well as impoundments and nearby ponds and lakes. The existence of this turtle species is threatened by habitat destruction, poor water quality and competition with aggressive non-native turtle species that share its range and habitat (e.g. red-eared slider).

Additionally, in response to your request, we recommend that you access county information on our website, at http://fishandboat.com/county.htm for locations of public boat launches on Darby Creek and the Delaware River.

This response represents the most up-to-date summary of the PNDI data and our files and is valid for two (2) years from the date of this letter. An absence of recorded species information does not necessarily imply species absence. Our data files and the PNDI system are continuously being updated with species occurrence information. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered, and consultation shall be re-initiated.

If you have any questions regarding this review, please contact Kathy Gipe at 814-359-5186 and refer to the SIR # 45340. Thank you for your cooperation and attention to this important matter of species conservation and habitat protection.

Sincerely,

Christopher A. Urban, Chief
Natural Diversity Section

CAU/KDG/dn

Cc: John Buzzar, PFBC

GREELEY AND HANSEN

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April 29, 2016

Ms. Kathy Gipe
PA Fish and Boat Commission
Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study
In Reply to SIR# 45340

Dear Ms. Gipe:

Greeley and Hansen is developing a Long Term Control Plan Update (LTCPU) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. As per our phone conversation on Wednesday, March 9, 2016, we are requesting additional information on the specific habitat location of the species listed in SIR #45340.

Two maps of the study area are provided as attachments to this letter including a map highlighting the specific focus area of Chester City and a second map showing the exact location of the combine sewer outfalls (CSOs). Per our telephone conversation, it is our understanding that a map of the specific habitat locations cannot be provided as this information is confidential. In order to properly determine if CSOs will impact these threatened and endangered species we need to better understand the species location within the focus project area. We request that you review the attached maps against your records and complete the table below.

CSO	Receiving Stream	Location	Distance Upstream to Nearest Species Habitat (miles)	Distance Downstream to Species Habitat (miles)	Above Tidal Boundary? (Yes or No)	Notes
2		Front & Booth				
3		Front & Highland				
4		Front & Hayes				
5		Front & Townsend				
7		Delaware & Reaney				
8		2nd & Tilghman				
9		2nd & Lloyd				
10		5th & Pusey				
11		2nd & Parker				
12		2nd & Edgmont				
13		2nd & Welsh				
14		3rd & Upland				
15		4th & Melrose				
16		8th & McDowell				
17		9th & Campbell				
18		Sun Drive & Hancock				
19		14th & Crozer				
20		Kerlin & Finland				
21		9th & Sproul				

CSO	Receiving Stream	Location	Distance Upstream to Nearest Species Habitat (miles)	Distance Downstream to Species Habitat (miles)	Above Tidal Boundary? (Yes or No)	Notes
22		6th & Sproul				
23		3rd & Edgmont				
24		3rd & Dock				
25		5th & Penn				

Additionally, information on the type of habitat (i.e. – spawning, nesting, siting) or other pertinent information would also be helpful. We appreciate your cooperation and assistance in completing this task. Should you need any additional information, please feel free to contact me at (215) 553-7919 or Julia Spicher at (215) 553-7926.

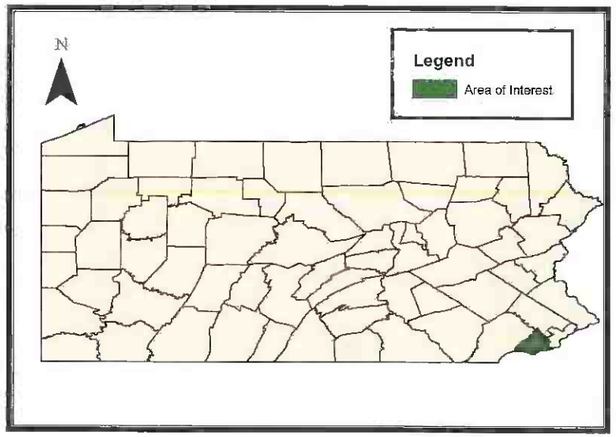
Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

/js
Enclosures

c: Michael DeSantis, DELCORA, w/enclosures
Edwin Bothwell, DELCORA, w/enclosures
Michael Hope, Greeley and Hansen
Julia Spicher, Greeley and Hansen



N

Radnor Twp
Haverford Twp
Newtown Twp
Marple Twp
Edgmont Twp
Upper Providence Twp
Upper Providence Twp
Upper Providence Twp
Springfield Twp
Clifton Heights Boro
Aldan Boro
Darby Boro
Collingdale Boro
Darby Twp
Morton Boro
Colwyn Boro
Sharon Hill Boro
Nether Providence Twp
Swarthmore Boro
Rutledge Boro
Glenolden Boro
Darby Twp
Folcroft Boro
Ridley Twp
Prospect Park Boro
Norwood Boro
Ridley Park Boro
Media Boro
Rose Valley Boro
Middletown Twp
Thornbury Twp
Chester Heights Boro
Concord Twp
Chadds Ford Twp
Aston Twp
Brookhaven Boro
Parkside Boro
Upland Boro
Chester Twp
Chester City
Eddystone Boro
Tinicum Twp
Bethel Twp
Upper Chichester Twp
Trainer Boro
Lower Chichester Twp
Marcus Hook Boro
Millbourne Boro
Upper Darby Twp
East Lansdowne Boro
Lansdowne Boro
Yeadon Boro

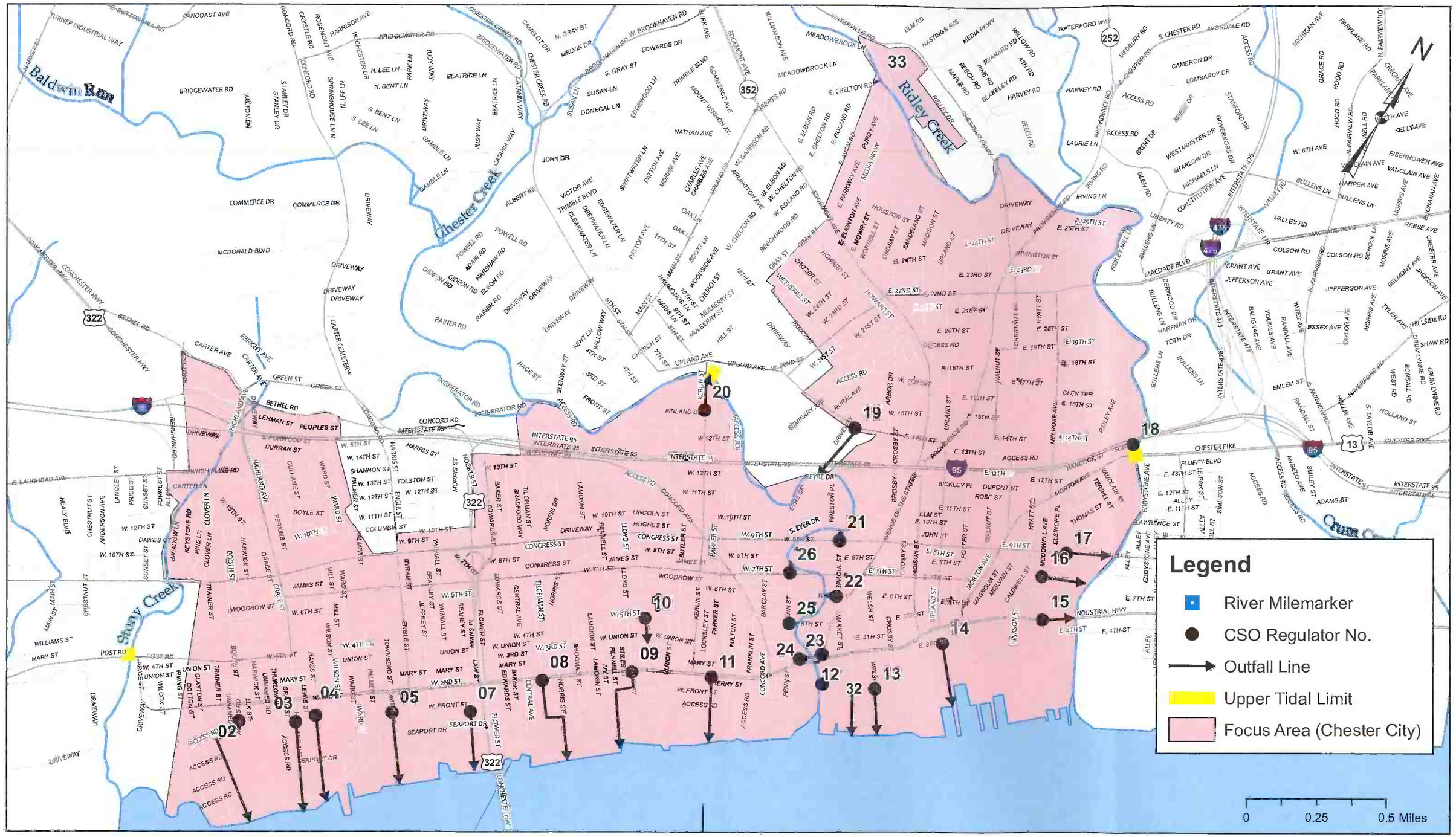
0 0.5 1 2 3 4 5 Miles

Legend
- Focus Area (Chester City)
- Study Area

CSO Long Term Control Plan Update
Delaware County Regional Water Quality Control Authority

IDENTIFCATION OF SENSITIVE AREAS
STUDY AREA MAP
March 2015

GREELEY AND HANSEN



CSO Long Term Control Plan Update
Delaware County Regional Water Quality Control Authority

IDENTIFCATION OF SENSITIVE AREAS
OUTFALL LOCATOIN MAP
March 2015

GREELEY AND HANSEN

GREELEY AND HANSEN

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October 29, 2015

Mr. Matthew Fisher
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway
Dover, DE 19901

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Fisher:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

Sensitive Areas are defined by the United States Environmental Protection Agency (USEPA) Federal Register Combined Sewer Overflow (CSO) Control Policy and the US EPA Guidance for Long Term Control Plan as follows:

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- Shellfish beds

USEPA requirements indicate that sensitive areas are given the highest priority during the development of technical alternatives.

This letter is being submitted to your agency as a formal request for information that your agency may have on sensitive areas within Delaware County, PA. Specifically, we are interested in sensitive areas located within the area of study as shown in GREEN on the attached map. If portions of the study area meet the above sensitive area criteria, we request that you provide the following information:

- Complete list of identified Sensitive Areas;
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DELCORA is under a Consent Decree to submit this study to USEPA in February 2016. In order to meet project milestones, we respectfully request you provide a response within 30 days of receipt of this letter, no later than November 23, 2015. We appreciate your cooperation and assistance in completing this study. Should you need any additional information, please feel free to contact me at (215) 553-7919 or Julia Spicher at (215) 553-7926.

Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
Michael DeSantis, DELCORA
Edwin Bothwell, DELCORA
Michael Hope, Greeley and Hansen
Julia Spicher, Greeley and Hansen

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF FISH & WILDLIFE
89 Kings Highway
Dover, Delaware 19901

Phone: (302) 739-9910
Fax: (302) 739-6157

11/25/2015

Marlene Finizio
Greeley and Hansen LLC
1700 Market St. Suite 2130
Philadelphia, Pennsylvania 19103

Dear Marlene Finizio:

In response to your request to comment on the Long Term Control Plan for the Delaware County Regional Water Quality Control Authority the Delaware Department of Natural Resources and Environmental Control Division of Fish and Wildlife would like to notify you that the Delaware River adjacent to your study area is inhabited by both the Atlantic Sturgeon, and the Shortnose Sturgeon. Both species are considered endangered and are protected by the Endangered Species Act. In addition this area is utilized by several anadromous fish species including but not limited to Striped Bass and American Shad. In regards to your specific study site, or further information on species that can be found in the Delaware River you should contact the Pennsylvania Fish and Boat Commission.

Thank You,

Ian Park

GREELEY AND HANSEN

1700 Market Street, Suite 2130
Philadelphia, Pennsylvania 19103
p 215 563 3460
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www.greeley-hansen.com

October 29, 2015

Mr. David Chanda
Director Fish and Wildlife
New Jersey Department of
Environmental Protection
P.O. Box 420
501 E. State Street, 3rd Floor
Trenton, NJ 08625

Subject: Delaware County Regional Water Quality Authority
CSO Long Term Control Plan Update
Sensitive Areas Study

Dear Mr. Chanda:

Greeley and Hansen is developing a Long Term Control Plan (LTCP) for the Delaware County Regional Water Quality Control Authority (DELCORA) located in Chester, PA. A map of the study area is provided as an attachment to this letter. The goal of this LTCP is to reduce the frequency, duration and intensity of combined sewer overflow events into the local waterbodies, including portions of the Delaware River, Chester Creek and Ridley Creek. As part of this evaluation, environmentally sensitive areas within the study area need to be identified so that appropriate considerations can be made to reduce combined sewer overflows to these areas.

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Yours very truly,

Greeley and Hansen LLC

Marlene Finizio
Project Manager

c: Robert Willert, DELCORA
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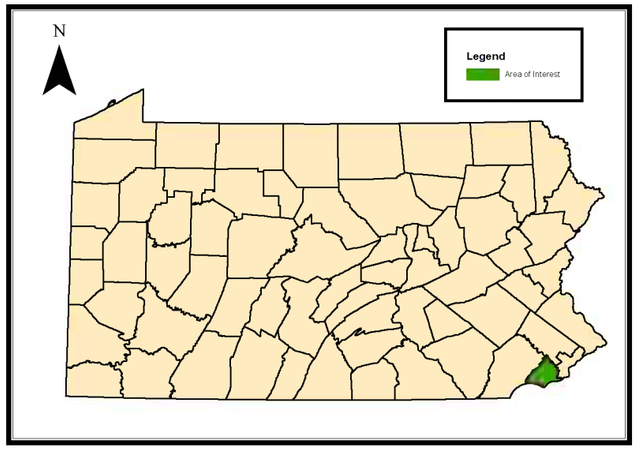

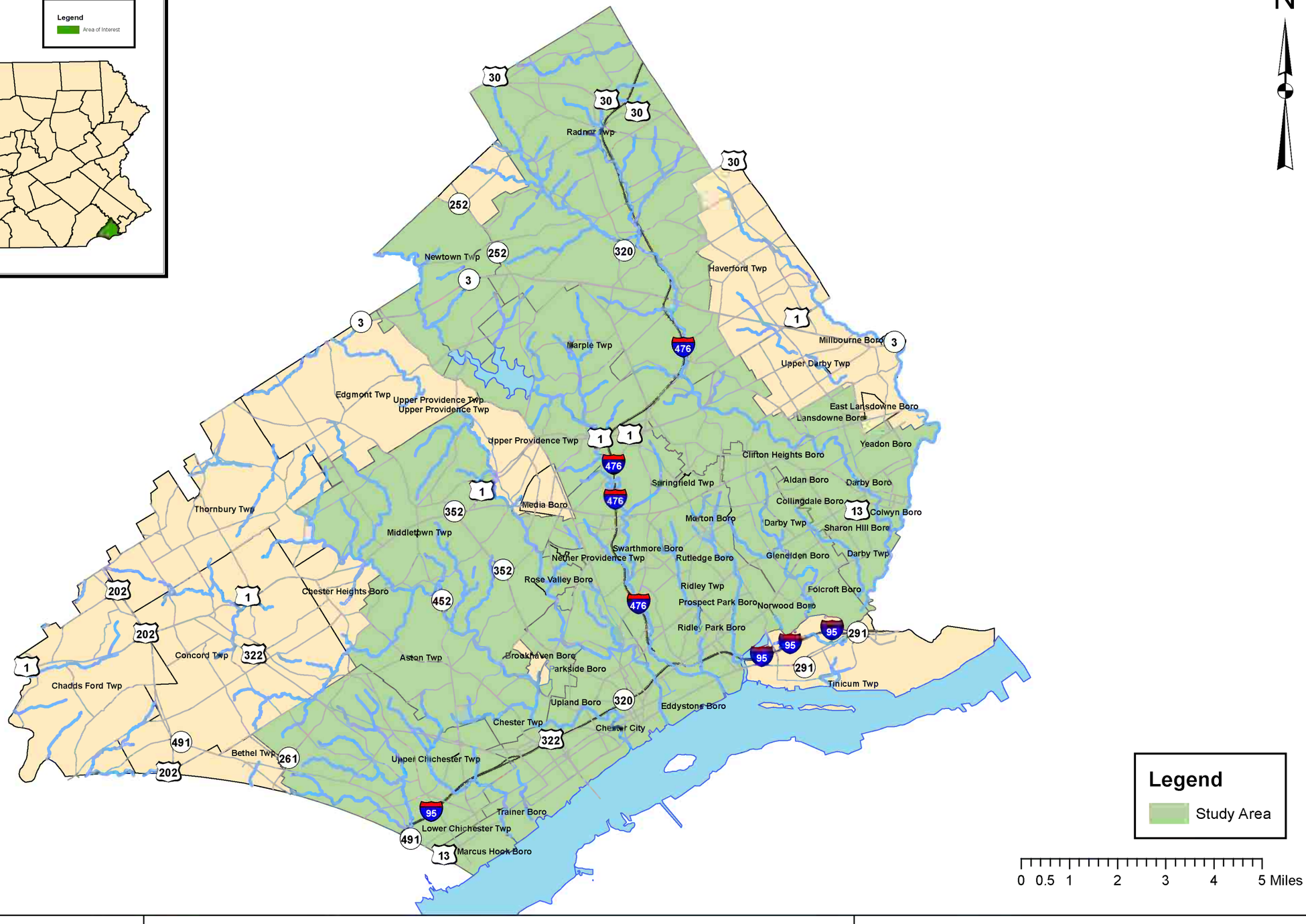

IDENTIFCATION OF SENSITIVE AREAS
STUDY AREA MAP
OCTOBER 2015

GREELEY AND HANSEN

ATTACHMENT B

Public Survey Tally Sheet

CSO Long Term Control Plan
Delaware County Regional Water Quality Control Authority
River and Creeks Use Survey

The Delaware River, Chester Creek and Ridley Creek provide enjoyment through many recreational activities (i.e. boating, fishing). The Delaware County Regional Water Quality Control Authority (DELCORA) is committed to enhancing the quality of the River and Creeks to support these uses. To assist in planning water quality improvements, please let us know how you use the Delaware River, Chester Creek and Ridley Creek by completing this survey. You can also go online to www.DELCORA.org and click on River and Creeks Use Survey to complete the survey. This survey only pertains to specific areas along the Delaware River, Chester Creek and Ridley Creek as identified by the green area of interest on the attached map (see reverse side). Please fill out only one (1) survey per household. Please return survey in the enclosed self-addressed envelope by December 18, 2015.

1. Do you or anyone in your household use the Delaware River, Chester Creek and/or Ridley Creek for any recreational activities (i.e. boating, swimming, fishing etc)?

   YES | 72 | NO | 421 | (If no, skip questions 2 and 3)

2. Please check the appropriate water activities and how frequently you or members of your household participate in these activities along the Delaware River, Chester Creek and Ridley Creek, focusing only in the area indicated in GREEN on the map.4Participation of water activities along the river or creeks outside the green area should not be included.

Activities															
	Delaware River					***Chester Creek***					***Ridley Creek***				
	Frequency					Frequency					Frequency				
	Daily	1x week	1x month	1x year	Never	Daily	1x week	1x month	1x year	Never	Daily	1x week	1x month	1x year	Never
Fishing Bank/Boat	4	10	12	10	457	6	5	9	12	461	1	8	11	14	459
Fishing from Wading	1	1	2	7	482	3	5	7	7	471	1	8	8	4	472
Rowing/Canoeing		1	3	4	485			3	3	487			3	2	488
Motor Boating	2	2	10	5	474			3	1	489			3	1	489
Kayaking			7	4	482			4	3	486			3	2	488
Jet Skiing	1	1	2	1	488			1	1	491			1	1	491
Water Skiing			1	2	490				2	491				2	491
Swimming			2	1	490			4	3	486			6	1	486
Wading	1	1	1	1	489		2	4	2	485	1		7	5	480
Other (Define) Tubing, Sailing			1	2	490			1		492			1		492

3. Please check the appropriate time of year you or a member of your household participates in any of the water activities.

Time of Year			
	Delaware River	***Chester Creek***	***Ridley Creek***
Year Round	11	8	8
April – October	37	35	34
November - March		1	2

4. Respondent Profile (please check all that apply)

Male	178
Female	289

Age less than 18	6
Age 18-39	37

Age 40-64	179
Age 65 and over	295

5. Comments:_____

_____

ATTACHMENT C

Applicable Pages from the 2014 PA Integrated Water Quality and Assessment Report (303(d) List)

2014 PA INTEGRATED WATER QUALITY MONITORING AND ASSESSMENT REPORT

Category 5 Streams

(Pollutants Requiring a TMDL)

2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date
Chester Creek			
HUC: 02040202			
Recreational (12466) - 0.57 miles			
Source Unknown	Pathogens	2006	2019
Recreational (12469) - 0.11 miles			
Source Unknown	Pathogens	2006	2019
Recreational (12474) - 0.26 miles			
Source Unknown	Pathogens	2006	2019
Aquatic Life (17135) - 7.88 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Aquatic Life (17136) - 0.35 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Aquatic Life (17138) - 7.68 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Aquatic Life (17372) - 2.5 miles			
Urban Runoff/Storm Sewers	Siltation	2014	2027
Chester Creek Unnamed Of (ID:25605816)			
HUC: 02040202			
Aquatic Life (17136) - 0.29 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Chester Creek Unnamed Of (ID:25606068)			
HUC: 02040202			
Aquatic Life (17136) - 0.39 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Chester Creek Unnamed Of (ID:25606113)			
HUC: 02040202			
Aquatic Life (17136) - 0.58 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Chester Creek Unnamed Of (ID:25606116)			
HUC: 02040202			
Aquatic Life (17136) - 0.21 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Chester Creek Unnamed Of (ID:25606161)			
HUC: 02040202			
Aquatic Life (17136) - 0.59 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027

Stream sections in red box are far upstream of DELCORA's CSO discharges

2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date
Poquessing Creek Unnamed To (ID:25600765)			
HUC: 02040202			
Aquatic Life (9687) - 0.6 miles			
Urban Runoff/Storm Sewers	Excessive Algal Growth	2002	2015
Preston Run			
HUC: 02040202			
Aquatic Life (17117) - 1.43 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Reeses Run			
HUC: 02040202			
Aquatic Life (17117) - 1.93 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2027
	Siltation	2014	2027
Ridley Creek			
HUC: 02040202			
Aquatic Life (16609) - 2.39 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2012	2025
	Siltation	2012	2025
Aquatic Life (16610) - 0.64 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2012	2025
	Siltation	2012	2025
Aquatic Life (16613) - 5.9 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2012	2025
	Siltation	2012	2025
Aquatic Life (16619) - 5.11 miles			
Source Unknown	Cause Unknown	2012	2025
Aquatic Life (16622) - 12.72 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2012	2025
	Siltation	2012	2025
Ridley Creek Unnamed Of (ID:25601429)			
HUC: 02040202			
Aquatic Life (16620) - 0.91 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2002	2015
	Siltation	2002	2015
Ridley Creek Unnamed Of (ID:25602007)			
HUC: 02040202			
Aquatic Life (16608) - 0.52 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2012	2025
	Siltation	2012	2025

Stream sections in red box are far upstream of DELCORA's CSO discharges

2014 PA INTEGRATED WATER QUALITY MONITORING AND ASSESSMENT REPORT

Category 4a Streams

(Approved TMDLs)

Stream Name / *Use Designation (Assessment ID)* / *Source*	*Cause*	*Date Listed*	*TMDL Date*
Hydrologic Unit Code: 02040202-Lower Delaware			
Chester Creek			
HUC: 02040202			
Aquatic Life (9900) - 1.05 miles			
Municipal Point Source	Cause Unknown	2002	2008
Aquatic Life (17372) - 2.5 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2008
Fish Consumption (17455) - 0.81 miles			
Source Unknown	PCB	1996	2006
Chester Creek Unnamed Of (ID:25621262)			
HUC: 02040202			
Aquatic Life (9900) - 0.98 miles			
Municipal Point Source	Cause Unknown	2002	2008
Chester Creek Unnamed Of (ID:25621282)			
HUC: 02040202			
Aquatic Life (9900) - 0.68 miles			
Municipal Point Source	Cause Unknown	2002	2008
Chester Creek Unnamed Of (ID:25621286)			
HUC: 02040202			
Aquatic Life (9900) - 0.6 miles			
Municipal Point Source	Cause Unknown	2002	2008
Chester Creek Unnamed Of (ID:25621308)			
HUC: 02040202			
Aquatic Life (9900) - 0.59 miles			
Municipal Point Source	Cause Unknown	2002	2008
Chester Creek Unnamed To (ID:25621322)			
HUC: 02040202			
Aquatic Life (9900) - 4.89 miles			
Municipal Point Source	Cause Unknown	2002	2008
Chester Creek Unnamed To (ID:25621352)			
HUC: 02040202			
Aquatic Life (17372) - 0.65 miles			
Urban Runoff/Storm Sewers	Cause Unknown	2014	2008
Crum Creek			
HUC: 02040202			
Fish Consumption (17455) - 1.4 miles			
Source Unknown	PCB	1996	2006
Delaware River			
HUC: 02040202			
Fish Consumption (17455) - 61.02 miles			
Source Unknown	PCB	1996	2006
Delaware River Unnamed To (ID:133072413)			
HUC: 02040202			
Fish Consumption (17455) - 0.34 miles			
Source Unknown	PCB	1996	2006
Delaware River Unnamed To (ID:134395494)			
HUC: 02040202			
Fish Consumption (17455) - 2.4 miles			
Source Unknown	PCB	1996	2006

Stream sections in red box are far upstream of DELCORA's CSO discharges

ATTACHMENT D

Applicable Water Quality Standards (WQS) Master Table

DELCORA CSO LTCPU - Applicable Water Quality Standards

Rev: 12-18-2015

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Alkalinity	DRBC WQRs - for Zone 4 / PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**Minimum**	**20**	20	20	---	---	---	---	---	---	---	---	---	---	20	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Alkalinity	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**120**	120		---	---	---	---	---	---	---	---	---	---	---	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Alkalinity	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**120**	120		---	---	---	---	---	---	---	---	---	---	---	mg/L as $CaCO_3$	Can eliminate from POCs since it is naturally occurring	Alkalinity
Aluminum	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**750**	---	---	750	87	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Aluminum	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**87**	---	---	750	**87**	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Aluminum	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**87**	---	---	750	**87**	---	---	---	---	---	750	---	750	87	µg/L	Total recoverable, restricted to pH 6.5 - 9	Aluminum
Ammonia	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**Maximum**	**$(NH_3 - N) \times (\log^{-1}[pK_T - pH] + 1)$**	---	$(NH_3 - N) \times (\log^{-1}[pK_T - pH] + 1)$	---	---	---	---	---	---	---	---	---	---	---	mg/L	pH dependent	Ammonia
Anthracene	DRBC WQRs - Table 7 / PA Code - Table 5	**Delaware River**	**Maximum**	**8,300**	---	---	---	---	---	---	8,300	40,000	---	---	8,300	---	---	µg/L		Anthracene
Anthracene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**8,300**	---	---	---	---	---	---	8,300	40,000	---	---	8,300	---	---	µg/L		Anthracene
Antimony	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**1,100**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**200**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	DRBC WQRs - Table 7 / PA Code - Table 5	**Delaware River**	**Maximum**	**5.6**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Antimony	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**5.6**	---	---	---	---	---	---	5.6	640	220	1,100	5.6	---	---	µg/L		Antimony
Arsenic (trivalent) (As III)	DRBC WQRs - Table 5 / PA Code - Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**340**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Arsenic (trivalent) (As III)	DRBC WQRs - Table 5 / PA Code - Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**150**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Arsenic (trivalent) (As III)	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**10**	---	---	340	150	---	---	---	---	150	340	10	340	150	µg/L	Dissolved criteria	Arsenic (trivalent) (As III)
Bacteria - Enterococcus (Above R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Upstream of RM 81.8**	**Maximum Geometric Average**	**88**	88	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Above R.M. 81.8)
Bacteria - Enterococcus (Below R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Downstream of RM 81.8**	**Maximum Geometric Average**	**33**	33	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Below R.M. 81.8)
Bacteria - Enterococcus	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum Geometric Average**	**88**	88	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Enterococcus (Above R.M. 81.8)
Bacteria - Fecal Coliform (Above R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Upstream of RM 81.8**	**Maximum Geometric Average**	**770**	770	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Fecal Coliform (Above R.M. 81.8)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Bacteria - Fecal Coliform (Below R.M. 81.8)	DRBC WQRs - for Zone 4	**Delaware River Downstream of RM 81.8**	**Maximum Geometric Average**	**200**	200	---	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL	DRBC WQRs and PA Code PA Code for WC Critical Use agree from May 1 - Sept 30, but PA Code of 2000 CFU/100 mL from Oct. 1 - April 30 for WC exceeds that allowed by DRBC Zone 4.	Bacteria - Fecal Coliform (Below R.M. 81.8)
Bacteria - Fecal Coliform	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum Geometric Average**	**770**	770	---	---	---	---	---	---	---	---	---	---	---	---	---	CFU/100 mL		Bacteria - Fecal Coliform (Above R.M. 81.8)
Barium	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**21,000**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Barium	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**4,100**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Barium	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**2,400**			---	---	---	---	---	---	4,100	21,000	2,400			µg/L		Barium
Benzene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**640**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**130**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**14**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**14**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
Benzene	DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.61**	---	---	---	---	0.61	14	---	3,100	130	640	1.2			µg/L		Benzene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**0.5**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**0.1**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
benzo (a) anthracene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.0038**	---	---	---	---	---	---	---	---	0.1	0.5	0.0038			µg/L		benzo (a) anthracene
Beryllium	DRBC WQRs - Table 7	**Delaware River**	**Maximum**	**420**							---	420	---	---				µg/L		Beryllium
Beryllium	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**420**							---	420	---	---				µg/L		Beryllium
Biological Oxygen Demand (BOD)	No Standard						---	---	---	---	---	---	---	---	---					Biological Oxygen Demand (BOD)
Bis (2-ethylhexyl) phthalate	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**4,500**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**910**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**2.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bis (2-ethylhexyl) phthalate	DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**1.2**	---	---	---	---	1.2	2.2	---	620	910	4,500	1.2			µg/L		Bis (2-ethylhexyl) phthalate
Bromodichloromethane (aka Dichlorobromomethane)	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**17**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Bromodichloromethane (aka Dichlorobromomethane)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**17**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)
Bromodichloromethane (aka Dichlorobromomethane)	PA Code 25 - 93.8c, Table 5 / DRBC WQRs - Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.55**					0.55	17	680	---	---	---	0.55			µg/L		Bromodichloromethane (aka Dichlorobromomethane)
Butylbenzyl phthalate	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**140**	---	---	---	---			1,500	1,900	35	140	150			µg/L		Butylbenzyl phthalate
Butylbenzyl phthalate	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**35**	---	---	---	---			1,500	1,900	35	140	150			µg/L		Butylbenzyl phthalate
Cadmium	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.651*EXP(1.0166*LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.651*EXP(0.7409*LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.651*EXP(1.0166*LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.651*EXP(0.7409*LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
Cadmium	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)**	---	---	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	---	---	3.4	16	(1.101672-(LN(hardness)x0.041838)) x Exp(0.7409 x LN(hardness)-4.719)	(1.136672-(LN(hardness)x0.041838)) x Exp(1.0166 x LN(hardness)-3.924)	---	2.0	0.25	µg/L	Dissolved criteria	Cadmium
CBOD5	No Standard						---	---	---	---	---	---	---	---	---					CBOD5
CBOD20	No Standard						---	---	---	---	---	---	---	---	---					CBOD20
Chlorine (Total Residual Chlorine)	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**4-day Average (Chronic Maximum)**	**11**		11	---	---	---	---	---	---				19	11	µg/L		Chlorine (Total Residual Chlorine)
Chlorine (Total Residual Chlorine)	PA Code (WWF, MF, TSF)	**Delaware River, Chester Creek, Ridley Creek**	**1-hour Average (Acute Maximum)**	**19**		19	---	---	---	---	---	---				19	11	µg/L		Chlorine (Total Residual Chlorine)
Chlorodibromomethane	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**13**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chlorodibromomethane	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**13**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chlorodibromomethane	DRBC WQRs - Table 6 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.4**	---	---	---	---	0.4	13			---	---	0.4			µg/L		Chlorodibromomethane
Chloroform	DRBC WQRs - Tables 6 & 7 / PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**1,900**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC WQRs - Tables 6 & 7 / PA Code Table 5	**Chester Creek, Ridley Creek, Delaware River Upstream of RM 81.8**	**Chronic Maximum**	**390**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**470**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
Chloroform	DRBC Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**470**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Chloroform	PA Code 25 - 93.8c, Table 5 / DRBC Table 6	**Delaware River Downstream of RM 81.8**	**Maximum**	**5.7**	---	---	---	---	5.7	470	68	2,100	390	1,900	5.7			µg/L		Chloroform
COD	No Standard						---	---	---	---	---	---								COD
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.277*EXP(0.819*LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.277*EXP(0.819*LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.277*EXP(0.819*LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.277*EXP(0.819*LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**(0.819 x LN(hardness)+3.7256)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	(0.819 x LN(hardness)+0.6848)	**(0.819 x LN(hardness)+3.7256)**	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (trivalent) (Cr III)	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**(0.819 x LN(hardness)+0.6848)**	---	---	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	---	---	---	380,000	**(0.819 x LN(hardness)+0.6848)**	(0.819 x LN(hardness)+3.7256)	---	570	74	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Chromium (trivalent) (Cr III)
Chromium (hexavalent) (Cr VI)	DRBC WQRs - Tables 5 & 7 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**16**	---	---	16	11	---	---	92	---	10	**16**	---	16	11	µg/L	Dissolved criteria	Chromium (hexavalent) (Cr VI)
Chromium (hexavalent) (Cr VI)	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**10**	---	---	16	11	---	---	92	---	10	16	---	16	11	µg/L	Dissolved criteria	Chromium (hexavalent) (Cr VI)
Chyrsene	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**18**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Chyrsene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**18**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Chyrsene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.0038**	---	---	---	---	3.8	18	---	---	---	---	0.0038			µg/L		Chyrsene
Copper	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**0.908*EXP(0.9422*LN(hardness)-1.7)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Delaware River**	**Chronic Maximum**	**0.908*EXP(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.908*EXP(0.9422*LN(hardness)-1.7)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.908*EXP(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Copper	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.960 x Exp(0.9422*LN(hardness)-1.70)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	0.960 x Exp(0.8545*LN(hardness)-1.702)	**0.960 x Exp(0.9422*LN(hardness)-1.70)**	---	---	---	µg/L	Dissolved criteria	Copper
Copper	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.960 x Exp(0.8545*LN(hardness)-1.702)**	---	---	0.908*EXP(0.9422*LN(hardness)-1.7)	0.908*EXP(0.8545*LN(hardness)-1.702)	---	---	---	---	**0.960 x Exp(0.8545*LN(hardness)-1.702)**	0.960 x Exp(0.9422*LN(hardness)-1.70)	---	---	---	µg/L	Dissolved criteria	Copper
Cyanide (free)	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**22**	---	---	22	5.2	---	---	140	140	5.2	22	140	22	5.2	µg/L		Cyanide (free)
Cyanide (free)	DRBC WQRs - Table 5 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**5.2**	---	---	22	5.2	---	---	140	140	5.2	22	140	22	5.2	µg/L		Cyanide (free)
Dieldrin	PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.24**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.056**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Dieldrin	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**0.000054**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.000054**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Dieldrin	DRBC WQRs - Table 6 / PA Code - Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.000052**	---	---	0.24	0.056	0.000052	0.000054	0.041	0.043	0.056	0.24	0.000052	0.24	0.056	µg/L		Dieldrin
Diethylphthalate	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**4,000**	---	---	---	---			17,000	44,000	800	4,000	17,000			µg/L		Diethylphthalate
Diethylphthalate	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**800**	---	---	---	---			17,000	44,000	800	4,000	17,000			µg/L		Diethylphthalate
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Delaware River**	**24 hr. Average Minimum**	**3.5**	**3.5**		---	---	---	---	---	---						mg/L	**Year Round Minimum**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Delaware River**	**24 hr. Average Minimum**	**6.5**	**6.5**		---	---	---	---	---	---						mg/L	**Minimum for April 1 to June 15 and Sept. 16 to Dec. 31**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**24 hr. Average Minimum**	**3.5**	**3.5**		---	---	---	---	---	---						mg/L	**Year Round Minimum**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_1$	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**24 hr. Average Minimum**	**6.5**	**6.5**		---	---	---	---	---	---						mg/L	**Minimum for April 1 to June 15 and Sept. 16 to Dec. 31**	Dissolved Oxygen (DO)$_1$
Dissolved Oxygen (DO)$_2$	PA Code (WWF)	**Chester Creek upstream of OF#20, & Ridley Creek from OF#18 upstream to Rt. 320**	**7-day Average**	**5.5**		5.5	---	---	---	---	---	---						mg/L		Dissolved Oxygen (DO)$_2$
Dissolved Oxygen (DO)$_2$	PA Code (WWF)	**Chester Creek upstream of OF#20, & Ridley Creek from OF#18 upstream to Rt. 320**	**Minimum**	**5.0**		5.0	---	---	---	---	---	---						mg/L		Dissolved Oxygen (DO)$_2$
Dissolved Oxygen (DO)$_3$ (Feb. 15 - July 31)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**7-day Average**	**6.0**		6.0	---	---	---	---	---	---						mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Feb. 15 - July 31)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**Minimum**	**5.0**		5.0	---	---	---	---	---	---						mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Aug. 1 - Feb. 14)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**7-day Average**	**5.5**		**5.5**												mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Dissolved Oxygen (DO)$_3$ (Aug. 1 - Feb. 14)	PA Code (TSF)	**Ridley Creek from Rt. 320 upstream to Media Water Intake**	**Minimum**	**5.0**		**5.0**												mg/L	TSF only applies to Ridley Creek for impacts by DELCORA CSOs	Dissolved Oxygen (DO)$_3$
Ethylbenzene	PA Code - Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**2,900**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**580**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	DRBC WQRs - Table 7	**Delaware River Upstream of RM 81.8**	**Maximum**	**2,100**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Ethylbenzene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2,100**	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Ethylbenzene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Downstream of RM 81.8	Maximum	530	---	---	---	---			530	2,100	580	2,900	530			µg/L		Ethylbenzene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Upstream of RM 81.8	Maximum	5,300	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Maximum	5,300	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Fluorene	DRBC WQRs - Table 7 / PA Code - Table 5	Delaware River Downstream of RM 81.8	Maximum	1,100	---	---	---	---			1,100	5,300	---	---	1,100			µg/L		Fluorene
Hardness	No Standard	Delaware River, Chester Creek, Ridley Creek	--		--	--	---	---	---	---	---	---						mg/L as $CaCO_3$	Needed to calculate some of the metal concentrations	Hardness
Iron (Fe)	PA Code (WWF, MF, TSF)	Delaware River, Chester Creek, Ridley Creek	30-day Average	1.5		1.5	---	---	---	---	---	---						mg/L as total recoverable	Iron as total recoverable	Iron $(Fe)_{(1)}$
Iron (Fe)	PA Code (WWF, MF, TSF)	Delaware River, Chester Creek, Ridley Creek	Maximum	0.3		0.3	---	---	---	---	---	---				---	1.0	mg/L as dissolved	Iron as dissolved	Iron $(Fe)_{(2)}$
Lead	DRBC WQRs - Table 5	Delaware River	Acute Maximum	38	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Delaware River	Chronic Maximum	5.4	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Acute Maximum	38	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	DRBC WQRs - Table 5	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Chronic Maximum	5.4	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Lead	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	---	---	38	5.4	---	---	---	---	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -4.705)	(1.46203 - (LN(hardness) x 0.145712)) x Exp(1.273 x LN(hardness) -1.460)	---	65	2.5	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Lead
Mercury (Hg)	PA Code Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	1.4	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	PA Code Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	0.77	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7	Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)	Maximum	0.051	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7	Delaware River Upstream of RM 81.8	Maximum	0.051	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Mercury (Hg)	DRBC WQRs - Table 7 / PA Code Table 5	Delaware River Downstream of RM 81.8	Maximum	0.05	---	---	1.4	0.77	---	---	0.05	0.051	0.77 (Hg2+)	1.4 (Hg2+)	0.05	1.4	0.77	µg/L	Dissolved criteria	Mercury (Hg)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Acute Maximum	12,000	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18	Chronic Maximum	2,400	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	DRBC WQRs - Table 6	Delaware River Upstream of RM 81.8	Maximum	590	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Methylene chloride (Dichloromethane)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**590**	---	---	---	---	---	590	---	260,000	2,400	12,000	4.6			µg/L		Methylene chloride (Dichloromethane)
Methylene chloride (Dichloromethane)	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**4.6**	---	---	---	---	---	590	---	260,000	2,400	12,000	**4.6**			µg/L		Methylene chloride (Dichloromethane)
Molybdenum	No Standard						---	---	---	---	---	---								Molybdenum
MTBE	No Standard						---	---	---	---	---	---								MTBE
Naphthalene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**140**			---	---	---	---	---	---	43	140	---			µg/L		Naphthalene
Naphthalene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**43**			---	---	---	---	---	---	**43**	140	---			µg/L		Naphthalene
Nickel	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.998 x Exp(0.846 x LN(hardness)+2.255)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	**0.998 x Exp(0.846 x LN(hardness)+2.255)**	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.997 x Exp(0.846 x LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	**0.997 x Exp(0.846 x LN(hardness)+0.0584)**	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.846*EXP(0.846*LN(hardness)+2.255)**	---	---	**0.846*EXP(0.846*LN(hardness)+2.255)**	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Delaware River Upstream of RM 81.8**	**Acute Maximum**	**0.846*EXP(0.846*LN(hardness)+2.255)**	---	---	**0.846*EXP(0.846*LN(hardness)+2.255)**	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 5	**Delaware River Upstream of RM 81.8**	**Chronic Maximum**	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	**0.846*EXP(0.846*LN(hardness)+0.0584)**	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nickel	DRBC WQRs - Table 7	**Delaware River Downstream of RM 81.8**	**Maximum**	**500**	---	---	0.846*EXP(0.846*LN(hardness)+2.255)	0.846*EXP(0.846*LN(hardness)+0.0584)	---	---	500	1,700	0.997 x Exp(0.846 x LN(hardness)+0.0584)	0.998 x Exp(0.846 x LN(hardness)+2.255)	610	470	52	µg/L	Dissolved criteria. Values for federal regulations are based on a hardness of 100 mg/L.	Nickel
Nitrate	No Standard						---	---	---	---	---	---								Nitrate
Nitrite	No Standard						---	---	---	---	---	---								Nitrite
Nitrate + Nitrate	No Standard																			Nitrate + Nitrate
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6	**Delaware River Upstream of RM 81.8**	**Maximum**	**0.51**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.51**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
N-Nitroso-di-n-propylamine	DRBC WQRs - Table 6 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**0.005**	---	---	---	---	0.005	0.51					0.005			µg/L		N-Nitroso-di-n-propylamine
Oil and Grease	No Standard						---	---	---	---	---	---								Oil and Grease
Osmotic Pressure (OP)	**PA Code (WWF, MF, TSF)**	**Delaware River, Chester Creek, Ridley Creek**	**Maximum**	**50**		50	---	---	---	---	---	---						milliosmoles/kg		Osmotic Pressure (OP)
PCBs (Total)	DRBC WQRs - Table 5 / PA Code Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.014**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
PCBs (Total)	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.000016**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
PCBs (Total)	DRBC WQRs - Table 6	**Delaware River**	**Maximum**	**0.000016**	---	---	1.0	0.014	0.000016	0.000016	0.008390	0.008490	0.014	---	0.000064	---	0.014	µg/L		PCBs (Total)
pH$_{(1)}$	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**8.5**	8.5		---	---	---	---	---	---				---	6.5 - 9	--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH$_{(1)}$
pH$_{(1)}$	DRBC WQRs - for Zone 4	**Delaware River**	**Minimum**	**6.5**	6.5		---	---	---	---	---	---						--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH$_{(1)}$

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
pH(1)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**8.5**	8.5		---	---	---	---	---	---				---	6.5 - 9	--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH(1)
pH(1)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Minimum**	**6.5**	6.5		---	---	---	---	---	---						--	Exceeds criteria from PA Code for WWF, MF, & TSF of pH 6 - 9	pH(1)
pH(2)	PA Code (WWF, MF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Maximum**	**9.0**		9.0	---	---	---	---	---	---						--	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	pH(2)
pH(2)	PA Code (WWF, MF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Minimum**	**6.0**		6.0	---	---	---	---	---	---						--	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	pH(2)
Phenanthrene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**5**			---	---	---	---	---	---	1	5	---			µg/L		Phenanthrene
Phenanthrene	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**1**			---	---	---	---	---	---	1	5	---			µg/L		Phenanthrene
Phenols	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**0.02**	0.02		---	---	---	---	---	---	---	---	10.4			mg/L		Phenols
Phenols	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.02**	0.02		---	---	---	---	---	---	---	---	10.4			mg/L		Phenols
Phosphate	No Standard						---	---	---	---	---	---								Phosphate
Pyrene	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**4,000**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Pyrene	DRBC WQRs - Table 7	**Delaware River Upstream of RM 81.8**	**Maximum**	**4,000**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Pyrene	DRBC WQRs - Table 7 / PA Code Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**830**	---	---	---	---			830	4,000	---	---	830			µg/L		Pyrene
Radioactivity - alpha emitters	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**3**	3		---	---	---	---	---	---						pc/L		Radioactivity - alpha emitters
Radioactivity - beta emitters	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**1,000**	1,000		---	---	---	---	---	---						pc/L		Radioactivity - beta emitters
Radioactivity - alpha emitters	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**3**	3		---	---	---	---	---	---						pc/L		Radioactivity - alpha emitters
Radioactivity - beta emitters	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**1,000**	1,000		---	---	---	---	---	---						pc/L		Radioactivity - beta emitters
Selenium (Se)	DRBC WQRs - Table 5	**Delaware River**	**Acute Maximum**	**20**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Selenium (Se)	DRBC WQRs - Table 5	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**20**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Selenium (Se)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**4.6**	---	---	20	5.0	---	---	170	4,200	4.6	---	---	---	5.0	µg/L	Total recoverable criteria	Selenium (Se)
Silver (Ag)	DRBC WQRs - Tables 5 & 7 / PA Code - Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**0.85*EXP(1.72*LN(hardness)-6.59)**	---	---	0.85*EXP(1.72*LN(hardness)-6.59)	NA	---	---	170	40,000	---	0.850 x Exp(1.72 x LN(hardness) - 6.590)	---	3.2	---	µg/L	Dissolved criteria	Silver (Ag)
Sulfide	No Standard						---	---	---	---	---	---								Sulfide
Synthetic Detergents (B)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum 30-day Average**	**1.0**	1.0		---	---	---	---	---	---						mg/L		Synthetic Detergents (B)
Synthetic Detergents (B)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum 30-day Average**	**1.0**	1.0		---	---	---	---	---	---						mg/L		Synthetic Detergents (B)
Temperature (A) (1)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**30**	30		---	---	---	---	---	---						°C		Temperature (A)
Temperature (A) (1)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**2.8 Deg above 24-hr gradient during the 1961-66 period**	2.8 Deg above 24-hr gradient during the 1961-66 period		---	---	---	---	---	---						°C		Temperature (A)

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Temperature [A] [1]	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**30**	30		---	---	---	---	---	---						°C		Temperature [A]
Temperature [A] [1]	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**2.8 Deg above 24-hr gradient during the 1961-66 period**	2.8 Deg above 24-hr gradient during the 1961-66 period		---	---	---	---	---	---						°C		Temperature [A]
Temperature [2]	PA Code (WWF, TSF)	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Maximum**	**Varies - see table on pg. 93-21 & 93-22**		Varies - see table on pg. 93-21 & 93-22	---	---	---	---	---	---						°F	Use the more stringent standard above from DRBC Zone 4 for the Delaware River	Temperature
Tetrachloroethene/ Tetrachloroethylene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**700**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**140**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Delaware River Upstream of R.M. 81.8**	**Maximum**	**3.3**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**3.3**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Tetrachloroethene/ Tetrachloroethylene	DRBC WQRs - Table 6	**Delaware River Downstream of R.M. 81.8**	**Maximum**	**0.69**			---	---	0.69	3.3	---	1,300	140	700				µg/L		Tetrachloroethene/ Tetrachloroethylene
Thallium	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**65**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**13**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Delaware River Upstream of R.M. 81.8**	**Maximum**	**0.47**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**0.47**							0.24	0.47	13	**65**				µg/L		**Thallium**
Thallium	DRBC WQRs - Table 7	**Delaware River Downstream of R.M. 81.8**	**Maximum**	**0.24**							0.24	0.47	13	**65**				µg/L		**Thallium**
Threshold Odor Number	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**24 at 60 °C**	24 at 60 °C		---	---	---	---	---	---						--		**Threshold Odor Number**
Threshold Odor Number	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**24 at 60 °C**	24 at 60 °C		---	---	---	---	---	---						--		**Threshold Odor Number**
Toluene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Acute Maximum**	**1,700**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Toluene	PA Code 25 - 93.8c, Table 5	**Chester Creek, Ridley Creek, Delaware Upstream of RM 81.8**	**Chronic Maximum**	**330**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Toluene	PA Code 25 - 93.8c, Table 5	**Delaware River Downstream of RM 81.8**	**Maximum**	**1,300**	---	---	---	---			1,300	15,000	330	1,700	1,300			µg/L		**Toluene**
Total Dissolved Solids (TDS)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**133% of background**	133% of background		---	---	---	---	---	---						mg/L		**Total Dissolved Solids (TDS)**
Total Dissolved Solids (TDS)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**133% of background**	133% of background		---	---	---	---	---	---						mg/L		**Total Dissolved Solids (TDS)**
TKN	No Standard						---	---	---	---	---	---								**TKN**
Total Organic Carbon (TOC)	No Standard						---	---	---	---	---	---								**Total Organic Carbon (TOC)**
Total Organic Halides (T.O.X.)	No Standard						---	---	---	---	---	---								**Total Organic Halides (T.O.X.)**
Total Nitrogen	No Standard						---	---	---	---	---	---								**Total Nitrogen**
Total Petroleum Hydrocarbon (TPH)	No Standard																			**Total Petroleum Hydrocarbon (TPH)**

Parameter	Source of Standard	Applicable Water Body	WQS Type	Water Quality Standard To Use	Standard Criterion (DRBC Zone 4 WQRs) *Applies to Delaware & Tidal Portions of Chester & Ridley*	Standard Criterion (25 PA Code Ch. 93 WQS, 93.7 Table 3 for TSF, WWF, MF & WC Critical Use Designations) *Applies to Delaware, Chester, Ridley*	Freshwater Objectives (DRBC WQRs Table 5 - Stream Quality Objectives for Toxic Pollutants for the Protection of Aquatic Life) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 6 - Stream Quality Objectives for Carcinogens) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Freshwater Objectives (DRBC WQRs Table 7 - Stream Quality Objectives for Systemic Toxicants) *Applies to Delaware & Tidal Portions of Chester & Ridley*		Fish & Aquatic Life Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*		Human Criteria (25 PA Code Ch. 93 WQS, 93.8c, Table 5) *Applies to Delaware, Chester, Ridley*	US EPA National *Recommended* Water Quality Criteria Aquatic Life Criteria Table *Applies to Delaware, Chester, Ridley*		Units	Notes	Parameter
							Acute	Chronic	Fish & Water Ingestion	Fish Ingestion Only	Fish & Water Ingestion	Fish Ingestion Only	Criteria Continuous Concentrations	Criteria Maximum Concentrations	Health Criteria	Acute Criteria Maximum Concentration (CMC)	Chronic Criteria Continuous Concentration (CCC)			
Total Phosphorus	No Standard						---	---	---	---	---	---								Total Phosphorus
Total Suspended Solids (TSS)	No Standard						---	---	---	---	---	---								Total Suspended Solids (TSS)
Turbidity (C)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum 30-day Average**	**40**	40		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Delaware River**	**Maximum**	**150**	150		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum 30-day Average**	**40**	40		---	---	---	---	---	---						NTU		Turbidity (C)
Turbidity (C)	DRBC WQRs - for Zone 4	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Maximum**	**150**	150		---	---	---	---	---	---						NTU		Turbidity (C)
Xylenes (total)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Acute Maximum**	**1,100**			---	---	---	---	---	---	210	1,100	70,000			µg/L		Xylenes (total)
Xylenes (total)	PA Code 25 - 93.8c, Table 5	**Delaware River, Chester Creek, Ridley Creek**	**Chronic Maximum**	**210**			---	---	---	---	---	---	210	1,100	70,000			µg/L		Xylenes (total)
Zinc	DRBC WQRs - Tables 5 & 7	**Delaware River**	**Acute Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Delaware River**	**Chronic Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Acute Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	DRBC WQRs - Tables 5 & 7	**Chester Creek - Mouth to OF#20 (Tidal limit), & Ridley Creek - Mouth to OF#18 (Tidal limit)**	**Chronic Maximum**	**0.95*EXP(0.8473*LN(hardness)+0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Acute Maximum**	**0.978 x Exp(0.8473 x LN(hardness) + 0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	0.986 x Exp(0.8473 x LN(hardness) + 0.884)	**0.978 x Exp(0.8473 x LN(hardness) + 0.884)**	---	120	120	µg/L	Dissolved criteria	Zinc
Zinc	PA Code 25 - 93.8c, Table 5	**Chester Creek upstream of OF#20, & Ridley Creek upstream from OF#18**	**Chronic Maximum**	**0.986 x Exp(0.8473 x LN(hardness) + 0.884)**	---	---	0.95*EXP(0.8473*LN(hardness)+0.884)	0.95*EXP(0.8473*LN(hardness)+0.884)	---	---	7,400	26,000	**0.986 x Exp(0.8473 x LN(hardness) + 0.884)**	0.978 x Exp(0.8473 x LN(hardness) + 0.884)	---	120	120	µg/L	Dissolved criteria	Zinc

(A) Temperature shall not exceed 5 °F (2.8 °C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or a maximum of 86 °F (30.0 °C) - whichever is less.

(B) Using M.B.A.S assay, with a maximum 30-day average of 1.0 mg/L.

(C) Unless exceeded due to natural conditions.

NOTES:

DRBC standards in their WQRs are referred to as "Stream Quality Objectives". DRBC's Stream Quality Objectives have primacy over the PA Code standards for the Delaware River.

PA CODE refers to the standards as "Water Quality Standards".

Ridley Creek is "TSF & MF" Critical Use from Rt. 320 Bridge upstream to the Media Water Intake. Ridley Creek is "WWF & MF" downstream from the Rt. 320 Bridge to mouth.

Chester Creek has a "TSF" Critical Use designation as well, but this is well upstream of the CSO discharge furthest upstream on Chester Creek and does not apply for this analysis.

ATTACHMENT E

CSO Outfalls Historical Sampling Data

CSO Sampling
25 – Sept – 14

Sample Point	Parameters				
	BOD (mg/L)	Ammonia (mg/L)	TSS (mg/L)	Phosphorus (mg/L)	Fecal Coliform (# / 100mL)
2nd & Dock Street	100	6.72	134	1.6	811,000
14th & Crozer	39.5	3.26	45	0.78	430,000
Sun Drive and Hancock Street	42.5	1.88	56	0.55	169,000

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

October 2, 2014

Mike Krause
DELCORA
P.O. Box 999
Chester, PA 19016

Certificate of Analysis

Project Name:	**Annual Stormwaters**	Workorder:	**2031197**
Purchase Order:		Workorder ID:	**CSO Sampling**

Dear Mike Krause:

Enclosed are the analytical results for samples received by the laboratory on Thursday, September 25, 2014.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mrs. Vanessa N Badman (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

This laboratory report may not be reproduced, except in full, without the written approval of ALS Environmental.

ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Ms. Irene Fitzgerald , Joe DiMatteo

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Vanessa N. Badman
Mrs. Vanessa N Badman
Project Coordinator

ALS Environmental

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SAMPLE SUMMARY

Workorder: 2031197 CSO Sampling

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2031197001	14th & Crozer	Water	9/25/2014 10:00	9/25/2014 20:30	Mike Krause
2031197002	2nd & Dock	Water	9/25/2014 09:40	9/25/2014 20:30	Mike Krause
2031197003	Sun & Hancock	Water	9/25/2014 09:50	9/25/2014 20:30	Mike Krause
2031197004	14th & Crozer	Water	9/25/2014 10:00	9/25/2014 16:10	Mike Krause
2031197005	2nd & Dock	Water	9/25/2014 09:40	9/25/2014 16:10	Mike Krause
2031197006	Sun & Hancock	Water	9/25/2014 09:50	9/25/2014 16:10	Mike Krause

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit

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ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197001** Date Collected: 9/25/2014 10:00 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 9/25/2014 20:30

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
WET CHEMISTRY										
Ammonia-N	3.26		mg/L	0.100	D6919-09			9/30/14 15:23	JAM	B
Biochemical Oxygen Demand	39.5		mg/L	2.0	S5210B-01			9/26/14 06:30	NAK	A
Phosphorus, Total	0.78		mg/L	0.10	EPA 365.1	9/26/14	LJF	9/30/14 06:57	LJF	B
Total Suspended Solids	45		mg/L	5	S2540D-97			9/29/14 21:30	NV	A

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

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ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197002** Date Collected: 9/25/2014 09:40 Matrix: Water

Sample ID: **2nd & Dock** Date Received: 9/25/2014 20:30

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
WET CHEMISTRY										
Ammonia-N	6.72		mg/L	0.100	D6919-09			9/30/14 15:43	JAM	B
Biochemical Oxygen Demand	100		mg/L	2.0	S5210B-01			9/26/14 06:30	NAK	A
Phosphorus, Total	1.6		mg/L	0.10	EPA 365.1	9/26/14	LJF	9/30/14 06:57	LJF	B
Total Suspended Solids	134		mg/L	5	S2540D-97			9/29/14 21:30	NV	A

Vanessa N. Badman

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ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197003** Date Collected: 9/25/2014 09:50 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 9/25/2014 20:30

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
WET CHEMISTRY										
Ammonia-N	1.88		mg/L	0.100	D6919-09			9/30/14 16:03	JAM	B
Biochemical Oxygen Demand	42.5		mg/L	2.0	S5210B-01			9/26/14 06:30	NAK	A
Phosphorus, Total	0.55		mg/L	0.10	EPA 365.1	9/26/14	LJF	9/30/14 06:57	LJF	B
Total Suspended Solids	56		mg/L	5	S2540D-97			9/29/14 21:30	NV	A

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ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197004** Date Collected: 9/25/2014 10:00 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 9/25/2014 16:10

Parameters	Results	Flag	Units	RDL	Method	Prepared By	Analyzed	By	Cntr
Spring City-PA1504546,NJPA071									
Fecal Coliform	430000		col/100mL	1	S9222D-97		9/25/14 17:50	BSM	A

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ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197005** Date Collected: 9/25/2014 09:40 Matrix: Water

Sample ID: **2nd & Dock** Date Received: 9/25/2014 16:10

Parameters	Results	Flag	Units	RDL	Method	Prepared By	Analyzed	By	Cntr
Spring City-PA1504546,NJPA071									
Fecal Coliform	811000	1	col/100mL	1	S9222D-97		9/25/14 16:45	BSM	A

Vanessa N. Badman

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2031197 CSO Sampling

Lab ID: **2031197006** Date Collected: 9/25/2014 09:50 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 9/25/2014 16:10

Parameters	Results	Flag	Units	RDL	Method	Prepared By	Analyzed	By	Cntr
Spring City-PA1504546,NJPA071									
Fecal Coliform	169000	1	col/100mL	1	S9222D-97		9/25/14 17:08	BSM	A

Vanessa N. Badman

Mrs. Vanessa N Badman
Project Coordinator

PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2031197005	1	2nd & Dock	S9222D-97	Fecal Coliform
This is an estimated result.				
2031197006	1	Sun & Hancock	S9222D-97	Fecal Coliform
This is an estimated result.				

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

COC #:

ALS Quot

2031197

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

Client Name: DELCORA
Address: 3201 W. Front Street
Chester PA 19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO Sampling
Bill To: Same

TAT [X] Normal-Standard TAT is 10-12 business days.
[ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.:

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Container Type	Container Size	Preservative	BOD, TSS	Phosphorus, NH3	Fecal Coliform						
					plastic	plastic	plastic									
					1L	500ml	250ml									
					none	H2SO4	Na2S2O3									
					ANALYSES/METHOD REQUESTED											
					Enter Number of Containers Per Sample or Field Results Below.											
1 14th & Crozer	9/25/2014	10:00	C	WW	1	1	1									
2 2nd & Dock	9/25/2014	9:40	C	WW	1	1	1									
3 Sun & Hancock	9/25/2014	9:50	C	WW	1	1	1									
4																
5																
6																
7																
8																
9																
10																

Rec
Cooler Temp: 2°C Therm ID: TH294
No. of Coolers: 1

	Y	N	Initial
Custody Seals Present?			
~~(if present) Seals Intact?~~			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

Fecal Analyzed @ Spring City
SPRL/BM
9-25-14 1610

ALS Field Services: [X] Pickup __Labor
__Composite Sampling __Rental Equipment
__Other:

Project Comments:

LOGGED BY(signature): [signature] DATE 9/26 TIME 1229
REVIEWED BY(signature): DATE TIME

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 [signature]	9/25/14	1300	2 [signature]	9-25	1300
3 [signature]	9-25	1830	4 [signature]	9-25-14	1830
5 [signature]	9-25-14	2030	6 [signature]	9-25	2030
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [X] PA [ ] NC [ ]
Reportable to PADEP? Yes [ ] PWSID #
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type-

* G=Grab; C=Composite **Matrix - Al=Air; DW=Drinking Water; GW=Groundwater; Oi=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

C.S.O. Sampling
29-Oct-12

Sample Point	Parameters				
	BOD (mg/L)	Ammonia (mg/L)	TSS (mg/L)	Phosphorus (mg/L)	Fecal Coliform (# / 100mL)
2nd & Dock St	35	2.18	106	0.823	>600,000
14th & Crozer	21	0.81	48	0.499	>600,000
Sun Drive and Hancock St.	28	1.79	47	0.813	>600,000

QC Laboratories

Analytical Report

MIKE KRAUSE
DELCORA PRE-TREATMENT
PO BOX 999
CHESTER, PA 19016

Regarding:
MIKE KRAUSE
DELCORA PRE-TREATMENT
3201 W. FRONT STREET
CHESTER, PA 19016

Account No:AL0069, DELCORA
Project No: AL0069, DELCORA

P.O. No:

Inv. No: 1468769
PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L4369219-1	SUN & HANCOCK GRAB	10/29/12 09:40am NA C	Customer

Received Date/Time/Temp 10/31/12 07:45pm 1.1 C Iced (Y/N): Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
AMMONIA NITROGEN AS N	SM 4500NH3 B,D	1.79 mg/l	0.100 mg/l	11/08/12 03:55PM MRP
PHOSPHORUS TOTAL	SM 4500P B.5 E	0.813 mg/l	0.0600 mg/l	11/01/12 09:00AM NM
TOTAL SUSPENDED SOLIDS	SM 2540D	47.0 mg/l	2.00 mg/l	11/01/12 12:21PM LMB

Notes:

A result of "ND" indicates that the analyte tested was either not detected or the concentration was below the RLs.
Definitions: NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC= Too numerous to count; pres=presumptive
A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
MCL= EPA recommended "maximum contaminant level", PLs = Customer-specific permit limits.
The test results meet all requirements of NELAC unless otherwise specified.
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Unless otherwise specified, the Environmental and Food Chemistry testing except Field Parameters were performed by QC Inc. located at 1205 Industrial Blvd., Southampton, PA 18966; Pharmaceutical, Dairy and Food Microbiological tests were performed by QC Inc. located at 702 Electronic Dr., Horsham, PA 19044.
QCL Accreditations: Southampton Div: EPA ID PA00018; NELAP ID's: PA 09-00131, NJ PA166, NY 11223
State ID's: CT PH-0768, DE PA-018, MD 206, SC 89021001; FDA Reg. # : 2515238
ACL Div: NELAP ID's: PA 68-335, NJ DE568; State ID's: DE 00011, MD 138; Wind Gap Div: State ID's: PA 48-01334, NJ PA001
E. Rutherford Div: State ID: NJ 02015; Vineland Div: State ID: NJ 06005; Reading Div: State ID: PA 06-03543
The reported results relate only to the samples.
All samples are collected as "grab" samples unless otherwise identified.

Regulatory authorities are assessing substantial fines for testing omissions. Please track your sample collections and results on a weekly, monthly, or quarterly basis to ensure compliance. QC's internet program 'LIVE ACCESS' will provide you with real-time access to collection dates and results. Please contact Customer Service for further information on acquiring LIVE ACCESS.

Serial Number: 2460396

Sun & Hancock

Client
Client Name Delcora
Address 3201 W Front St
Chester, PA 19013
Contact Mike Krause
Phone (610) 876-5523 x 218
Work ID

CHAIN OF CUSTODY RECORD

Due
Quote
Misc.
Sampled by:

Atlantic Coast Laboratories, Inc.
630 churchmans Road
Newark, Delaware 19702
(302)266-9121 * 454-8720 (FAX)

Sample ID	Comp Date Time Start	Date Smpl	Time	Container Size	Container G/P	Grab Sample	Composite	No. of Containers	Sample Matrix	Preservative	TSS	Phos-phorus, NH3						Comments
Sun & Hancock		10/29/12	9:40	1000	P	X		1	WW	NONE	X							
Sun & Hancock		10/29/12	9:40	500	P	X		1	WW	H2SO4		X						

Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received by:
[signature]	10/31/12 1035	[signature]			
Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received for Laboratory by:

Lab Use Only	Yes	No	Remarks
Samples Iced			
Samples Prsrvd			

QC Laboratories

Analytical Report

MIKE KRAUSE
DELCORA PRE-TREATMENT
PO BOX 999
CHESTER, PA 19016

Regarding:
MIKE KRAUSE
DELCORA PRE-TREATMENT
3201 W. FRONT STREET
CHESTER, PA 19016

Account No:AL0069, DELCORA
Project No: AL0069, DELCORA

P.O. No:

Inv. No: 1468768
PWSID No:

Sample Number	Sample Description	Samp. Date/Time/Temp	Sampled by
L4369218-1	2ND & DOCK GRAB	10/29/12 10:00am NA C	Customer

Received Date/Time/Temp 10/31/12 07:45pm 1.1 C Iced (Y/N): Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
AMMONIA NITROGEN AS N	SM 4500NH3 B,D	2.18 mg/l	0.100 mg/l	11/08/12 03:55PM MRP
PHOSPHORUS TOTAL	SM 4500P B.5 E	0.823 mg/l	0.0600 mg/l	11/01/12 09:00AM NM
TOTAL SUSPENDED SOLIDS	SM 2540D	106 mg/l	2.00 mg/l	11/01/12 12:50PM LMB

Notes:

A result of "ND" indicates that the analyte tested was either not detected or the concentration was below the RLs.
Definitions: NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC= Too numerous to count; pres=presumptive
A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
MCL= EPA recommended "maximum contaminant level", PLs = Customer-specific permit limits.
The test results meet all requirements of NELAC unless otherwise specified.
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QCL Accreditations: Southampton Div: EPA ID PA00018; NELAP ID's: PA 09-00131, NJ PA166, NY 11223
State ID's: CT PH-0768, DE PA-018, MD 206, SC 89021001; FDA Reg. # : 2515238
ACL Div: NELAP ID's: PA 68-335, NJ DE568; State ID's: DE 00011, MD 138; Wind Gap Div: State ID's: PA 48-01334, NJ PA001
E. Rutherford Div: State ID: NJ 02015; Vineland Div: State ID: NJ 06005; Reading Div: State ID: PA 06-03543
The reported results relate only to the samples.
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Serial Number: 2460395

Client
Client Name Delcora
Address 3201 W Front St
Chester, PA 19013
Contact Mike Krause
Phone (610) 876-5523 x 218
Work ID

CHAIN OF CUSTODY RECORD

Due
Quote
Misc.
Sampled by:

Atlantic Coast Laboratories, Inc.
630 churchmans Road
Newark, Delaware 19702
(302)266-9121 * 454-8720 (FAX)

Sample ID	Comp Date Time Start	Date Smpl	Time	Container Size	Container G/P	Grab Sample	Composite	No. of Containers	Sample Matrix	Preservative	TSS	Phos-phorus, NH3						Comments
2nd & Dock		10/29/12	10:00	1000	P	X		1	WW	NONE	X							
2nd & Dock		10/29/12	10:00	500	P	X		1	WW	H2SO4		X						

Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received by:
	10/31/12 1035				
Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received for Laboratory by:

Lab Use Only	Yes	No	Remarks
Samples Iced			
Samples Prsrvd			

QC Laboratories

Analytical Report

MIKE KRAUSE
DELCORA PRE-TREATMENT
PO BOX 999
CHESTER, PA 19016

Regarding:
MIKE KRAUSE
DELCORA PRE-TREATMENT
3201 W. FRONT STREET
CHESTER, PA 19016

Account No:AL0069, DELCORA
Project No: AL0069, DELCORA

P.O. No:

Inv. No: 1468767
PWSID No:

Sample Number Sample Description
L4369220-1 14TH & CROZER GRAB

Samp. Date/Time/Temp Sampled by
10/29/12 09:20am NA C Customer

Received Date/Time/Temp 10/31/12 07:45pm 1.1 C Iced (Y/N): Y

Parameter	Method	Result	RLs	Test Date, Time, Analyst
GENERAL CHEMISTRY				
AMMONIA NITROGEN AS N	SM 4500NH3 B,D	0.810 mg/l	0.100 mg/l	11/08/12 03:55PM MRP
PHOSPHORUS TOTAL	SM 4500P B.5 E	0.499 mg/l	0.0300 mg/l	11/02/12 08:50AM NM
TOTAL SUSPENDED SOLIDS	SM 2540D	48.0 mg/l	2.00 mg/l	11/01/12 12:50PM LMB

Notes:

A result of "ND" indicates that the analyte tested was either not detected or the concentration was below the RLs.
Definitions: NEG=negative; POS=positive; COL=colonies; RLs=laboratory reporting limits; L/A=laboratory accident; TNTC= Too numerous to count; pres=presumptive
A result marked with "DRY" indicates that the result was calculated and reported on a dry weight basis.
MCL= EPA recommended "maximum contaminant level", PLs = Customer-specific permit limits.
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State ID's: CT PH-0768, DE PA-018, MD 206, SC 89021001; FDA Reg. # : 2515238
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E. Rutherford Div: State ID: NJ 02015; Vineland Div: State ID: NJ 06005; Reading Div: State ID: PA 06-03543
The reported results relate only to the samples.
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Serial Number: 2460389

Client
Client Name Delcora
Address 3201 W Front St
Chester, PA 19013
Contact Mike Krause
Phone (610) 876-5523 x 218
Work ID

CHAIN OF CUSTODY RECORD

Due
Quote
Misc.
Sampled by:

Atlantic Coast Laboratories, Inc.
630 churchmans Road
Newark, Delaware 19702
(302)266-9121 * 454-8720 (FAX)

Sample ID	Comp Date Time Start	Date Smpl	Time	Container Size	Container G/P	Grab Sample	Composite	No. of Containers	Sample Matrix	Preservative	TSS	Phos-phorus, NH3						Comments
14th & Crozer		10/29/12	9:20	1000	P	X		1	WW	NONE	X							
14th & Crozer		10/29/12	9:20	500	P	X		1	WW	H2SO4		X						

Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received by:
[signature]	10/30/12 1035	[signature]			
Relinquished by:	Date/Time	Received by:	Relinquished by:	Date \ Time	Received for Laboratory by:

Lab Use Only	Yes	No	Remarks
Samples Iced			
Samples Prsrvd			

Fecal Daily Worksheet

	Analyst	Date	Time		
Setup & Sample Date	MK	10/29/2012	2:25 PM		
Read	MK	10/30/2012	2:00 PM		
14th & Crozer					
Dilutions	Blank 1	5TNTC	1TNTC	0.1TNTC	0.01
Raw Count (CFU)	0	TNTC	TNTC	TNTC	TNTC
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)			>	600000	

	Analyst	Date	Time		
Setup & Sample Date	MK	10/29/2012	2:25 PM		
Read	MK	10/30/2012	2:00 PM		
2nd & Dock					
Dilutions	Blank 1	5TNTC	1TNTC	0.1TNTC	0.01
Raw Count (CFU)	0	TNTC	TNTC	TNTC	TNTC
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)			>	600,000	

	Analyst	Date	Time		
Setup & Sample Date	MK	10/29/2012	2:25 PM		
Read	MK	10/30/2012	2:00 PM		
Sun & Hancock					
Dilutions	Blank 1	5TNTC	1TNTC	0.1TNTC	0.01
Raw Count (CFU)	0	TNTC	TNTC	TNTC	TNTC
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)			>	600,000	

	Analyst	Date	Time		
Setup & Sample Date					
Read					
Dilutions	Blank 1	125	75	25	5
Raw Count (CFU)					
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?					
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)					

	Analyst	Date	Time
Setup & Sample Date			
Read			

BOD Worksheet

Date of Analysis		10/30/12
Date of WRTP Sample		10/29/12
Date of CFR Sample		
Date of CFTM Sample		
Date of SF and TB Sample		
Setup	TPB	10/30/12
Read 5 Day	MK	11/04/12
Read 20 Day		11/19/12

	LOT #	Op'd Date	EXP. Date
GGA Control	B109-01	10/7/2012	11/21/2012

Soln. T°	Calib. T°
20.5	20.4
20.8	23.6

Theor. DO

Seed Lot #	52017	3/13/2013
6L Nutrient Lot #	A2254	9/31/2017
3L Nutrient Lot #	A0316	11/15/2015
300mL Nutrient Lot #	A0344	12/31/2015
N Inhibitor Lot #	A2093	5/31/2015

CBOD5

	Bottle #	Sample Volume (mL)	Volume Fraction	Extra Nutrient	Nitr. Inhib	Initial DO	Final DO	Depletion	Seed Volume	Seed Blank	BOD5 (mg/L)	BOD5 (AVG.)	Quality Control
BLANK 1		0	0.00		x				-				
BLANK 2		0	0.00		x				-				
BLANK 3		0	0.00		x				-				
CONTROL 1		6	0.02		x				2				
CONTROL 2		6	0.02		x				2				
SEED 1		18	0.06		x				-				
SEED 2		20	0.07		x				-			0.00	
SEED 3		22	0.07		x				-				
EFF 1					x				2				
EFF 2					x				2				
EFF 3					x				2				
EFF 1					x				2				
EFF 2					x				2				RPD
EFF 3					x				2				AVG
INF 1					x				2				
INF 2					x				2				
INF 3					x				2				
CFR EFF 1					x				2				
CFR EFF 2					x				2				
CFR EFF 3					x				2				
CFTM EFF 1					x				2				
CFTM EFF 2					x				2				
CFTM EFF 3					x				2				
SF EFF 1					x				2				
SF EFF 2					x				2				
SF EFF 3					x				2				
THBY EFF 1					x				2				
THBY EFF 2					x				2				
THBY EFF 3					x				2				
RV EFF 1					x				2				
RV EFF 2					x				2				
RV EFF 3					x				2				
PP EFF 1					x				2				
PP EFF 2					x				2				
PP EFF 3					x				2				
PR EFF 1					x				2				
PR EFF 2					x				2				
PR EFF 3					x				2				

BOD5

	Bottle #	Sample Volume (mL)	Volume Fraction	Extra Nutrient	Nitr. Inhib	Initial DO	Final DO	Depletion	Seed Volume	Seed Blank	BOD5 (mg/L)	BOD5 (AVG.)	Quality Control
BLANK 1	239	0	0.00			8.63	8.37	0.26	-		0.26		
BLANK 2	215	0	0.00			8.62	8.40	0.22	-		0.22	0.19	
BLANK 3	12	0	0.00			8.63	8.53	0.10	-		0.10		Pass
CONTROL 1	231	6	0.02			8.66	3.80	4.86	2		215	208	
CONTROL 2	226		0.02			8.66	4.09	4.57	2		200		Pass
SEED 1	112	16	0.05			8.61	4.07	4.54	-	53%	0.57		
SEED 2	77	18	0.06			8.60	3.52	5.08	-	59%	0.56	0.56	
SEED 3	61	20	0.07			8.60	3.05	5.55	-	65%	0.56		
SUN 1	11	30	0.10			8.68	5.35	3.33	2		28		
SUN 2	0	60	0.20			8.72	2.63	6.09	2		28	28	
SUN 3	79	90	0.30			8.77	0.25		2				
14TH 1	615	30	0.10			8.66	5.94	2.72	2		22		
14th 2	123	60	0.20			8.70	3.82	4.88	2		22	21	
14th 3	71	90	0.30			8.73	1.97	6.76	2		21		
CPS 1	301	30	0.10			8.64	4.51	4.13	2		36		
CPS 2	272	60	0.20			8.63	1.01	7.62	2		35	35	
CPS 3	189	90	0.30			8.62	0.02		2				
CFR INF 1									2				Duplicate
CFR INF 2									2				Results
CFR INF 3									2				RPD%
CFTM INF 1									2				
CFTM INF 2									2				
CFTM INF 3									2				
SF INF 1									2				
SF INF 2									2				
SF INF 3									2				
THBY INF 1									2				
THBY INF 2									2				
THBY INF 3									2				
RV INF 1									2				
RV INF 2									2				
RV INF 3									2				
PP INF 1									2				
PP INF 2									2				
PP INF 3									2				
PR INF 1									2				
PR INF 2									2				
PP INF 3									2				

C.S.O. Sampling
27-Nov-13

Sample Point	Parameters				
	BOD (mg/L)	Ammonia (mg/L)	TSS (mg/L)	Phosphorus (mg/L)	Fecal Coliform (# / 100mL)
2nd & Dock St	65	2.1	204	1.32	>200,000
14th & Crozer	40	0.9	163	1.21	190,000
Sun Drive and Hancock St.	13	0.2	40	0.350	150,000

CERTIFICATE OF ANALYSIS
M.J. Reider Associates, Inc.

Attention: Michael Krause
Reported To: DELCORA Plant Sampling
3201 West Front St.
Chester PA 19016-0000

Date of Report: 12/06/13
Lab ID: 2991-13-0053078

Date Collected: 11/27/13 00:00
Collected By: Client

Sample Desc: CSO Outfall (Site 1) 14th + Crozer

Date Received: 11/27/13 14:05

	Result	Unit	Rep Limit	Dilutn Factor	Procedure	Test Date	Test Time	Analyst
CHEMISTRY								
COLORMETRIC								
Phosphorus as P, Total	1.21	mg/l	.05	1	SM 4500P-E	12/02	11:15	ALD
NITROGENS								
Nitrogen, Ammonia	0.9	mg/l	.1	1	D6919-03	11/27	17:37	JCL
OTHER								
Biochemical Oxygen Demand	40	mg/l	2	1	SM 5210B	11/27	16:00	EMW
RESIDUES								
Solids, Total Suspended	163	mg/l	1	1	SM 2540D	12/03	08:40	TMH

Distribution of Reports:

Reviewed and Approved by:

Barbara R Coyle

Barbara Coyle
Laboratory Director

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THE NELAC INSTITUTE

ENVIRONMENTAL TESTING LABORATORY 107 ANGELICA STREET, READING, PA 19611
PHONE: 610-374-5129 • FAX: 610-374-7234 • **www.mjreider.com**
NELAP accredited by PA. (PADEP #06-00003) (NYSDOH11630) Visit our website to view our current NELAC accreditations for various drinking water, wastewater and solid & chemical materials analytes.

QUALITY ETHICS SERVICE ACIL Seal of Excellence

CERTIFICATE OF ANALYSIS
M.J. Reider Associates, Inc.

Attention: Michael Krause
Reported To: DELCORA Plant Sampling
3201 West Front St.
Chester PA 19016-0000

Date of Report: 12/06/13
Lab ID: 2991-13-0053079

Date Collected: 11/27/13 00:15
Collected By: Client

Sample Desc: CSO Outfall (Site 2) Sun + Hancock

Date Received: 11/27/13 14:05

	Result	Unit	Rep Limit	Dilutn Factor	Procedure	Test Date	Test Time	Analyst
CHEMISTRY								
COLORMETRIC								
Phosphorus as P, Total	0.35	mg/l	.05	1	SM 4500P-E	12/02	11:15	ALD
NITROGENS								
Nitrogen, Ammonia	0.2	mg/l	.1	1	D6919-03	11/27	17:37	JCL
OTHER								
Biochemical Oxygen Demand	13	mg/l	2	1	SM 5210B	11/27	16:00	EMW
RESIDUES								
Solids, Total Suspended	40	mg/l	1	1	SM 2540D	12/03	08:40	TMH

Distribution of Reports:

Reviewed and Approved by:

Barbara R Coyle

Barbara Coyle
Laboratory Director

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ENVIRONMENTAL TESTING LABORATORY 107 ANGELICA STREET, READING, PA 19611
PHONE: 610-374-5129 • FAX: 610-374-7234 • **www.mjreider.com**

NELAP accredited by PA. (PADEP #06-00003) (NYSDOH11630) Visit our website to view our current NELAC accreditations for various drinking water, wastewater and solid & chemical materials analytes.

THE NELAC INSTITUTE

QUALITY ETHICS SERVICES ACIL Seal of Excellence

CERTIFICATE OF ANALYSIS
M.J. Reider Associates, Inc.

Attention: Michael Krause
Reported To: DELCORA Plant Sampling
3201 West Front St.
Chester PA 19016-0000

Date of Report: 12/06/13
Lab ID: 2991-13-0053080

Date Collected: 11/27/13 00:30
Collected By: Client

Sample Desc: CSO Outfall (Site 3) 2nd + Dock (CPS)

Date Received: 11/27/13 14:05

	Result	Unit	Rep Limit	Dilutn Factor	Procedure	Test Date	Test Time	Analyst
CHEMISTRY								
COLORMETRIC								
Phosphorus as P, Total	1.32	mg/l	.05	1	SM 4500P-E	12/02	11:15	ALD
NITROGENS								
Nitrogen, Ammonia	2.1	mg/l	.1	1	D6919-03	11/27	17:37	JCL
OTHER								
Biochemical Oxygen Demand	65	mg/l	2	1	SM 5210B	11/27	16:00	EMW
RESIDUES								
Solids, Total Suspended	204	mg/l	1	1	SM 2540D	12/03	08:40	TMH

Distribution of Reports:

Reviewed and Approved by:

Barbara Coyle
Laboratory Director

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ENVIRONMENTAL TESTING LABORATORY 107 ANGELICA STREET, READING, PA 19611
PHONE: 610-374-5129 • FAX: 610-374-7234 • **www.mjreider.com**

NELAP accredited by PA. (PADEP #06-00003) (NYSDOH11630) Visit our website to view our current NELAC accreditations for various drinking water, wastewater and solid & chemical materials analytes.

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brc
12/31/12 8:15:57 AM

M. J. REIDER ASSOCIATES, INC.

COFC.
Page:

Chain of Custody

Account: 2991 Work Order: 005523 Project Leader: BRC No: 211349
Work Order Description: Annual CSO Outfalls

Customer: Michael Krause

Address: DELCORA Plant Sampling
3201 West Front St.
Chester PA 19016-0000

Remarks: _____

Phone: 610.876.5523 Ext: 218

Total Sampling Time (hours): _____ Bottle Prep by: _____

Samplers: CST

Laboratory Receipt Temp: 5 Deg C. If Temp Unacceptable, On Ice? (Y) N
Approved By: _____

==========

Sample No: 1 Desc: CSO Outfall (Site 1) 14TH + CROZER
53078 nh3-n, tss, po4-p, bod, ~~fec~~

Matrix: ww Date: 11/27/13
Time: 0900
A - 1 X L BOD/TSS P w/ Cool to 6 C;
B - 1 X Pt NH3/PO4 P w/ H2SO4(pH<2);
~~C - 1 X 4oz FECAL P w/ Sterile/Na2S2O3;~~

Sample No: 2 Desc: CSO Outfall (Site 2) SUN + HANCOCK
53079 nh3-n, tss, po4-p, bod, ~~fec~~

Matrix: ww Date: 11/27/13
Time: 0015
A - 1 X L BOD/TSS P w/ Cool to 6 C;
B - 1 X Pt NH3/PO4 P w/ H2SO4(pH<2);
~~C - 1 X 4oz FECAL P w/ Sterile/Na2S2O3;~~

Sample No: 3 Desc: CSO Outfall (Site 3) 2ND + DOCK (CPS)
53080 nh3-n, tss, po4-p, bod, ~~fec~~

Matrix: ww Date: 11/27/13
Time: 0030
A - 1 X L BOD/TSS P w/ Cool to 6 C;
B - 1 X Pt NH3/PO4 P w/ H2SO4(pH<2);
~~C - 1 X 4oz FECAL P w/ Sterile/Na2S2O3;~~

Relinquished by: _____ Received by: _____ Received for laboratory by: _____

Date: 11/27/13 Time: 1020 Date: 11/27/13 Time: 1905

Sample entered by: DSM

	Analyst	Date	Time		
Setup & Sample Date	MK	11/27/2013	2:40 AM		
Read	MK	11/28/2013	2:00 AM		
14th & Crozer					
Dilutions	Blank 1	5tntc	1tntc	0.5tntc	0.1
Raw Count (CFU)	0	tntc	tntc	tntc	190
Actual Density (CFU/100mL)					190000
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)	190,000				

	Analyst	Date	Time		
Setup & Sample Date	MK	11/27/2013	2:40 AM		
Read	MK	11/28/2013	2:00 AM		
Sun & Hancock					
Dilutions	Blank 1	5tntc	1tntc	0.5tntc	0.1
Raw Count (CFU)	0	tntc	tntc	tntc	150
Actual Density (CFU/100mL)					150000
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)	150,000				

	Analyst	Date	Time		
Setup & Sample Date	MK	11/27/2013	2:40 AM		
Read	MK	11/28/2013	2:00 AM		
2nd & Dock (CPS)					
Dilutions	Blank 1	5tntc	1tntc	0.5tntc	0.1
Raw Count (CFU)		tntc	tntc	tntc	tntc
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?		Above	Above	Above	Above
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)			>	200,000	

	Analyst	Date	Time		
Setup & Sample Date					
Read					
Spring Hill Farm					
Dilutions	Blank 1	125	75	25	5
Raw Count (CFU)					
Actual Density (CFU/100mL)					
Meets Target (20-40 CFU)?					
Results that Meet Target					
Target Results Count/100mL					
Average (CFU/100mL)					

	Analyst	Date	Time
Setup & Sample Date			
Read			

ATTACHMENT F

Laboratory Data for Additional Sampling of the CSO Outfalls

ALS Environmental

34 Dogwood Lane ▪ Middletown, PA 17057 ▪ Phone: 717-944-5541 ▪ Fax: 717-944-1430 ▪ www.alsglobal.com

NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

December 3, 2015

Ms. Irene Fitzgerald
DELCORA
P.O. Box 999
Chester, PA 19016

Certificate of Analysis

Project Name:	**2015-LOWER DELAWARE TESTING**	Workorder:	**2107040**
Purchase Order:		Workorder ID:	**CSO WW LTCP**

Dear Ms. Fitzgerald:

Enclosed are the analytical results for samples received by the laboratory on Tuesday, November 10, 2015.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mr. Brad W Kintzer (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

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ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Mr. Ray Rios , Mr. Mike Krause

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Brad W. Kintzer
Mr. Brad W Kintzer
Project Coordinator

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

SAMPLE SUMMARY

Workorder: 2107040 CSO WW LTCP

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2107040001	CPS/EPS1 (74/26)	Water	11/10/2015 05:00	11/10/2015 12:05	Collected by Client

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit
I	Indicates reported value is greater than or equal to the Method Detection Limit (MDL) but less than the Report Detection Limit (RDL)
(S)	Surrogate Compound
NC	Not Calculated
*	Result outside of QC limits

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PROJECT SUMMARY

Workorder: 2107040 CSO WW LTCP

Workorder Comments

See attached subcontracted radiological results from ALS-Ft. Collins. VLF 12/1/15

Sample Comments

Lab ID: 2107040001 **Sample ID:** CPS/EPS1 (74/26) **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

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ANALYTICAL RESULTS

Workorder: 2107040 CSO WW LTCP

Lab ID: **2107040001** Date Collected: 11/10/2015 05:00 Matrix: Water

Sample ID: **CPS/EPS1 (74/26)** Date Received: 11/10/2015 12:05

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Bromodichloromethane	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Chloroform	9.0		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Ethylbenzene	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Methylene Chloride	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Tetrachloroethene	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Toluene	ND		ug/L	5.0	EPA 624			11/11/15 06:32	CJG	R
Total Xylenes	ND		ug/L	15.0	EPA 624			11/11/15 06:32	CJG	R
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	93.5		%	72 - 142	EPA 624			11/11/15 06:32	CJG	R
4-Bromofluorobenzene (S)	89.7		%	73 - 119	EPA 624			11/11/15 06:32	CJG	R
Dibromofluoromethane (S)	87.5		%	74 - 132	EPA 624			11/11/15 06:32	CJG	R
Toluene-d8 (S)	88.8		%	75 - 133	EPA 624			11/11/15 06:32	CJG	R
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Chrysene	ND		ug/L	1.4	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
bis(2-Ethylhexyl)phthalate	8.5		ug/L	2.8	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Phenanthrene	ND		ug/L	1.4	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	98.7		%	38 - 134	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
2-Fluorobiphenyl (S)	84.7		%	37 - 113	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
2-Fluorophenol (S)	44		%	17 - 73	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Nitrobenzene-d5 (S)	73.6		%	37 - 124	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Phenol-d5 (S)	29.8		%	11 - 53	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Terphenyl-d14 (S)	86.3		%	33 - 125	EPA 625	11/16/15	LEH	11/17/15 04:41	DHF	T
Pesticides and PCBs										
Dieldrin	0.024		ug/L	0.019	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Total Polychlorinated Biphenyl	|		ug/L		EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1016	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1221	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1232	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1242	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V

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ANALYTICAL RESULTS

Workorder: 2107040 CSO WW LTCP

Lab ID: **2107040001** Date Collected: 11/10/2015 05:00 Matrix: Water

Sample ID: **CPS/EPS1 (74/26)** Date Received: 11/10/2015 12:05

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1254	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Aroclor-1260	ND		ug/L	0.46	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	36		%	30 - 150	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
Tetrachloro-m-xylene (S)	46.9		%	36 - 112	EPA 608	11/14/15	GEC	11/17/15 20:35	RWS	V
WET CHEMISTRY										
Ammonia-N	5.93		mg/L	0.100	D6919-09			11/12/15 17:43	JAM	A
Biochemical Oxygen Demand	126		mg/L	2.0	S5210B-11			11/11/15 16:30	GMM	B
Carbonaceous BOD	76.9	1	mg/L	2.0	S5210B-11			11/11/15 06:30	GMM	B
Carbonaceous BOD 20 Day	101		mg/L	2.0	S5210B-11			11/11/15 11:20	RMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	11/11/15	MMA	11/13/15 09:53	SYB	F
Dissolved Oxygen	ND		mg/L	1.0	S4500OG-01			11/16/15 08:00	RMM	B
Halogen, Total Organic (TOX)	41.8		ug/L	20.0	SW846 9020B			11/18/15 13:29	PAG	M
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			11/10/15 23:37	MSA	B
Nitrate-N	ND		mg/L	0.20	EPA 300.0			11/11/15 17:20	FSC	B
Nitrite-N	ND		mg/L	0.20	EPA 300.0			11/11/15 17:20	FSC	B
Odor	20		T.O.N.	1	S2150B-97			11/10/15 23:36	MSA	L
Oil/Grease Hexane Extractable	12.0		mg/L	2.2	EPA 1664B			11/15/15 13:20	AT	G
Oil/Grease Silica Gel Treated	ND		mg/L	2.2	EPA 1664B			11/15/15 13:20	AT	G
Phenolics	0.010		mg/L	0.005	EPA 420.4	11/19/15	AMH	11/25/15 15:32	AMH	I
Phosphorus, Total	2.4		mg/L	0.10	EPA 365.1	11/16/15	NV	11/20/15 13:05	C_W	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			11/12/15 14:30	THB	K
Surfactants (MBAS)	0.357		mg/L	0.025	S5540C-00			11/11/15 03:30	MBW	J
Total Dissolved Solids	173		mg/L	5	S2540C-11			11/12/15 12:42	ML	B
Total Kjeldahl Nitrogen	13.4		mg/L	4.0	S4500NH3G-11	11/11/15	J1H	11/11/15 13:31	DRM	A
Total Nitrogen	13.4		mg/L	1.00	Calculation			11/22/15 15:33	NJA	A
Total Suspended Solids	222		mg/L	5	S2540D-11			11/11/15 21:56	NV	B
Turbidity	69.2		NTU	0.10	S2130B-01			11/11/15 00:00	MSA	B
METALS										
Hardness	93.7		mg/L	1.7	EPA 200.7	11/11/15	JPS	11/12/15 09:58	TSS	O1
Aluminum, Total	1.8		mg/L	0.040	EPA 200.8	11/12/15	JPS	11/13/15 04:07	ZMC	O2
Antimony, Total	0.0014		mg/L	0.0010	EPA 200.8	11/12/15	JPS	11/13/15 04:07	ZMC	O2
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	11/12/15	JPS	11/13/15 04:07	ZMC	O2

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ANALYTICAL RESULTS

Workorder: 2107040 CSO WW LTCP

Lab ID: **2107040001** Date Collected: 11/10/2015 05:00 Matrix: Water

Sample ID: **CPS/EPS1 (74/26)** Date Received: 11/10/2015 12:05

Parameters	Results	Flag	Units	RDL	Method	Prepared By	Analyzed	By	Cntr
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Chromium, Total	0.0045		mg/L	0.0010	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Copper, Total	0.056		mg/L	0.0025	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Iron, Total	3.7		mg/L	0.15	EPA 200.7	11/11/15 JPS	11/12/15 09:58	TSS	O1
Lead, Total	0.021		mg/L	0.0010	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Mercury, Total	0.00025		mg/L	0.00020	EPA 245.1	11/23/15 MNP	11/23/15 09:41	MNP	O3
Molybdenum, Total	0.0022		mg/L	0.0010	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
Zinc, Total	0.13		mg/L	0.0025	EPA 200.8	11/12/15 JPS	11/13/15 04:07	ZMC	O2
MICROBIOLOGY									
Enterococcus	68700		col/100mL	100	S9230D		11/10/15 12:14	LLJ	Q
Fecal Coliform	3600000	2	col/100mL	100000	S9222D-97		11/10/15 14:50	LLJ	P
Sub'd to NELAP CERTIFIED Lab									
Gross Alpha	0.00		pCi/L		EPA 900.0		11/24/15 09:30	SUB	X
Gross Alpha Uncertainty +/-	1.10		pCi/L		EPA 900.0		11/24/15 09:30	SUB	X
Gross Beta	8.20		pCi/L		EPA 900.0		11/24/15 09:30	SUB	X
Gross Beta Uncertainty +/-	2.10		pCi/L		EPA 900.0		11/24/15 09:30	SUB	X

Mr. Brad W Kintzer
Project Coordinator

ALS Environmental

34 Dogwood Lane ■ Middletown, PA 17057 ■ Phone: 717-944-5541 ■ Fax: 717-944-1430 ■ www.alsglobal.com

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PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2107040001	1	CPS/EPS1 (74/26)	S5210B-11	Carbonaceous BOD
The laboratory control sample associated with this analysis was recovered at 83% which is outside the acceptance limit of 86% to 114%. Reanalysis was not performed due to holding time restrictions.				
2107040001	2	CPS/EPS1 (74/26)	S9222D-97	Fecal Coliform
Analyte was analyzed past the 8 hour holding time.				

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

BWK

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC
ALS

2107040

1 of 2

Client Name: DELCORA	Container Type	plastic	plastic	plastic	plastic	plastic	plastic	glass	glass	glass	plastic
Address: 3201 W. Front Street	Container Size	250ml	1L	500ml	500ml	120ml	120ml	1L	1L	40ml	1L
Chester PA 19013	Preservation	~~NaOH/Zn(O2C~~	~~none~~	~~HNO3~~	~~none~~	~~Na2S2O3~~	~~Na2S2O3~~	~~none~~	~~none~~	~~none~~	~~None~~

Receiving Lab)

Cooler Temp: 2° Therm ID: 77-294

No. of Coolers: ____ Y N Initial

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:

Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT [X] Normal-Standard TAT is 10-12 business days.
[ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.:

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Total Sulfide	CBOD5, CBOD20, BOD5	Metals, Total Hardness	Hexavalent Chromium, Trivalent Chromium	Fecal Coliform	Enterococcus	608	625	624	Gross Alpha/ Beta
					Enter Number of Containers Per Sample or Field Results Below.									
1 CPS/ EPS1 (74/26)	11/10/15	5:00	G	WW	1	2	1	1	1	1	2	2	2	1
2														
3														
4														
5														
6														
7														
8														
9														
10														

Sample/COC Comments

ALS Field Services: Pickup _Labor
_Composite Sampling _Rental Equipment
_Other: _____

Project Comments:

LOGGED BY(signature): _____ DATE: 11/10/15 TIME: 1452

REVIEWED BY(signature): _____ DATE: _____ TIME: _____

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]

Special Processing: USACE [ ] Navy [ ] [ ]

State Samples Collected In: [ ] NY [ ] NJ [X] PA [ ] NC [ ]

Reportable to PADEP? Yes [ ]

PWSID # _____

Sample Disposal: Lab [ ] Special [ ]

EDDS: Format Type- _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Rios	11/10/15	1000	2	11/10	1000
3	11/10	1045	4 ALS	11/10/15	1045
5 ALS	11/10/15	1205	6 ALS	11/10	1205
7			8		
9			10		

*G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 210240 — 2 of 2
ALS Quote #: 514787

Client Name: DELCORA
Address: 3201 W. Front Street, Chester PA 19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT: [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.: _____

Container Type	glass	glass	plastic	plastic	plastic	glass	glass	plastic	glass	plastic
Container Size	1L	1L	500ml	500ml	1L	500ml	250ml	1L	1L	2L
Preservative	H2SO4	H2SO4	none	NaOH	H2SO4	H2SO4	H2SO4	none	none	none

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Oil and Grease	TPH	Nitrate, Nitrite, Turbidity *	Total Cyanide	Total Phosphorus, Ammonia, TKN, Total Nitrogen	Phenolics	TOX	TSS, TDS, DO	Odor	MBAS
					Enter Number of Containers Per Sample or Field Results Below.									
1 CPS/ EPS1 (74/26)	11/10/15	5:00	G	WW	1	1	1	1	1	1	2	1	1	1
2														
3														
4														
5														
6														
7														
8														
9														
10														

Receipt Information (completed by Receiving Lab)
Cooler Temp: 2° C Therm ID: TH-294
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:
Sample/COC Comments

ALS Field Services: [ ] Pickup [ ] Labor [ ] Composite Sampling [ ] Rental Equipment [ ] Other: _____

Project Comments:

LOGGED BY (signature): _____ DATE: 11/10/15 TIME: 1452
REVIEWED BY (signature): _____ DATE: _____ TIME: _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Rios	11/10/15	1000	2	11-10	1000
3 ALS 4M 4/10	11.10	1645	4 ALS	11/10/15	1645
5 ALS	4/10/15	1205	6 ALS	11/10/15	1205
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [X] PA [ ] NC
Reportable to PADEP? Yes [ ]
PWSID #: _____
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type: _____

*G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

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Environmental • Industrial Hygiene • Field Services
34 Dogwood Lane • Middletown, PA 17057 • 717.944.5541 • Fax: 717.944.1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #:	1 of 1
ALSI Quote-#:	

Client Name: ALS Environmental
Address: 34 Dogwood Lane
Middletown, PA 17057
Contact: Brad Kintzer
Phone#: (717) 944-5541
Project Name/#:
Bill To: ALS Environmental

TAT: [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALSI approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y ALMDT.Subcontract@ALSGlobal.com
Fax? [ ] -Y No.: _____

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Container Type	Container Size	Preservative	Gross Alpha & Beta								
					Plastic	1 L	NONE	ANALYSES/METHOD REQUESTED								
1 2107040 001	11/10/15	0500	G	WW				1								
2																
3																
4																
5																
6																
7																
8																
9																
10																

Receipt Information (completed by Receiving Lab)
Cooler Temp: _____ Therm. ID: _____
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier Tracking #: _____

Sample/COC Comments
Subcontract: ALS FL Collins

ALSI Field Services: ☐Pickup ☐Labor ☐Composite Sampling ☐Rental Equipment ☐Other: _____

Project Comments:

LOGGED BY (Signature): _____ Date: _____ Time: _____
REVIEWED BY (Signature): _____ Date: _____ Time: _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1	11/11/15	1530	2		
3			4		
5			6		
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [ ] PA [ ] NC [ ] other
Reportable to PADEP? Yes [ ] PWSID #: _____
Sample Disposal: Lab [ ] Special [ ]
EDDs: Format Type: _____

* G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

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Rev 5/05

ALS

Monday, November 30, 2015

Brad Kintzer
ALS Environmental
34 Dogwood Lane
Middletown, PA 17057

Re: ALS Workorder: 1511233
Project Name:
Project Number: 2107040

Dear Mr. Kintzer:

One water sample was received from ALS Environmental, on 11/12/2015. The sample was scheduled for the following analysis:

Gross Alpha/Beta

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Jeff R. Kujawa
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

ALS Environmental

1511233

Gross Alpha/Beta:
The samples were analyzed for gross alpha and beta activity by gas flow proportional counting according to the current revision of SOP 724. Gross alpha results are referenced to ^{241}Am. Gross beta results are referenced to $^{90}Sr/Y$.

All acceptance criteria were met.

ALS Environmental -- FC

Sample Number(s) Cross-Reference Table

OrderNum: 1511233
Client Name: ALS Environmental
Client Project Name:
Client Project Number: 2107040
Client PO Number: 2107040

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
2107040001	1511233-1		WATER	10-Nov-15	5:00

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Environmental • Industrial Hygiene • Field Services
34 Dogwood Lane • Middletown, PA 17057 • 717.944.5541 • Fax: 717.944.1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 151233 | 1 of 1
ALSI Quote #:

Client Name: ALS Environmental
Address: 34 Dogwood Lane, Middletown, PA 17057
Contact: Brad Kintzer
Phone#: (717) 944-5541
Project Name#:
Bill To: ALS Environmental

TAT: [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALSI approval and surcharges.
Date Required: ASAP Approved By:
Email? [X] Y ALMDT_Subcontract@ALSGlobal.com
Fax? [ ] Y No.

Container Type: Plastic
Container Size: 1 L
Preservative: NONE

ANALYSES/METHOD REQUESTED: Gross Alpha & Beta

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Gross Alpha & Beta
1 2107040001	11/10/15	0500	G	WW	1
2					
3					
4					
5					
6					
7					
8					
9					
10					

Receipt Information (completed by Receiving Lab)
Cooler Temp: ____ Therm. ID: ____
No. of Coolers: ____

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Lauren tracking #:

Sample/COC Comments: Subcontract: ALS Ft. Collins

ALSI Field Services: ☐Pickup ☐Labor ☐Composite Sampling ☐Rental Equipment ☐Other:

Project Comments:
LOGGED BY (signature):
REVIEWED BY (signature):

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1	11/11/15	1530	2 ALS FC	11-12-15	0940
3			4		
5			6		
7			8		
9			10		

Data Deliverables: [ ] Standard (Level II) [ ] CLP-like [ ] USACE
Special Processing: [ ] USACE [ ] Navy [ ] PA
State Samples Collected In: [ ] NY [ ] NJ [ ] PA [ ] NC [ ] Other
Reportable to PADEP? [ ] Yes [ ] No PWS ID #:
Sample Disposal: [ ] Lab [ ] Return [ ] Special
EDDs: Format Type:

*G=Grab; C=Composite **Matrix - A=Air; DW=Drinking Water; GW=Groundwater; O=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

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ALS

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS PA Workorder No: 1511233

Project Manager: SRK Initials: SDM Date: 11-12-15

1. Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	(NONE)	YES	NO
3. Are Custody seals on sample containers intact?	(NONE)	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(YES)	NO
5. Are the COC and bottle labels complete and legible?		(YES)	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		(YES)	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	(YES)	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	(YES)	NO
9. Are all aqueous non-preserved samples pH 4-9?	(N/A)	YES	NO
10. Is there sufficient sample for the requested analyses?		(YES)	NO
11. Were all samples placed in the proper containers for the requested analyses?		(YES)	NO
12. Are all samples within holding times for the requested analyses?		(YES)	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		(YES)	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	(N/A)	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: X dusting ____ moderate ____ heavy	N/A	(YES)	NO
16. Were the samples shipped on ice?		YES	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	(COOLER ONLY)	YES	NO

Cooler #:	1
Temperature (°C):	A-6
No. of custody seals on cooler:	0
DOT Survey/ Acceptance Information — External µR/hr reading:	11
DOT Survey/ Acceptance Information — Background µR/hr reading:	12

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? (YES) NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

→ 15.) light dusting of sediment.

If applicable, was the client contacted? YES / NO (NA) Contact: _____ Date/Time: _____

Project Manager Signature / Date: 11-12-15

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

Page 1 of 6 of 10

Client:	ALS Environmental	**Date:**	*30-Nov-15*
Project:	2107040	**Work Order:**	1511233
Sample ID:	2107040001	**Lab ID:**	1511233-1
Legal Location:		**Matrix:**	WATER
Collection Date:	11/10/2015 05:00	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC			**PAI 724**		Prep Date: **11/20/2015**	Prep By: **ECP**
GROSS ALPHA	ND (+/- 1.1)	U	2.6	pCi/l	NA	11/24/2015 09:30
GROSS BETA	**8.2 (+/- 2.1)**		**2.8**	**pCi/l**	NA	11/24/2015 09:30

Client:	ALS Environmental	**Date:**	*30-Nov-15*
Project:	2107040	**Work Order:**	1511233
Sample ID:	2107040001	**Lab ID:**	1511233-1
Legal Location:		**Matrix:**	WATER
Collection Date:	11/10/2015 05:00	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight',

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received',

G - Sample density differs by more than 15% of LCS density.

D - DER is greater than Control Limit

M - Requested MDC not met.

LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).

U or ND - Indicates that the compound was analyzed for but not detected.

E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.

M - Duplicate injection precision was not met.

N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.

Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.

* - Duplicate analysis (relative percent difference) not within control limits.

S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.

B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.

E - Analyte concentration exceeds the upper level of the calibration range.

J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).

A - A tentatively identified compound is a suspected aldol-condensation product.

X - The analyte was diluted below an accurate quantitation level.

* - The spike recovery is equal to or outside the control criteria used.

+ - The relative percent difference (RPD) equals or exceeds the control criteria.

G - A pattern resembling gasoline was detected in this sample.

D - A pattern resembling diesel was detected in this sample.

M - A pattern resembling motor oil was detected in this sample.

C - A pattern resembling crude oil was detected in this sample.

4 - A pattern resembling JP-4 was detected in this sample.

5 - A pattern resembling JP-5 was detected in this sample.

H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.

L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.

Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

Batch ID: **AB151120-1-5** Instrument ID **LB4100-C** Method: **Gross Alpha/Beta by GFPC**

LCS Sample ID: **AB151120-1** Units: **pCi/l** Analysis Date: **11/24/2015 09:30**

Client ID: Run ID: **AB151120-1A** Prep Date: **11/20/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	248 (+/-41)	3	225.4		110	70-130					P
GROSS BETA	201 (+/-33)	5	203.9		98.7	70-130					P,M3

MB Sample ID: **AB151120-1** Units: **pCi/l** Analysis Date: **11/24/2015 15:01**

Client ID: Run ID: **AB151120-1A** Prep Date: **11/20/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	ND	0.94									U
GROSS BETA	ND	1.08									U

The following samples were analyzed in this batch: 1511233-1

ALS Environmental

34 Dogwood Lane ■ Middletown, PA 17057 ■ Phone: 717-944-5541 ■ Fax: 717-944-1430 ■ www.alsglobal.com

NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

December 16, 2015

Ms. Irene Fitzgerald
DELCORA
P.O. Box 999
Chester, PA 19016

Certificate of Analysis

Project Name:	**2015-LOWER DELAWARE TESTING**	Workorder:	**2109302**
Purchase Order:		Workorder ID:	**2015-LOWER DELAWARE TESTING**

Dear Ms. Fitzgerald:

Enclosed are the analytical results for samples received by the laboratory on Thursday, November 19, 2015.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mr. Brad W Kintzer (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

This laboratory report may not be reproduced, except in full, without the written approval of ALS Environmental.

ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Mr. Ray Rios , Mr. Mike Krause

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Brad W. Kintzer
Mr. Brad W Kintzer
Project Coordinator

ALS Environmental

34 Dogwood Lane ▪ Middletown, PA 17057 ▪ Phone: 717-944-5541 ▪ Fax: 717-944-1430 ▪ www.alsglobal.com

NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

SAMPLE SUMMARY

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2109302001	CPS/EPS1 (72/28)	Water	11/19/2015 15:20	11/19/2015 21:10	Collected by Client
2109302002	CPS1	Water	11/19/2015 15:20	11/19/2015 21:10	Collected by Client
2109302003	14th & Crozer	Water	11/19/2015 15:10	11/19/2015 21:10	Collected by Client
2109302004	Sun & Hancock	Water	11/19/2015 16:10	11/19/2015 21:10	Collected by Client

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit
I	Indicates reported value is greater than or equal to the Method Detection Limit (MDL) but less than the Report Detection Limit (RDL)
(S)	Surrogate Compound
NC	Not Calculated
*	Result outside of QC limits

ALS Environmental

34 Dogwood Lane ■ Middletown, PA 17057 ■ Phone: 717-944-5541 ■ Fax: 717-944-1430 ■ www.alsglobal.com

NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

PROJECT SUMMARY

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Workorder Comments

See attached subcontracted radiological results from ALS-Ft. Collins. VLF

Sample Comments

Lab ID: 2109302001 **Sample ID:** CPS/EPS1 (72/28) **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2109302002 **Sample ID:** CPS1 **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2109302003 **Sample ID:** 14th **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2109302004 **Sample ID:** Sun **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302001** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS/EPS1 (72/28)** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Chloroform	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Toluene	ND		ug/L	5.0	EPA 624			11/21/15 20:54	CJG	S
Total Xylenes	ND		ug/L	15.0	EPA 624			11/21/15 20:54	CJG	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	96.4		%	72 - 142	EPA 624			11/21/15 20:54	CJG	S
4-Bromofluorobenzene (S)	110		%	73 - 119	EPA 624			11/21/15 20:54	CJG	S
Dibromofluoromethane (S)	88.4		%	74 - 132	EPA 624			11/21/15 20:54	CJG	S
Toluene-d8 (S)	98.8		%	75 - 133	EPA 624			11/21/15 20:54	CJG	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Chrysene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
bis(2-Ethylhexyl)phthalate	20.3		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Phenanthrene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	95.9		%	47 - 128	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
2-Fluorobiphenyl (S)	74.4		%	52 - 118	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
2-Fluorophenol (S)	38.9		%	20 - 87	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Nitrobenzene-d5 (S)	84.5		%	27 - 139	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Phenol-d5 (S)	27		%	10 - 81	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Terphenyl-d14 (S)	71.2		%	46 - 133	EPA 625	11/25/15	VLM	11/29/15 22:53	GEC	U
Pesticides and PCBs										
Dieldrin	0.022		ug/L	0.019	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Total Polychlorinated Biphenyl	0.0		ug/L		EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1016	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1221	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1232	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1242	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302001** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS/EPS1 (72/28)** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1254	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Aroclor-1260	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	35.7		%	30 - 150	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
Tetrachloro-m-xylene (S)	52.6		%	36 - 112	EPA 608	11/20/15	JSR	11/23/15 20:34	KJH	W
WET CHEMISTRY										
Ammonia-N	7.36		mg/L	0.100	D6919-09			11/20/15 16:33	JAM	A
Biochemical Oxygen Demand	140	1	mg/L	2.0	S5210B-11			11/20/15 23:22	NAK	B
Carbonaceous BOD	145	2	mg/L	2.0	S5210B-11			11/21/15 06:35	GMM	B
Carbonaceous BOD 20 Day	38.8		mg/L	2.0	S5210B-11			11/21/15 09:00	RMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	11/23/15	MMA	11/25/15 05:30	LJF	G
Dissolved Oxygen	2.4		mg/L	1.0	S4500OG-01			11/25/15 06:50	RMM	B
Halogen, Total Organic (TOX)	35.1		ug/L	20.0	SW846 9020B			11/30/15 14:02	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			11/20/15 04:56	MSA	B
Nitrate-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:08	FSC	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:08	FSC	B
Odor	40		T.O.N.	1	S2150B-97			11/21/16 10:12	MSA	M
Oil/Grease Hexane Extractable	15.0		mg/L	2.0	EPA 1664B			11/22/15 12:00	AT	H
Oil/Grease Silica Gel Treated	3.4		mg/L	2.0	EPA 1664B			11/22/15 12:00	AT	H
Phenolics	0.024		mg/L	0.005	EPA 420.4	12/9/15	NV	12/10/15 16:34	AMH	J
Phosphorus, Total	2.5		mg/L	0.10	EPA 365.1	12/7/15	LJF	12/8/15 04:21	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			11/25/15 21:15	DRM	L
Surfactants (MBAS)	0.652		mg/L	0.025	S5540C-00			11/21/15 05:00	MBW	K
Total Dissolved Solids	232		mg/L	5	S2540C-11			11/24/15 09:45	ML	B
Total Kjeldahl Nitrogen	19.1		mg/L	4.0	S4500NH3G-11	11/25/15	J1H	11/29/15 11:40	NJA	A
Total Nitrogen	19.1		mg/L	1.00	Calculation			12/2/15 14:27	NJA	A
Total Suspended Solids	532	3	mg/L	5	S2540D-11			11/29/15 18:05	NV	B
Turbidity	117		NTU	0.10	S2130B-01			11/21/15 07:01	MSA	B
METALS										
Hardness	94.9		mg/L	1.7	EPA 200.7	11/23/15	JPS	11/24/15 16:59	TSS	P1
Aluminum, Total	1.4		mg/L	0.20	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Antimony, Total	ND		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:34	MO	P3
Arsenic, Total	ND		mg/L	0.0075	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302001** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS/EPS1 (72/28)** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Cadmium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Chromium, Total	ND		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Copper, Total	0.075		mg/L	0.013	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Iron, Total	2.9		mg/L	0.15	EPA 200.7	11/23/15	JPS	11/24/15 16:59	TSS	P1
Lead, Total	0.027		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Mercury, Total	0.00029		mg/L	0.00020	EPA 245.1	12/3/15	MNP	12/3/15 14:07	MNP	P4
Molybdenum, Total	0.0011		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:34	MO	P3
Selenium, Total	ND		mg/L	0.010	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Silver, Total	ND		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Thallium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
Zinc, Total	0.22		mg/L	0.013	EPA 200.8	11/23/15	JPS	11/24/15 03:21	ZMC	P2
MICROBIOLOGY										
Enterococcus	199000		col/100mL	100	S9230D			11/19/15 21:58	ABL	R
Fecal Coliform	3200000		col/100mL	100000	SM9222D+EPA 625/R-92/013 APX F			11/19/15 22:24	ABL	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	ND		pCi/L	2.70	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Alpha Uncertainty +/-	1.60		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta	9.00		pCi/L	2.70	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta Uncertainty +/-	2.20		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y

Mr. Brad W Kintzer
Project Coordinator

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302002** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS1** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Chloroform	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			11/21/15 21:16	CJG	S
Total Xylenes	ND		ug/L	15.0	EPA 624			11/21/15 21:16	CJG	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	100		%	72 - 142	EPA 624			11/21/15 21:16	CJG	S
4-Bromofluorobenzene (S)	115		%	73 - 119	EPA 624			11/21/15 21:16	CJG	S
Dibromofluoromethane (S)	89.6		%	74 - 132	EPA 624			11/21/15 21:16	CJG	S
Toluene-d8 (S)	101		%	75 - 133	EPA 624			11/21/15 21:16	CJG	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Chrysene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
bis(2-Ethylhexyl)phthalate	12.0		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Phenanthrene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	96.5		%	47 - 128	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
2-Fluorobiphenyl (S)	76.5		%	52 - 118	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
2-Fluorophenol (S)	45.3		%	20 - 87	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Nitrobenzene-d5 (S)	90.8		%	27 - 139	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Phenol-d5 (S)	30.9		%	10 - 81	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Terphenyl-d14 (S)	71.2		%	46 - 133	EPA 625	11/25/15	VLM	11/29/15 23:18	GEC	U
Pesticides and PCBs										
Dieldrin	ND		ug/L	0.019	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Total Polychlorinated Biphenyl	0.0		ug/L		EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1016	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1221	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1232	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1242	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1248	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302002** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS1** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1254	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Aroclor-1260	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	29.1	4	%	30 - 150	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
Tetrachloro-m-xylene (S)	49.5		%	36 - 112	EPA 608	11/20/15	JSR	11/23/15 20:56	KJH	W
WET CHEMISTRY										
Ammonia-N	7.47		mg/L	0.100	D6919-09			11/21/15 01:03	JAM	A
Biochemical Oxygen Demand	57.7	1	mg/L	2.0	S5210B-11			11/20/15 23:22	NAK	B
Carbonaceous BOD	81.5	2	mg/L	2.0	S5210B-11			11/21/15 06:35	GMM	B
Carbonaceous BOD 20 Day	7.7		mg/L	2.0	S5210B-11			11/21/15 09:00	RMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	11/23/15	MMA	11/25/15 05:30	LJF	G
Dissolved Oxygen	2.5		mg/L	1.0	S4500OG-01			11/25/15 06:50	RMM	B
Halogen, Total Organic (TOX)	26.0		ug/L	20.0	SW846 9020B			11/30/15 15:46	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			11/20/15 04:56	MSA	B
Nitrate-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:21	FSC	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:21	FSC	B
Odor	30		T.O.N.	1	S2150B-97			11/21/16 10:12	MSA	M
Oil/Grease Hexane Extractable	14.8		mg/L	2.1	EPA 1664B			11/22/15 12:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.1	EPA 1664B			11/22/15 12:00	AT	H
Phenolics	0.068		mg/L	0.005	EPA 420.4	12/9/15	NV	12/10/15 16:35	AMH	J
Phosphorus, Total	2.1		mg/L	0.10	EPA 365.1	12/7/15	LJF	12/8/15 04:21	LJF	A
Sulfide, Total	1.3		mg/L	1.0	S4500S2F-00			11/25/15 21:15	DRM	L
Surfactants (MBAS)	0.557		mg/L	0.025	S5540C-00			11/21/15 05:00	MBW	K
Total Dissolved Solids	186		mg/L	5	S2540C-11			11/24/15 09:45	ML	B
Total Kjeldahl Nitrogen	21.2		mg/L	4.0	S4500NH3G-11	11/25/15	J1H	11/29/15 11:40	NJA	A
Total Nitrogen	21.2		mg/L	1.00	Calculation			12/2/15 14:27	NJA	A
Total Suspended Solids	108	3	mg/L	5	S2540D-11			11/29/15 18:05	NV	B
Turbidity	126		NTU	0.10	S2130B-01			11/21/15 07:01	MSA	B
METALS										
Hardness	85.2		mg/L	0.33	EPA 200.7	11/23/15	JPS	11/24/15 17:44	TSS	P1
Aluminum, Total	1.2		mg/L	0.20	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Antimony, Total	ND		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:38	MO	P3
Arsenic, Total	ND		mg/L	0.0075	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Cadmium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302002** Date Collected: 11/19/2015 15:20 Matrix: Water

Sample ID: **CPS1** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Chromium, Total	0.011		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Copper, Total	0.042		mg/L	0.013	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Iron, Total	2.9		mg/L	0.030	EPA 200.7	11/23/15	JPS	11/24/15 17:44	TSS	P1
Lead, Total	0.028		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Mercury, Total	0.00020		mg/L	0.00020	EPA 245.1	12/3/15	MNP	12/3/15 14:08	MNP	P4
Molybdenum, Total	0.0013		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:38	MO	P3
Selenium, Total	ND		mg/L	0.010	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:38	MO	P3
Thallium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:25	ZMC	P2
Zinc, Total	0.22		mg/L	0.0025	EPA 200.8	11/29/15	JPS	12/1/15 12:38	MO	P3
MICROBIOLOGY										
Enterococcus	>241960 COL/100 ML		col/100mL	100	S9230D			11/19/15 21:58	ABL	R
Fecal Coliform	2600000		col/100mL	100000	SM9222D+EPA 625/R-92/013 APX F			11/19/15 22:24	ABL	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	2.70		pCi/L	2.10	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Alpha Uncertainty +/-	1.40		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta	7.80		pCi/L	2.70	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta Uncertainty +/-	2.00		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302003** Date Collected: 11/19/2015 15:10 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Chloroform	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Toluene	ND		ug/L	5.0	EPA 624			11/21/15 21:38	CJG	S
Total Xylenes	ND		ug/L	15.0	EPA 624			11/21/15 21:38	CJG	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	101		%	72 - 142	EPA 624			11/21/15 21:38	CJG	S
4-Bromofluorobenzene (S)	112		%	73 - 119	EPA 624			11/21/15 21:38	CJG	S
Dibromofluoromethane (S)	90		%	74 - 132	EPA 624			11/21/15 21:38	CJG	S
Toluene-d8 (S)	100		%	75 - 133	EPA 624			11/21/15 21:38	CJG	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Chrysene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
bis(2-Ethylhexyl)phthalate	4.4		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Phenanthrene	ND		ug/L	1.4	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	90.8		%	47 - 128	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
2-Fluorobiphenyl (S)	75		%	52 - 118	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
2-Fluorophenol (S)	40.3		%	20 - 87	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Nitrobenzene-d5 (S)	86.7		%	27 - 139	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Phenol-d5 (S)	27.4		%	10 - 81	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Terphenyl-d14 (S)	69.3		%	46 - 133	EPA 625	11/25/15	VLM	11/29/15 21:38	GEC	U
Pesticides and PCBs										
Dieldrin	ND		ug/L	0.019	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Total Polychlorinated Biphenyl	0.0		ug/L		EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1016	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1221	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1232	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1242	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302003** Date Collected: 11/19/2015 15:10 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1254	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Aroclor-1260	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	46.9		%	30 - 150	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
Tetrachloro-m-xylene (S)	49.7		%	36 - 112	EPA 608	11/20/15	JSR	11/23/15 17:14	KJH	W
WET CHEMISTRY										
Ammonia-N	4.85		mg/L	0.100	D6919-09			11/20/15 16:52	JAM	A
Biochemical Oxygen Demand	51.8	1	mg/L	2.0	S5210B-11			11/20/15 23:22	NAK	B
Carbonaceous BOD	66.7	2	mg/L	2.0	S5210B-11			11/21/15 06:35	GMM	B
Carbonaceous BOD 20 Day	12.8		mg/L	2.0	S5210B-11			11/21/15 09:00	RMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	11/23/15	MMA	11/25/15 05:30	LJF	G
Dissolved Oxygen	4.3		mg/L	1.0	S4500OG-01			11/25/15 06:50	RMM	B
Halogen, Total Organic (TOX)	26.8		ug/L	20.0	SW846 9020B			12/1/15 13:58	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			11/20/15 04:56	MSA	B
Nitrate-N	0.85		mg/L	0.50	EPA 300.0			11/20/15 15:35	FSC	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:35	FSC	B
Odor	20		T.O.N.	1	S2150B-97			11/21/16 10:12	MSA	M
Oil/Grease Hexane Extractable	7.2		mg/L	2.0	EPA 1664B			11/22/15 12:00	AT	H
Oil/Grease Silica Gel Treated	2.3		mg/L	2.0	EPA 1664B			11/22/15 12:00	AT	H
Phenolics	0.016		mg/L	0.005	EPA 420.4	12/9/15	NV	12/10/15 16:36	AMH	J
Phosphorus, Total	1.4		mg/L	0.10	EPA 365.1	12/7/15	LJF	12/8/15 04:21	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			11/25/15 21:15	DRM	L
Surfactants (MBAS)	0.485		mg/L	0.025	S5540C-00			11/21/15 05:00	MBW	K
Total Dissolved Solids	150		mg/L	5	S2540C-11			11/24/15 09:45	ML	B
Total Kjeldahl Nitrogen	14.1		mg/L	4.0	S4500NH3G-11	11/25/15	J1H	11/29/15 11:40	NJA	A
Total Nitrogen	15.0		mg/L	1.00	Calculation			12/7/15 21:21	NJA	A
Total Suspended Solids	140	3	mg/L	5	S2540D-11			11/29/15 18:05	NV	B
Turbidity	37.2		NTU	0.10	S2130B-01			11/21/15 07:01	MSA	B
METALS										
Hardness	58.1		mg/L	0.33	EPA 200.7	11/23/15	JPS	11/24/15 17:48	TSS	P1
Aluminum, Total	0.64		mg/L	0.20	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Antimony, Total	0.0013		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:42	MO	P3
Arsenic, Total	ND		mg/L	0.0075	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302003** Date Collected: 11/19/2015 15:10 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Cadmium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Chromium, Total	0.0094		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Copper, Total	0.033		mg/L	0.013	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Iron, Total	0.76		mg/L	0.030	EPA 200.7	11/23/15	JPS	11/24/15 17:48	TSS	P1
Lead, Total	0.016		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Mercury, Total	ND		mg/L	0.00020	EPA 245.1	12/3/15	MNP	12/3/15 14:09	MNP	P4
Molybdenum, Total	0.0027		mg/L	0.0010	EPA 200.8	11/29/15	JPS	12/1/15 12:42	MO	P3
Selenium, Total	ND		mg/L	0.010	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Silver, Total	ND		mg/L	0.0050	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Thallium, Total	ND		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
Zinc, Total	0.11		mg/L	0.013	EPA 200.8	11/23/15	JPS	11/24/15 03:36	ZMC	P2
MICROBIOLOGY										
Enterococcus	77000		col/100mL	100	S9230D			11/19/15 21:58	ABL	R
Fecal Coliform	470000		col/100mL	10000	SM9222D+EPA 625/R-92/013 APX F			11/19/15 22:24	ABL	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	2.30		pCi/L	2.30	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Alpha Uncertainty +/-	1.30		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta	10.7		pCi/L	2.60	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta Uncertainty +/-	2.40		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302004** Date Collected: 11/19/2015 16:10 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Chloroform	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Toluene	ND		ug/L	5.0	EPA 624			11/21/15 22:00	CJG	S
Total Xylenes	ND		ug/L	15.0	EPA 624			11/21/15 22:00	CJG	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	101		%	72 - 142	EPA 624			11/21/15 22:00	CJG	S
4-Bromofluorobenzene (S)	115		%	73 - 119	EPA 624			11/21/15 22:00	CJG	S
Dibromofluoromethane (S)	92.3		%	74 - 132	EPA 624			11/21/15 22:00	CJG	S
Toluene-d8 (S)	99.9		%	75 - 133	EPA 624			11/21/15 22:00	CJG	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.5	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Chrysene	ND		ug/L	1.5	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
bis(2-Ethylhexyl)phthalate	11.8		ug/L	3.1	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	3.1	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Phenanthrene	ND		ug/L	1.5	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	96.9		%	47 - 128	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
2-Fluorobiphenyl (S)	76.5		%	52 - 118	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
2-Fluorophenol (S)	46.8		%	20 - 87	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Nitrobenzene-d5 (S)	87.1		%	27 - 139	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Phenol-d5 (S)	31.8		%	10 - 81	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Terphenyl-d14 (S)	80.3		%	46 - 133	EPA 625	11/25/15	VLM	11/29/15 23:43	GEC	U
Pesticides and PCBs										
Dieldrin	ND		ug/L	0.019	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Total Polychlorinated Biphenyl	0.0		ug/L		EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1016	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1221	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1232	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1242	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W

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ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302004** Date Collected: 11/19/2015 16:10 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1254	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Aroclor-1260	ND		ug/L	0.46	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	56.1		%	30 - 150	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
Tetrachloro-m-xylene (S)	50.7		%	36 - 112	EPA 608	11/20/15	JSR	11/23/15 14:16	KJH	W
WET CHEMISTRY										
Ammonia-N	1.63		mg/L	0.100	D6919-09			11/20/15 17:11	JAM	A
Biochemical Oxygen Demand	26.2	1	mg/L	2.0	S5210B-11			11/20/15 23:22	NAK	B
Carbonaceous BOD	17.3	2	mg/L	2.0	S5210B-11			11/21/15 06:35	GMM	B
Carbonaceous BOD 20 Day	ND		mg/L	20.0	S5210B-11			11/21/15 09:00	RMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	11/23/15	MMA	11/25/15 05:30	LJF	G
Dissolved Oxygen	5.4		mg/L	1.0	S4500OG-01			11/25/15 06:50	RMM	B
Halogen, Total Organic (TOX)	ND		ug/L	20.0	SW846 9020B			12/1/15 14:34	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			11/20/15 04:56	MSA	B
Nitrate-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:48	FSC	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			11/20/15 15:48	FSC	B
Odor	2		T.O.N.	1	S2150B-97			11/21/16 10:12	MSA	M
Oil/Grease Hexane Extractable	ND		mg/L	2.1	EPA 1664B			11/22/15 12:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.1	EPA 1664B			11/22/15 12:00	AT	H
Phenolics	0.012		mg/L	0.005	EPA 420.4	12/9/15	NV	12/10/15 16:37	AMH	J
Phosphorus, Total	0.56		mg/L	0.10	EPA 365.1	12/7/15	LJF	12/8/15 04:21	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			11/25/15 21:15	DRM	L
Surfactants (MBAS)	0.123		mg/L	0.025	S5540C-00			11/21/15 05:00	MBW	K
Total Dissolved Solids	39		mg/L	5	S2540C-11			11/24/15 09:45	ML	B
Total Kjeldahl Nitrogen	5.3	4	mg/L	1.0	S4500NH3G-11	12/1/15	DRM	12/1/15 12:57	DRM	A
Total Nitrogen	5.30		mg/L	1.00	Calculation			12/7/15 21:21	NJA	A
Total Suspended Solids	76	3	mg/L	5	S2540D-11			11/29/15 18:05	NV	B
Turbidity	26.2		NTU	0.10	S2130B-01			11/21/15 07:01	MSA	B
METALS										
Hardness	18.9		mg/L	0.33	EPA 200.7	11/23/15	JPS	11/24/15 17:52	TSS	P1
Aluminum, Total	0.47		mg/L	0.040	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Antimony, Total	0.0023		mg/L	0.0010	EPA 200.8	11/30/15	JPS	12/1/15 12:49	MO	P3
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2

ALS Environmental

34 Dogwood Lane ▪ Middletown, PA 17057 ▪ Phone: 717-944-5541 ▪ Fax: 717-944-1430 ▪ www.alsglobal.com

NELAP Certifications: NJ PA010 , NY 11759 , PA 22-293 DoD ELAP: A2LA 0818.01
State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2109302 2015-LOWER DELAWARE TESTING

Lab ID: **2109302004** Date Collected: 11/19/2015 16:10 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 11/19/2015 21:10

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Chromium, Total	0.0032		mg/L	0.0010	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Copper, Total	0.025		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Iron, Total	0.72		mg/L	0.030	EPA 200.7	11/23/15	JPS	11/24/15 17:52	TSS	P1
Lead, Total	0.0081		mg/L	0.0010	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Mercury, Total	ND		mg/L	0.00020	EPA 245.1	12/3/15	MNP	12/3/15 14:10	MNP	P4
Molybdenum, Total	0.0031		mg/L	0.0010	EPA 200.8	11/30/15	JPS	12/1/15 12:49	MO	P3
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
Zinc, Total	0.14		mg/L	0.0025	EPA 200.8	11/23/15	JPS	11/24/15 03:40	ZMC	P2
MICROBIOLOGY										
Enterococcus	8160		col/100mL	10	S9230D			11/19/15 21:58	ABL	R
Fecal Coliform	1260000		col/100mL	10000	SM9222D+EPA 625/R-92/013 APX F			11/19/15 22:24	ABL	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	2.30		pCi/L	2.20	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Alpha Uncertainty +/-	1.30		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta	6.50		pCi/L	2.70	EPA 900.0			12/2/15 12:07	SUB	Y
Gross Beta Uncertainty +/-	1.90		pCi/L		EPA 900.0			12/2/15 12:07	SUB	Y

Mr. Brad W Kintzer
Project Coordinator

PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2109302001	1	CPS/EPS1 (72/28)	S5210B-11	Biochemical Oxygen Demand
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.26 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302001	2	CPS/EPS1 (72/28)	S5210B-11	Carbonaceous BOD
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.22 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302001	3	CPS/EPS1 (72/28)	S2540D-11	Total Suspended Solids
This sample was analyzed after the 7 day holding time for total suspended solids had expired.				
2109302002	1	CPS1	S5210B-11	Biochemical Oxygen Demand
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.26 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302002	2	CPS1	S5210B-11	Carbonaceous BOD
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.22 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302002	3	CPS1	S2540D-11	Total Suspended Solids
This sample was analyzed after the 7 day holding time for total suspended solids had expired.				
2109302002	4	CPS1	EPA 608	Decachlorobiphenyls
The surrogate Decachlorobiphenyls for method EPA 608 was outside of control limits. The % Recovery was reported as 29.1 and the control limits were 30 to 150. This result was reported at a dilution of 1.				
2109302003	1	14th & Crozer	S5210B-11	Biochemical Oxygen Demand
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.26 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302003	2	14th & Crozer	S5210B-11	Carbonaceous BOD
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.22 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302003	3	14th & Crozer	S2540D-11	Total Suspended Solids
This sample was analyzed after the 7 day holding time for total suspended solids had expired.				
2109302004	1	Sun & Hancock	S5210B-11	Biochemical Oxygen Demand
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.26 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302004	2	Sun & Hancock	S5210B-11	Carbonaceous BOD
The dilution water blank associated with this analyte had a dissolved oxygen depletion of 0.22 mg/l. Criteria states that the depletion should be at a maximum 0.2 mg/l.				
2109302004	3	Sun & Hancock	S2540D-11	Total Suspended Solids
This sample was analyzed after the 7 day holding time for total suspended solids had expired.				
2109302004	4	Sun & Hancock	S4500NH3G-11	Total Kjeldahl Nitrogen
The recovery of the Matrix Spike (MS) associated to this analyte was outside of the established control limits.				

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ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

B

COC ALS

* 2 1 0 9 3 0 2 *

Client Name: DELCORA
Address: 3201 W. Front Street
Chester PA 19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.: _____

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Container Type	Container Size	Preservative	Total Sulfide	CBOD5, CBOD20, BOD5	Metals, Total Hardness	Hexavalent Chromium, Trivalent Chromium	Fecal Coliform	Enterococcus	608	625	624	Gross Alpha/ Beta
					plastic	250ml	HZn(O2C	plastic	plastic	plastic	plastic	plastic	plastic	glass	glass	glass	plastic
								1L	500ml	500ml	120ml	120ml	1L	1L	40ml	1L	
								none	HNO3	none	Na2S2O3	Na2S2O3	none	none	none	None	
					ANALYSES/METHOD REQUESTED												
					Enter Number of Containers Per Sample or Field Results Below.												
1 CPS/ EPS1 (72/28)	11/19/15	15:20	G	WW	1	2	1	1	1	1	2	2	2	1			
2 CPS1	11/19/15	15:20	G	WW	1	2	1	1	1	1	2	2	2	1			
3 14th & Crozer	11/19/15	15:10	G	WW	1	2	1	1	1	1	2	2	2	1			
4 Sun & Hancock	11/19/15	16:10	G	WW	1	2	1	1	1	1	2	2	2	1			
5																	
6																	
7																	
8																	
9																	
10																	

Receipt Information (completed by Receiving Lab)
Cooler Temp: 1 Therm ID: 294
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?	✓		
COC/Labels Complete/Accurate?	✓		
Cont. in Good Cond.?	✓		
Correct Containers?	✓		
Correct Sample Volumes?	✓		
Correct Preservation?	✓		
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

MICRO REC'D 11/19/15 2110

ALS Field Services: __Pickup __Labor __Composite Sampling __Rental Equipment __Other: _____

Project Comments:

LOGGED BY (signature): _____ DATE: 11/20/15 TIME: 0910
REVIEWED BY (signature): _____ DATE: _____ TIME: _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Rios	11/19/15	1704	2	11-19	1705
3	11-19	1905	4	11/19	1905
5	11/19	2110	6	11/19/15	2115
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [x] PA [ ] NC [ ]
Reportable to PADEP? Yes [ ] PWSID # _____
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type- _____

* G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

Wednesday, December 16, 2015 5:19:04 PM
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ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 210930 — 2 of 2
ALS Quote #: 514787

Client Name: DELCORA
Address: 3201 W. Front Street
Chester PA 19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.: _____

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Oil and Grease	TPH	Nitrate, Nitrite, Turbidity	Total Cyanide	Total Phosphorus, Ammonia, TKN, Total Nitrogen	Phenolics	TOX	TSS, TDS, DO	Odor	MBAS
Container Type					glass	glass	plastic	plastic	plastic	glass	glass	plastic	glass	plastic
Container Size					1L	1L	500ml	500ml	1L	500ml	250ml	1L	1L	2L
Preservative					H2SO4	H2SO4	none	NaOH	H2SO4	H2SO4	H2SO4	none	none	none
					ANALYSES/METHOD REQUESTED									
					Enter Number of Containers Per Sample or Field Results Below.									
1 CPS/ EPS1 (72/28)	11-19-15	15:20	G	WW	1	1	1	1	1	1	2	1	1	1
2 CPS1	11-19-15	15:20	G	WW	1	1	1	1	1	1	2	1	1	1
3 14th & Crozer	11-19-15	15:10	G	WW	1	1	1	1	1	1	2	1	1	1
4 Sun & Hancock	11-19-15	16:10	G	WW	1	1	1	1	1	1	2	1	1	1
5	11-19													
6														
7														
8														
9														
10														

Receipt Information (completed by Receiving Lab)
Cooler Temp: 1 Therm ID: 244
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?	✓		
COC/Labels Complete/Accurate?	✓		
Cont. in Good Cond.?	✓		
Correct Containers?	✓		
Correct Sample Volumes?	✓		
Correct Preservation?	✓		
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: _Pickup _Labor _Composite Sampling _Rental Equipment _Other: _____

Project Comments:

LOGGED BY(signature): _____ DATE _____ TIME _____
REVIEWED BY(signature): _____ DATE _____ TIME _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Reed	11/19/15	1705	2 Bradley Dean A	11/19	1705
3 Dean A	11-19	1905	4	11/19	1905
5	11/19	2100	6	11/19-15	2110
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [x] PA [ ] NC [ ]
Reportable to PADEP? Yes [ ]
PWSID # _____
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type- _____

*G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: _____ of _____

ALS Quote #: _____

Client Name: ALS Environmental - Middletown

Address: 34 Dogwood Lane
Middletown, PA 17057

Contact: Brad Kintzer

Phone#:

Project Name/#: DELCORA

Bill To:

TAT [X] Normal-Standard TAT is 10-12 business days.
[ ] Rush-Subject to ALS approval and surcharges.

Date Required: _____ Approved By: _____

Email? [X] -Y

Fax? [ ] -Y No.:

Container Type	P
Container Size	1L
Preservative	HNO3

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Gross Alpha/Beta	Subcontract to: ALS - Ft. Collins	Enter Number of Containers Per Sample or Field Results Below.
1 2109302001	11/19/15	1520	G	WW	1		
2 2109302002	11/19/15	1520	G	WW	1		
3 2109302003	11/19/15	1510	G	WW	1		
4 2109302~~003~~ 004	11/19/15	1610	G	WW	1		
5 SSL 11/24/15 23							
6							
7							
8							
9							
10							

Receipt Information (completed by Receiving Lab)

Cooler Temp: _____ Therm ID: _____

	Y	N	Initial
No. of Coolers:			
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: _Pickup _Labor
_Composite Sampling _Rental Equipment
_Other: _____

Project Comments:

LOGGED BY(signature): Date: TAT:

REVIEWED BY(signature): Date: TAT:

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 [signature]	11/23/15	1520	2		
3			4		
5			6		
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]

Special Processing: USACE [ ] Navy [ ]

State Samples Collected in: [ ] NY [ ] NJ [ ] PA [ ] NC [ ]

Reportable to PADEP? Yes [ ]

PWSID # _____

Sample Disposal: Lab [ ] Special [ ]

EDDS: Format Type- _____

*G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

Thursday, December 10, 2015

Brad Kintzer
ALS Environmental
34 Dogwood Lane
Middletown, PA 17057

Re: ALS Workorder: 1511447
Project Name:
Project Number: 2109302

Dear Mr. Kintzer:

Four water samples were received from ALS Environmental, on 11/24/2015. The samples were scheduled for the following analysis:

Gross Alpha/Beta

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Jeff R. Kujawa
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

ALS Environmental

1511451

Gross Alpha/Beta:
The sample was analyzed for gross alpha and beta activity by gas flow proportional counting according to the current revision of SOP 724. Gross alpha results are referenced to ^{241}Am. Gross beta results are referenced to $^{90}Sr/Y$.

All acceptance criteria were met.

ALS Environmental -- FC

Sample Number(s) Cross-Reference Table

OrderNum: 1511447
Client Name: ALS Environmental
Client Project Name:
Client Project Number: 2109302
Client PO Number: 2109302

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
2109302001	1511447-1		WATER	19-Nov-15	15:20
2109302002	1511447-2		WATER	19-Nov-15	15:20
2109302003	1511447-3		WATER	19-Nov-15	15:10
2109302004	1511447-4		WATER	19-Nov-15	16:10

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F. 717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 151447 of

ALS Quote #:

Client Name: ALS Environmental - Middletown
Address: 34 Dogwood Lane, Middletown, PA 17057
Contact: Brad Kintzer
Phone#:
Project Name/#: DELCORA
Bill To:

TAT: [X] Normal-Standard TAT is 10-12 business days [ ] Rush-Subject to ALS approval and surcharges.
Date Required: Approved By:
Email? [X] Y
Fax? [ ] Y No

Container Type	P
Container Size	1L
Preservative	HNO3

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Gross Alpha/Beta	Subcontract to ALS-FtCollins	Enter Number of Containers Per Sample or Field Results Below.
1 2109302001 (1)	11/19/15	1520	G	WW			
2 2109302002 (2)	11/19/15	1520	G	WW			
3 2109302003 (3)	11/19/15	1510	G	WW			
4 2109302003 (4)	11/19/15	1610	G	WW	1		
5							
6							
7							
8							
9							
10							

Receipt Information (completed by Receiving Lab)

Cooler Temp: ____ Therm ID: ____
No. of Coolers: ____

	Y	N	Initial
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: _Pickup _Labor _Composite Sampling _Rental Equipment _Other:

Project Comments:

LOGGED BY(signature): Date:
REVIEWED BY(signature): Date:

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1	11/23/15	1520	2 ALS FC	11/24/15	0950
3			4		
5			6		
7			8		
9			10		

Deliverables: [ ] Standard [ ] CLP-like [ ] USACE

Special Processing: [ ] USACE [ ] Navy

State Samples Collected In: [ ] NY [ ] NJ [ ] PA [ ] NC

Reportable to PADEP? [ ] Yes [ ] No PWSID #:

Sample Disposal: [ ] Lab [ ] Special

EDDS: Format Type:

* G=Grab; C=Composite ** Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

ALS

ALS Environmental - Fort Collins

CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS PA Workorder No: 1511447

Project Manager: JRK Initials: SDM Date: 11-24-15

1. Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	(NONE)	YES	NO
3. Are Custody seals on sample containers intact?	(NONE)	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(YES)	NO
5. Are the COC and bottle labels complete and legible?		(YES)	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of containers, matrix, requested analyses, etc.)		YES	(NO)
7. Were airbills / shipping documents present and/or removable?	DROP OFF	(YES)	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	(YES)	NO
9. Are all aqueous non-preserved samples pH 4-9?	(N/A)	YES	NO
10. Is there sufficient sample for the requested analyses?		(YES)	NO
11. Were all samples placed in the proper containers for the requested analyses?		(YES)	NO
12. Are all samples within holding times for the requested analyses?		(YES)	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		(YES)	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	(N/A)	YES	NO
15. Do any water samples contain sediment? Amount of sediment: K dusting ____ moderate ____ heavy	N/A	(YES)	NO
16. Were the samples shipped on ice?		YES	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	(RAD ONLY)	YES	NO

Cooler #:	1						
Temperature (°C):	Amb						
No. of custody seals on cooler:	0						
DOT Survey Acceptance Information: External µR/hr reading:	12						
Background µR/hr reading:	12						

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? (YES) / NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

6.) Sample 4 → Sample ID on bottle says → 2109302004
COC says 2109302003 → Sample date & time match.

15.) Samples 1 through 4 have a dusting of sediment.

If applicable, was the client contacted? YES / NO / (NA) Contact: _____ Date/Time: _____

Project Manager Signature / Date: [signature] 11-24-15

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

1511407

7 of 13

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package,-whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

Client:	ALS Environmental	**Date:**	*10-Dec-15*
Project:	2109302	**Work Order:**	1511447
Sample ID:	2109302001	**Lab ID:**	1511447-1
Legal Location:		**Matrix:**	WATER
Collection Date:	11/19/2015 15:20	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **11/30/2015**	PrepBy: **ECP**
GROSS ALPHA	ND (+/- 1.6)	U	2.7	pCi/l	NA	12/2/2015 12:07
GROSS BETA	**9 (+/- 2.2)**		**2.7**	**pCi/l**	NA	12/2/2015 12:07

Client:	ALS Environmental	**Date:**	*10-Dec-15*
Project:	2109302	**Work Order:**	1511447
Sample ID:	2109302002	**Lab ID:**	1511447-2
Legal Location:		**Matrix:**	WATER
Collection Date:	11/19/2015 15:20	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **11/30/2015**	PrepBy: **ECP**
GROSS ALPHA	2.7 (+/- 1.4)	LT	2.1	pCi/l	NA	12/2/2015 12:07
GROSS BETA	7.8 (+/- 2)		2.7	pCi/l	NA	12/2/2015 12:07

Client:	ALS Environmental	**Date:**	*10-Dec-15*
Project:	2109302	**Work Order:**	1511447
Sample ID:	2109302003	**Lab ID:**	1511447-3
Legal Location:		**Matrix:**	WATER
Collection Date:	11/19/2015 15:10	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **11/30/2015**	PrepBy: **ECP**
GROSS ALPHA	2.3 (+/- 1.3)	LT	2.3	pCi/l	NA	12/2/2015 12:07
GROSS BETA	10.7 (+/- 2.4)		2.6	pCi/l	NA	12/2/2015 12:07

Client:	ALS Environmental	**Date:**	*10-Dec-15*
Project:	2109302	**Work Order:**	1511447
Sample ID:	2109302004	**Lab ID:**	1511447-4
Legal Location:		**Matrix:**	WATER
Collection Date:	11/19/2015 16:10	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		PAI 724			Prep Date: 11/30/2015	PrepBy: ECP
GROSS ALPHA	2.3 (+/- 1.3)	LT	2.2	pCi/l	NA	12/2/2015 12:07
GROSS BETA	6.5 (+/- 1.9)		2.7	pCi/l	NA	12/2/2015 12:07

Client:	ALS Environmental	**Date:**	*10-Dec-15*
Project:	2109302	**Work Order:**	1511447
Sample ID:	2109302004	**Lab ID:**	1511447-4
Legal Location:		**Matrix:**	WATER
Collection Date:	11/19/2015 16:10	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

" - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.

G - Sample density differs by more than 15% of LCS density.

D - DER is greater than Control Limit

M - Requested MDC not met.

LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).

U or ND - Indicates that the compound was analyzed for but not detected.

E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.

M - Duplicate injection precision was not met.

N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.

Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.

* - Duplicate analysis (relative percent difference) not within control limits.

S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.

B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.

E - Analyte concentration exceeds the upper level of the calibration range.

J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).

A - A tentatively identified compound is a suspected aldol-condensation product.

X - The analyte was diluted below an accurate quantitation level.

* - The spike recovery is equal to or outside the control criteria used.

+ - The relative percent difference (RPD) equals or exceeds the control criteria.

G - A pattern resembling gasoline was detected in this sample.

D - A pattern resembling diesel was detected in this sample.

M - A pattern resembling motor oil was detected in this sample.

C - A pattern resembling crude oil was detected in this sample.

4 - A pattern resembling JP-4 was detected in this sample.

5 - A pattern resembling JP-5 was detected in this sample.

H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.

L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.

Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

ALS Environmental -- FC

Client: ALS Environmental
Work Order: 1511447
Project: 2109302

Date: *12/10/2015 4:58*

QC BATCH REPORT

Batch ID: **AB151130-1-3** Instrument ID **LB4100-C** Method: **Gross Alpha/Beta by GFPC**

LCS Sample ID: **AB151130-1** Units: **pCi/l** Analysis Date: **12/2/2015 13:39**
Client ID: Run ID: **AB151130-1A** Prep Date: **11/30/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	239 (+/- 43)	7	225.4		106	70-130					P,M3
GROSS BETA	197 (+/- 34)	12	203.8		96.6	70-130					P,M3

LCSD Sample ID: **AB151130-1** Units: **pCi/l** Analysis Date: **12/2/2015 13:39**
Client ID: Run ID: **AB151130-1A** Prep Date: **11/30/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	208 (+/- 39)	7	225.4		92.5	70-130		239	0.5	2.1	P,M3
GROSS BETA	200 (+/- 35)	11	203.8		98.2	70-130		197	0.07	2.1	P,M3

MB Sample ID: **AB151130-1** Units: **pCi/l** Analysis Date: **12/3/2015 12:06**
Client ID: Run ID: **AB151130-1A** Prep Date: **11/30/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	ND	0.81									U
GROSS BETA	ND	1.04									U

The following samples were analyzed in this batch: 1511447-1 1511447-2 1511447-3 1511447-4

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

January 7, 2016

Ms. Irene Fitzgerald
DELCORA
P.O. Box 999
Chester, PA 19016

Certificate of Analysis

Revised Report - 1/7/2016 6:17:18 AM - See workorder comment section for explanation

Project Name:	**2015-LOWER DELAWARE TESTING**	Workorder:	**2110770**
Purchase Order:		Workorder ID:	**2015-LOWER DELAWARE TESTING**

Dear Ms. Fitzgerald:

Enclosed are the analytical results for samples received by the laboratory on Tuesday, December 1, 2015.

The ALS Environmental laboratory in Middletown, Pennsylvania is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory and as such, certifies that all applicable test results meet the requirements of NELAP.

If you have any questions regarding this certificate of analysis, please contact Mr. Brad W Kintzer (Project Coordinator) at (717) 944-5541.

Analyses were performed according to our laboratory's NELAP-approved quality assurance program and any applicable state requirements. The test results meet requirements of the current NELAP standards or state requirements, where applicable. For a specific list of accredited analytes, refer to the certifications section of the ALS website at www.alsglobal.com/en/Our-Services/Life-Sciences/Environmental/Downloads.

This laboratory report may not be reproduced, except in full, without the written approval of ALS Environmental.

ALS Spring City: 10 Riverside Drive, Spring City, PA 19475 610-948-4903

CC: Mr. Ray Rios , Mr. Mike Krause

This page is included as part of the Analytical Report and must be retained as a permanent record thereof.

Brad W. Kintzer
Mr. Brad W Kintzer
Project Coordinator

ALS Environmental

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

SAMPLE SUMMARY

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID	Sample ID	Matrix	Date Collected	Date Received	Collected By
2110770001	CPS/EPS1 (72/28) LTCPWWCSO	Water	12/1/2015 09:43	12/1/2015 13:55	Mr. Ray Rios
2110770002	CPS1	Water	12/1/2015 09:43	12/1/2015 13:55	Mr. Ray Rios
2110770003	14th & Crozer	Water	12/1/2015 09:20	12/1/2015 13:55	Mr. Ray Rios
2110770004	Sun & Hancock	Water	12/1/2015 11:00	12/1/2015 13:55	Mr. Ray Rios

Notes

-- Samples collected by ALS personnel are done so in accordance with the procedures set forth in the ALS Field Sampling Plan (20 - Field Services Sampling Plan).
-- All Waste Water analyses comply with methodology requirements of 40 CFR Part 136.
-- All Drinking Water analyses comply with methodology requirements of 40 CFR Part 141.
-- Unless otherwise noted, all quantitative results for soils are reported on a dry weight basis.
-- The Chain of Custody document is included as part of this report.
-- All Library Search analytes should be regarded as tentative identifications based on the presumptive evidence of the mass spectra. Concentrations reported are estimated values.
-- Parameters identified as "analyze immediately" require analysis within 15 minutes of collection. Any "analyze immediately" parameters not listed under the header "Field Parameters" are preformed in the laboratory and are therefore analyzed out of hold time.
-- Method references listed on this report beginning with the prefix “S” followed by a method number (such as S2310B-97) refer to methods from “Standard Methods for the Examination of Water and Wastewater”.

Standard Acronyms/Flags

J	Indicates an estimated value between the Method Detection Limit (MDL) and the Practical Quantitation Limit (PQL) for the analyte
U	Indicates that the analyte was Not Detected (ND)
N	Indicates presumptive evidence of the presence of a compound
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
RDL	Reporting Detection Limit
ND	Not Detected - indicates that the analyte was Not Detected at the RDL
Cntr	Analysis was performed using this container
RegLmt	Regulatory Limit
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
DUP	Sample Duplicate
%Rec	Percent Recovery
RPD	Relative Percent Difference
LOD	DoD Limit of Detection
LOQ	DoD Limit of Quantitation
DL	DoD Detection Limit
I	Indicates reported value is greater than or equal to the Method Detection Limit (MDL) but less than the Report Detection Limit (RDL)
(S)	Surrogate Compound
NC	Not Calculated
*	Result outside of QC limits

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PROJECT SUMMARY

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Workorder Comments

See attached subcontracted radiological results from ALS-Ft. Collins. VLF 12/23/15

This report was modified on 1/6/16 to add Total Nitogen to all samples. BWK

Sample Comments

Lab ID: 2110770001 **Sample ID:** CPS/EPS1 (72/28) LTCPWWCSO **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2110770002 **Sample ID:** CPS1 **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2110770003 **Sample ID:** 14th **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

Lab ID: 2110770004 **Sample ID:** Sun **Sample Type:** SAMPLE

MBAS calculated as LAS molecular weight 342 g/mol.

The reporting limits for GCMS volatile analytes were raised due to the dilution of the sample caused by matrix.

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770001** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS/EPS1 (72/28) LTCPWWCSO** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Chloroform	5.7		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Toluene	8.6		ug/L	5.0	EPA 624			12/2/15 23:49	DD	S
Total Xylenes	ND		ug/L	15.0	EPA 624			12/2/15 23:49	DD	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	100		%	72 - 142	EPA 624			12/2/15 23:49	DD	S
4-Bromofluorobenzene (S)	97.4		%	73 - 119	EPA 624			12/2/15 23:49	DD	S
Dibromofluoromethane (S)	86		%	74 - 132	EPA 624			12/2/15 23:49	DD	S
Toluene-d8 (S)	90.5		%	75 - 133	EPA 624			12/2/15 23:49	DD	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Chrysene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
bis(2-Ethylhexyl)phthalate	9.1		ug/L	2.8	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Phenanthrene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	100		%	47 - 128	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
2-Fluorobiphenyl (S)	74		%	52 - 118	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
2-Fluorophenol (S)	35.2		%	20 - 87	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Nitrobenzene-d5 (S)	72.4		%	27 - 139	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Phenol-d5 (S)	28		%	10 - 81	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Terphenyl-d14 (S)	81		%	46 - 133	EPA 625	12/3/15	CAC	12/4/15 09:54	DHF	U
Pesticides and PCBs										
Dieldrin	0.023		ug/L	0.019	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Total Polychlorinated Biphenyl	|		ug/L		EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1016	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1221	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1232	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1242	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770001** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS/EPS1 (72/28) LTCPWWCSO** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1254	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Aroclor-1260	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	43.6		%	30 - 150	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
Tetrachloro-m-xylene (S)	52.3		%	36 - 112	EPA 608	12/7/15	JSR	12/9/15 17:33	RWS	W
WET CHEMISTRY										
Ammonia-N	27.4		mg/L	0.100	D6919-09			12/2/15 19:05	JAM	A
Biochemical Oxygen Demand	119		mg/L	2.0	S5210B-11			12/2/15 04:20	GMM	B
Carbonaceous BOD	105		mg/L	2.0	S5210B-11			12/2/15 06:55	GMM	B
Carbonaceous BOD 20 Day	260		mg/L	2.0	S5210B-11			12/2/15 11:27	GMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	12/14/15	MMA	12/15/15 00:20	LJF	G
Dissolved Oxygen	2.2		mg/L	1.0	S4500OG-01			12/7/15 07:28	RMM	B
Halogen, Total Organic (TOX)	53.4		ug/L	20.0	SW846 9020B			12/9/15 11:01	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			12/2/15 01:11	MSA	B
Nitrate-N	0.65		mg/L	0.50	EPA 300.0			12/2/15 11:57	JP	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			12/2/15 11:57	JP	B
Odor	10		T.O.N.	1	S2150B-97			12/2/15 04:05	MSA	M
Oil/Grease Hexane Extractable	20.7		mg/L	2.0	EPA 1664B			12/6/15 14:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.0	EPA 1664B			12/6/15 14:00	AT	H
Phenolics	0.050		mg/L	0.005	EPA 420.4	12/14/15	NV	12/17/15 11:42	AMH	J
Phosphorus, Total	3.4		mg/L	0.10	EPA 365.1	12/4/15	NV	12/10/15 04:17	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			12/2/15 19:10	DRM	L
Surfactants (MBAS)	0.539		mg/L	0.025	S5540C-00			12/3/15 02:25	MBW	K
Total Dissolved Solids	300		mg/L	5	S2540C-11			12/2/15 08:53	ML	B
Total Kjeldahl Nitrogen	33.9		mg/L	4.0	S4500NH3G-11	12/3/15	J1H	12/8/15 11:00	C_W	A
Total Nitrogen	34.6		mg/L	1.20	Calculation			1/6/16 20:51	NJA	A
Total Suspended Solids	190		mg/L	5	S2540D-11			12/1/15 22:18	NV	B
Turbidity	87.2		NTU	0.10	S2130B-01			12/3/15 03:09	MSA	B
METALS										
Hardness	137		mg/L	0.66	EPA 200.7	12/2/15	JPS	12/3/15 13:05	TSS	P1
Trivalent Chromium	ND		mg/L	0.010	Calculation			12/15/15 10:51	AGM	B
Aluminum, Total	0.75		mg/L	0.040	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Antimony, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770001** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS/EPS1 (72/28) LTCPWWCSO** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Chromium, Total	0.0048		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Copper, Total	0.066		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Iron, Total	2.7		mg/L	0.060	EPA 200.7	12/2/15	JPS	12/3/15 13:05	TSS	P1
Lead, Total	0.0094		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Mercury, Total	ND		mg/L	0.00020	EPA 245.1	12/10/15	MNP	12/10/15 12:09	MNP	P3
Molybdenum, Total	0.0018		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
Zinc, Total	0.12		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:29	ZMC	P2
MICROBIOLOGY										
Enterococcus	242000		col/100mL	100	S9230D			12/1/15 14:18	LLJ	R
Fecal Coliform	21000000		col/100mL	1000000	SM9222D+EPA 625/R-92/013 APX F			12/1/15 15:04	LLJ	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	ND		pCi/L	2.60	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Alpha Uncertainty +/-	1.20		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta	10.5		pCi/L	2.80	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta Uncertainty +/-	2.40		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770002** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS1** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Chloroform	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Toluene	ND		ug/L	5.0	EPA 624			12/2/15 23:27	DD	S
Total Xylenes	ND		ug/L	15.0	EPA 624			12/2/15 23:27	DD	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	97.1		%	72 - 142	EPA 624			12/2/15 23:27	DD	S
4-Bromofluorobenzene (S)	97.8		%	73 - 119	EPA 624			12/2/15 23:27	DD	S
Dibromofluoromethane (S)	86.1		%	74 - 132	EPA 624			12/2/15 23:27	DD	S
Toluene-d8 (S)	89.4		%	75 - 133	EPA 624			12/2/15 23:27	DD	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Chrysene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
bis(2-Ethylhexyl)phthalate	7.3		ug/L	2.8	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Phenanthrene	ND		ug/L	1.4	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	98.4		%	47 - 128	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
2-Fluorobiphenyl (S)	74		%	52 - 118	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
2-Fluorophenol (S)	35		%	20 - 87	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Nitrobenzene-d5 (S)	74.3		%	27 - 139	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Phenol-d5 (S)	26.6		%	10 - 81	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Terphenyl-d14 (S)	82.4		%	46 - 133	EPA 625	12/3/15	CAC	12/4/15 10:21	DHF	U
Pesticides and PCBs										
Dieldrin	0.020		ug/L	0.019	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Total Polychlorinated Biphenyl	|		ug/L		EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1016	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1221	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1232	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1242	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770002** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS1** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1254	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Aroclor-1260	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	32.1		%	30 - 150	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
Tetrachloro-m-xylene (S)	51.2		%	36 - 112	EPA 608	12/7/15	JSR	12/9/15 17:55	RWS	W
WET CHEMISTRY										
Ammonia-N	20.0		mg/L	0.100	D6919-09			12/2/15 19:24	JAM	A
Biochemical Oxygen Demand	94.0		mg/L	2.0	S5210B-11			12/2/15 04:20	GMM	B
Carbonaceous BOD	92.3		mg/L	2.0	S5210B-11			12/2/15 06:55	GMM	B
Carbonaceous BOD 20 Day	151		mg/L	2.0	S5210B-11			12/2/15 11:27	GMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	12/14/15	MMA	12/15/15 00:20	LJF	G
Dissolved Oxygen	2.5		mg/L	1.0	S4500OG-01			12/7/15 07:28	RMM	B
Halogen, Total Organic (TOX)	36.1		ug/L	20.0	SW846 9020B			12/9/15 11:36	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			12/2/15 01:11	MSA	B
Nitrate-N	0.90		mg/L	0.50	EPA 300.0			12/2/15 12:10	JP	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			12/2/15 12:10	JP	B
Odor	5		T.O.N.	1	S2150B-97			12/2/15 04:05	MSA	M
Oil/Grease Hexane Extractable	12.4		mg/L	2.1	EPA 1664B			12/6/15 14:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.1	EPA 1664B			12/6/15 14:00	AT	H
Phenolics	0.028		mg/L	0.005	EPA 420.4	12/14/15	NV	12/17/15 11:43	AMH	J
Phosphorus, Total	2.5		mg/L	0.10	EPA 365.1	12/4/15	NV	12/10/15 04:17	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			12/2/15 19:10	DRM	L
Surfactants (MBAS)	0.505		mg/L	0.025	S5540C-00			12/3/15 02:25	MBW	K
Total Dissolved Solids	277		mg/L	5	S2540C-11			12/2/15 08:53	ML	B
Total Kjeldahl Nitrogen	23.5		mg/L	4.0	S4500NH3G-11	12/3/15	J1H	12/8/15 11:00	C_W	A
Total Nitrogen	24.4		mg/L	1.20	Calculation			12/14/15 14:11	NJA	A
Total Suspended Solids	186		mg/L	5	S2540D-11			12/1/15 22:18	NV	B
Turbidity	81.9		NTU	0.10	S2130B-01			12/3/15 03:09	MSA	B
METALS										
Hardness	127		mg/L	0.66	EPA 200.7	12/2/15	JPS	12/3/15 13:17	TSS	P1
Trivalent Chromium	ND		mg/L	0.010	Calculation			12/15/15 10:52	AGM	B
Aluminum, Total	0.40		mg/L	0.040	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Antimony, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770002** Date Collected: 12/1/2015 09:43 Matrix: Water

Sample ID: **CPS1** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Chromium, Total	0.0014		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Copper, Total	0.041		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Iron, Total	1.3		mg/L	0.060	EPA 200.7	12/2/15	JPS	12/3/15 13:17	TSS	P1
Lead, Total	0.0096		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Mercury, Total	ND		mg/L	0.00020	EPA 245.1	12/10/15	MNP	12/10/15 12:10	MNP	P3
Molybdenum, Total	0.0012		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
Zinc, Total	0.13		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:33	ZMC	P2
MICROBIOLOGY										
Enterococcus	199000		col/100mL	100	S9230D			12/1/15 14:18	LLJ	R
Fecal Coliform	3700000		col/100mL	100000	SM9222D+EPA 625/R-92/013 APX F			12/1/15 16:28	LLJ	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	ND		pCi/L	2.50	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Alpha Uncertainty +/-	1.00		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta	9.50		pCi/L	2.70	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta Uncertainty +/-	2.20		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770003** Date Collected: 12/1/2015 09:20 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Chloroform	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Toluene	ND		ug/L	5.0	EPA 624			12/3/15 00:11	DD	S
Total Xylenes	ND		ug/L	15.0	EPA 624			12/3/15 00:11	DD	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	100		%	72 - 142	EPA 624			12/3/15 00:11	DD	S
4-Bromofluorobenzene (S)	98		%	73 - 119	EPA 624			12/3/15 00:11	DD	S
Dibromofluoromethane (S)	83.4		%	74 - 132	EPA 624			12/3/15 00:11	DD	S
Toluene-d8 (S)	90.5		%	75 - 133	EPA 624			12/3/15 00:11	DD	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Chrysene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
bis(2-Ethylhexyl)phthalate	8.0		ug/L	2.8	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Phenanthrene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	99.3		%	47 - 128	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
2-Fluorobiphenyl (S)	64.3		%	52 - 118	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
2-Fluorophenol (S)	40.9		%	20 - 87	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Nitrobenzene-d5 (S)	68.9		%	27 - 139	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Phenol-d5 (S)	31		%	10 - 81	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Terphenyl-d14 (S)	85.6		%	46 - 133	EPA 625	12/4/15	CAC	12/6/15 18:58	GEC	U
Pesticides and PCBs										
Dieldrin	ND		ug/L	0.019	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Total Polychlorinated Biphenyl	|		ug/L		EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1016	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1221	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1232	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1242	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770003** Date Collected: 12/1/2015 09:20 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1254	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Aroclor-1260	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	23.9	2	%	30 - 150	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
Tetrachloro-m-xylene (S)	43.8		%	36 - 112	EPA 608	12/7/15	JSR	12/9/15 18:18	RWS	W
WET CHEMISTRY										
Ammonia-N	13.4		mg/L	0.100	D6919-09			12/2/15 19:43	JAM	A
Biochemical Oxygen Demand	81.9		mg/L	2.0	S5210B-11			12/2/15 04:20	GMM	B
Carbonaceous BOD	63.4		mg/L	2.0	S5210B-11			12/2/15 06:55	GMM	B
Carbonaceous BOD 20 Day	72.2		mg/L	2.0	S5210B-11			12/2/15 11:27	GMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	12/14/15	MMA	12/15/15 00:20	LJF	G
Dissolved Oxygen	1.5		mg/L	1.0	S4500OG-01			12/7/15 07:28	RMM	B
Halogen, Total Organic (TOX)	41.2		ug/L	20.0	SW846 9020B			12/9/15 12:08	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			12/2/15 01:11	MSA	B
Nitrate-N	2.0		mg/L	0.50	EPA 300.0			12/2/15 07:51	JP	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			12/2/15 07:51	JP	B
Odor	10		T.O.N.	1	S2150B-97			12/2/15 04:05	MSA	M
Oil/Grease Hexane Extractable	8.4		mg/L	2.0	EPA 1664B			12/6/15 14:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.0	EPA 1664B			12/6/15 14:00	AT	H
Phenolics	0.016		mg/L	0.005	EPA 420.4	12/14/15	NV	12/17/15 11:44	AMH	J
Phosphorus, Total	2.3		mg/L	0.10	EPA 365.1	12/4/15	NV	12/10/15 04:17	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			12/2/15 19:10	DRM	L
Surfactants (MBAS)	0.383		mg/L	0.025	S5540C-00			12/3/15 02:25	MBW	K
Total Dissolved Solids	230		mg/L	5	S2540C-11			12/2/15 08:53	ML	B
Total Kjeldahl Nitrogen	21.0		mg/L	4.0	S4500NH3G-11	12/3/15	J1H	12/8/15 11:00	C_W	A
Total Nitrogen	23.0		mg/L	1.20	Calculation			12/14/15 14:11	NJA	A
Total Suspended Solids	112		mg/L	5	S2540D-11			12/1/15 22:18	NV	B
Turbidity	57.4		NTU	0.10	S2130B-01			12/3/15 03:09	MSA	B
METALS										
Hardness	102		mg/L	0.66	EPA 200.7	12/2/15	JPS	12/3/15 13:21	TSS	P1
Trivalent Chromium	ND		mg/L	0.010	Calculation			12/15/15 10:52	AGM	B
Aluminum, Total	0.25		mg/L	0.040	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Antimony, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770003** Date Collected: 12/1/2015 09:20 Matrix: Water

Sample ID: **14th & Crozer** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Chromium, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Copper, Total	0.029		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Iron, Total	0.47		mg/L	0.060	EPA 200.7	12/2/15	JPS	12/3/15 13:21	TSS	P1
Lead, Total	0.0060		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Mercury, Total	ND		mg/L	0.00020	EPA 245.1	12/10/15	MNP	12/10/15 12:11	MNP	P3
Molybdenum, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
Zinc, Total	0.067		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:37	ZMC	P2
MICROBIOLOGY										
Enterococcus	173000		col/100mL	100	S9230D			12/1/15 14:18	LLJ	R
Fecal Coliform	1030000	1	col/100mL	10000	SM9222D+EPA 625/R-92/013 APX F			12/1/15 16:28	LLJ	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	ND		pCi/L	2.30	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Alpha Uncertainty +/-	1.20		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta	8.20		pCi/L	2.70	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta Uncertainty +/-	2.10		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y

Mr. Brad W Kintzer
Project Coordinator

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770004** Date Collected: 12/1/2015 11:00 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
VOLATILE ORGANICS										
Benzene	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Bromodichloromethane	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Chlorodibromomethane	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Chloroform	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Ethylbenzene	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Methyl t-Butyl Ether	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Methylene Chloride	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Tetrachloroethene	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Toluene	ND		ug/L	5.0	EPA 624			12/3/15 00:33	DD	S
Total Xylenes	ND		ug/L	15.0	EPA 624			12/3/15 00:33	DD	S
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
1,2-Dichloroethane-d4 (S)	98.7		%	72 - 142	EPA 624			12/3/15 00:33	DD	S
4-Bromofluorobenzene (S)	95		%	73 - 119	EPA 624			12/3/15 00:33	DD	S
Dibromofluoromethane (S)	85.1		%	74 - 132	EPA 624			12/3/15 00:33	DD	S
Toluene-d8 (S)	90.7		%	75 - 133	EPA 624			12/3/15 00:33	DD	S
SEMIVOLATILES										
Benzo(a)anthracene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Chrysene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
bis(2-Ethylhexyl)phthalate	4.9		ug/L	2.8	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
N-Nitroso-di-n-propylamine	ND		ug/L	2.8	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Phenanthrene	ND		ug/L	1.4	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
2,4,6-Tribromophenol (S)	45.9	2	%	47 - 128	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
2-Fluorobiphenyl (S)	69.3		%	52 - 118	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
2-Fluorophenol (S)	17.5	1	%	20 - 87	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Nitrobenzene-d5 (S)	76.9		%	27 - 139	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Phenol-d5 (S)	23.6		%	10 - 81	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Terphenyl-d14 (S)	88.4		%	46 - 133	EPA 625	12/4/15	CAC	12/6/15 19:23	GEC	U
Pesticides and PCBs										
Dieldrin	ND		ug/L	0.019	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Total Polychlorinated Biphenyl	|		ug/L		EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1016	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1221	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1232	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1242	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W

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State Certifications: DE ID 11 , MA PA0102 , MD 128 , VA 460157 , WV 343

ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770004** Date Collected: 12/1/2015 11:00 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Aroclor-1248	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1254	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Aroclor-1260	ND		ug/L	0.47	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Surrogate Recoveries	*Results*	*Flag*	*Units*	*Limits*	*Method*	*Prepared*	*By*	*Analyzed*	*By*	*Cntr*
Decachlorobiphenyls (S)	39.8		%	30 - 150	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
Tetrachloro-m-xylene (S)	52.9		%	36 - 112	EPA 608	12/7/15	JSR	12/9/15 18:40	RWS	W
WET CHEMISTRY										
Ammonia-N	3.63		mg/L	0.100	D6919-09			12/2/15 20:02	JAM	A
Biochemical Oxygen Demand	70.7		mg/L	2.0	S5210B-11			12/2/15 04:20	GMM	B
Carbonaceous BOD	49.4		mg/L	2.0	S5210B-11			12/2/15 06:55	GMM	B
Carbonaceous BOD 20 Day	96.8		mg/L	2.0	S5210B-11			12/2/15 11:27	GMM	B
Cyanide, Total	ND		mg/L	0.0050	EPA 335.4	12/14/15	MMA	12/15/15 00:20	LJF	G
Dissolved Oxygen	4.4		mg/L	1.0	S4500OG-01			12/7/15 07:28	RMM	B
Halogen, Total Organic (TOX)	ND		ug/L	20.0	SW846 9020B			12/9/15 12:40	PAG	N
Hexavalent Chromium	ND		mg/L	0.010	S3500CrB-09			12/2/15 01:11	MSA	B
Nitrate-N	ND		mg/L	0.50	EPA 300.0			12/2/15 09:26	JP	B
Nitrite-N	ND		mg/L	0.50	EPA 300.0			12/2/15 09:26	JP	B
Odor	2		T.O.N.	1	S2150B-97			12/2/15 04:05	MSA	M
Oil/Grease Hexane Extractable	2.6		mg/L	2.1	EPA 1664B			12/6/15 14:00	AT	H
Oil/Grease Silica Gel Treated	ND		mg/L	2.1	EPA 1664B			12/6/15 14:00	AT	H
Phenolics	0.009		mg/L	0.005	EPA 420.4	12/14/15	NV	12/17/15 11:45	AMH	J
Phosphorus, Total	1.4		mg/L	0.10	EPA 365.1	12/4/15	NV	12/10/15 04:17	LJF	A
Sulfide, Total	ND		mg/L	1.0	S4500S2F-00			12/2/15 19:10	DRM	L
Surfactants (MBAS)	0.067		mg/L	0.025	S5540C-00			12/3/15 02:25	MBW	K
Total Dissolved Solids	26		mg/L	5	S2540C-11			12/2/15 08:53	ML	B
Total Kjeldahl Nitrogen	8.3		mg/L	4.0	S4500NH3G-11	12/3/15	J1H	12/8/15 11:00	C_W	A
Total Nitrogen	8.30		mg/L	1.20	Calculation			12/14/15 14:11	NJA	A
Total Suspended Solids	200		mg/L	5	S2540D-11			12/1/15 22:18	NV	B
Turbidity	80.6		NTU	0.10	S2130B-01			12/3/15 03:09	MSA	B
METALS										
Hardness	31.5		mg/L	1.7	EPA 200.7	12/3/15	JPS	12/4/15 07:50	TSS	P1
Trivalent Chromium	ND		mg/L	0.010	Calculation			12/15/15 10:53	AGM	B
Aluminum, Total	0.44		mg/L	0.040	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Antimony, Total	0.0018		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2

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ANALYTICAL RESULTS

Workorder: 2110770 2015-LOWER DELAWARE TESTING

Lab ID: **2110770004** Date Collected: 12/1/2015 11:00 Matrix: Water

Sample ID: **Sun & Hancock** Date Received: 12/1/2015 13:55

Parameters	Results	Flag	Units	RDL	Method	Prepared	By	Analyzed	By	Cntr
Arsenic, Total	ND		mg/L	0.0015	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Cadmium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Chromium, Total	0.0031		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Copper, Total	0.032		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Iron, Total	1.5		mg/L	0.15	EPA 200.7	12/3/15	JPS	12/4/15 07:50	TSS	P1
Lead, Total	0.020		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Mercury, Total	0.0011		mg/L	0.00020	EPA 245.1	12/10/15	MNP	12/10/15 12:12	MNP	P3
Molybdenum, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Selenium, Total	ND		mg/L	0.0020	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Silver, Total	ND		mg/L	0.0010	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Thallium, Total	ND		mg/L	0.00050	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
Zinc, Total	0.20		mg/L	0.0025	EPA 200.8	12/3/15	JPS	12/4/15 04:40	ZMC	P2
MICROBIOLOGY										
Enterococcus	34500		col/100mL	100	S9230D			12/1/15 14:18	LLJ	R
Fecal Coliform	2100000		col/100mL	100000	SM9222D+EPA 625/R-92/013 APX F			12/1/15 16:28	LLJ	Q
Sub'd to NELAP CERTIFIED Lab										
Gross Alpha	2.70		pCi/L	2.40	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Alpha Uncertainty +/-	1.50		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta	4.20		pCi/L	2.70	EPA 900.0			12/11/15 10:43	SUB	Y
Gross Beta Uncertainty +/-	1.60		pCi/L		EPA 900.0			12/11/15 10:43	SUB	Y

Mr. Brad W Kintzer
Project Coordinator

PARAMETER QUALIFIERS

Lab ID	#	Sample ID	Analytical Method	Analyte
2110770003	1	14th & Crozer	SM9222D+EPA 625/R-92/013 APX F	Fecal Coliform
This is an estimated result.				
2110770003	2	14th & Crozer	EPA 608	Decachlorobiphenyls
The surrogate Decachlorobiphenyls for method EPA 608 was outside of control limits. The % Recovery was reported as 23.9 and the control limits were 30 to 150. This result was reported at a dilution of 1.				
2110770004	1	Sun & Hancock	EPA 625	2-Fluorophenol
The surrogate 2-Fluorophenol for method EPA 625 was outside of control limits. The % Recovery was reported as 17.5 and the control limits were 20 to 87. This result was reported at a dilution of 1.				
2110770004	2	Sun & Hancock	EPA 625	2,4,6-Tribromophenol
The surrogate 2,4,6-Tribromophenol for method EPA 625 was outside of control limits. The % Recovery was reported as 45.9 and the control limits were 47 to 128. This result was reported at a dilution of 1.				

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CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

1 of 2

Client Name: DELCORA
Address: 3201 W. Front Street
Chester PA 19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT [x] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [x] -Y
Fax? [ ] -Y No.: _____

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Total Sulfide	CBOD5, CBOD20, BOD5	Metals, Total Hardness	Hexavalent Chromium, Trivalent Chromium	Fecal Coliform	Enterococcus	608	625	624	Gross Alpha/ Beta
Container Type					plastic	plastic	plastic	plastic	plastic	plastic	glass	glass	glass	
Container Size					250ml	1L	500ml	500ml	120ml	120ml	1L	1L	40ml	1L
Preservative					NaOH/Zn(OAc)	none	HNO3	none	Na2S2O3	Na2S2O3	none	none	none	None
					Enter Number of Containers Per Sample or Field Results Below.									
1 CPS/ EPS1 (72/28) *	12/1/2015	9:43	G	WW	1	2	1	1	1	1	2	2	2	1
2 CPS1 - Labeled as CPS	12/1/2015	9:43	G	WW	1	2	1	1	1	1	2	2	2	1
3 14th & Crozer	12/1/2015	9:20	G	WW	1	2	1	1	1	1	2	2	2	1
4 Sun & Hancock	12/1/2015	11:00	G	WW	1	2	1	1	1	1	2	2	2	1
5 * Labeled as LTCPWWCSO	AS 12/1/15													
6	W													
7 MICRO REC'D	12/1/15 1355													
8														
9														
10														

Cooler Temp: 4°c Therm ID: IR-284
No. of Coolers: _____ Y N Initial

	Y	N	Initial
Custody Seals Present?			AM
(If present) Seals Intact?			
Received on Ice?	/		
COC/Labels Complete/Accurate?	/		
Cont. in Good Cond.?	/		
Correct Containers?	/		
Correct Sample Volumes?	/		
Correct Preservation?	/		
Headspace/Volatiles?			AM

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: [x] Pickup [ ] Labor [ ] Composite Sampling [ ] Rental Equipment [ ] Other: _____

Project Comments:

LOGGED BY(signature): _____ DATE 12-1-15 TIME 1323
REVIEWED BY(signature): _____ DATE _____ TIME _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Rig	12-1-15	1135	2 Ron Hoover	12-1	1135
3	12-1	1305	4 ALS	12/1/15	1305
5 ALS	12/1/15	1355	6	12/1/15	1355
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [x] PA [ ] NC [ ]
Reportable to PADEP? Yes [ ] PWSID # _____
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type-

*G=Grab; C=Composite **Matrix - Al=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

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Rev 10/11

Thursday, January 07, 2016 6:17:25 AM
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CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 210770 — 2 of 2
ALS Quote #: 514787

Client Name: DELCORA
Address: 3201 W. Front Street, Chester-PA-19013
Contact: Mike Krause
Phone#: 610-876-5523 x218
Project Name/#: CSO WW LTCP
Bill To: Same

TAT: [X] Normal-Standard TAT is 10-12 business days. [ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y
Fax? [ ] -Y No.:

Container Type	glass	glass	plastic	plastic	plastic	glass	glass	plastic	glass	plastic
Container Size	1L	1L	500ml	500ml	1L	500ml	250ml	1L	1L	2L
Preservative	H2SO4	H2SO4	none	NaOH	H2SO4	H2SO4	H2SO4	none	none	none

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Oil and Grease	TPH	Nitrate, Nitrite, Turbidity	Total Cyanide	Total Phosphorus, Ammonia, TKN, Total Nitrogen	Phenolics	TOX	TSS, TDS, DO	Odor	MBAS
					Enter Number of Containers Per Sample or Field Results Below.									
1 CPS/ EPS1 (72/28)	12/1/2015	9:43	G	WW	1	1	1	1	1	1	2	1	1	1
2 CPS1	12/1/2015	9:43	G	WW	1	1	1	1	1	1	2	1	1	1
3 14th & Crozer	12/1/2015	9:20	G	WW	1	1	1	1	1	1	2	1	1	1
4 Sun & Hancock	12/1/2015	11:00	G	WW	1	1	1	1	1	1	2	1	1	1
5														
6														
7														
8														
9														
10														

Receipt Information (completed by Receiving Lab)
Cooler Temp: 4°C Therm ID: TH-294
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?		✓	KU
(If present) Seals Intact?			
Received on Ice?	✓		
COC/Labels Complete/Accurate?	✓		
Cont. in Good Cond.?	✓		
Correct Containers?	✓		
Correct Sample Volumes?	✓		
Correct Preservation?	✓		
Headspace/Volatiles?	✓		

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: [X] Pickup [ ] Labor [ ] Composite Sampling [ ] Rental Equipment [ ] Other: _____

Project Comments:

LOGGED BY(signature): _____ DATE: 12-1-15 TIME: 1125
REVIEWED BY(signature): _____ DATE: _____ TIME: _____

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ] [ ]
State Samples Collected In: [ ] NY [ ] NJ [X] PA [ ] NC [ ]
Reportable to PADEP? Yes [ ]
PWSID #
Sample Disposal: Lab [ ] Special [ ]
EDDS: Format Type:

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1 Raymond Rios	12/1/15	1135	2 Ron Hoover	12-1	1135
3 Ron H	12-4	1355	4 [illegible] ACS	12/4/15	1305
5 [illegible] - ALS	12/4/15	1355	6 [illegible]	12/4/15	1355
7			8		
9			10		

*G=Grab; C=Composite **Matrix - AI=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11

Analytical Laboratory Services, Inc.
Environmental • Industrial Hygiene • Field Services
34 Dogwood Lane • Middletown, PA 17057 • 717.944.5541 • Fax: 717.944.1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 1 of 1
ALSI Quote #:

Client Name: ALS Environmental
Address: 34 Dogwood Lane
Middletown, PA 17057
Contact: Brad Kintzer
Phone#: (717) 944-5541
Project Name/#:
Bill To: ALS Environmental

TAT [X] Normal-Standard TAT is 10-12 business days.
[ ] Rush-Subject to ALSI approval and surcharges.
Date Required: _____ Approved By: _____
Email? [X] -Y ALMDT_Subcontract@ALSGlobal.com
Fax? [ ] -Y No.: _____

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Container Type	Container Size	Preservative	Gross Alpha & Beta								
					Plastic	1 L	NONE	ANALYSES/METHOD REQUESTED								
1 2110770 001	12/1/15	0943	G	WW				1								
2 2110770 002	12/1/15	0943	G	WW				1								
3 2110770 003	12/1/15	0920	G	WW				1								
4 2110770 004	12/1/15	1100	G	WW				1								
5																
6																
7																
8																
9																
10																

Receipt Information (completed by Receiving Lab)
Cooler Temp: _____ Therm. ID: _____
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier tracking #: _____

Sample/COC Comments
Subcontract: ALS Ft. Collins

ALSI Field Services: ☐Pickup ☐Labor
☐Composite Sampling ☐Rental Equipment
☐Other: _____

Project Comments:

LOGGED BY(signature): _____ Date: _____ Time: _____
REVIEWED BY(signature): _____ Date: _____ Time: _____

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1	12/2/15	1602	2		
3			4		
5			6		
7			8		
9			10		

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE [ ]
Special Processing: USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [ ] PA [ ] NC [ ] other
Reportable to PADEP? Yes [ ]
PWSID #: _____
Sample Disposal: Lab [ ] Special [ ]
EDDs: Format Type: _____

*G=Grab; C=Composite **Matrix - Al=Air; DW=Drinking Water; GW=Groundwater; Oil=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

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Rev 5/05

Tuesday, December 22, 2015

Brad Kintzer
ALS Environmental
34 Dogwood Lane
Middletown, PA 17057

Re: ALS Workorder: 1512056
Project Name:
Project Number: 2110770

Dear Mr. Kintzer:

Four water samples were received from ALS Environmental, on 12/3/2015. The samples were scheduled for the following analysis:

Gross Alpha/Beta

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Jeff R. Kujawa
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

ALS Environmental

1512056

Gross Alpha/Beta:
The samples were analyzed for gross alpha and beta activity by gas flow proportional counting according to the current revision of SOP 724. Gross alpha results are referenced to ^{241}Am. Gross beta results are referenced to $^{90}Sr/Y$.

All acceptance criteria were met.

ALS Environmental -- FC

Sample Number(s) Cross-Reference Table

OrderNum: 1512056
Client Name: ALS Environmental
Client Project Name:
Client Project Number: 2110770
Client PO Number: 2110770

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
2110770001	1512056-1		WATER	01-Dec-15	9:43
2110770002	1512056-2		WATER	01-Dec-15	9:43
2110770003	1512056-3		WATER	01-Dec-15	9:20
2110770004	1512056-4		WATER	01-Dec-15	11:00

Thursday, January 07, 2016 6:17:25 AM
Page 24 of 32

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CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: 1 of 1
ALSI Quote #:

Client Name: ALS Environmental
Address: 34 Dogwood Lane, Middletown, PA 17057
Contact: Brad Kintzer
Phone#: (717) 944-5541
Project Name/#:
Bill To: ALS Environmental

TAT [X] Normal-Standard TAT is 10-12 business days [ ] Rush-Subject to ALSI approval and surcharges
Date Required: Approved By:
Email? [X] Y ALMOT_Subcontract@ALSGlobal.com
Fax? [ ] Y No:

Container Type: Plastic
Container Size: 1L
Preservative: NONE

ANALYSES/METHOD REQUESTED

Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Gross Alpha & Beta									
1 2110770 001	12/1/15	0943	G	WW	1									
2 2110770 002	12/1/15	0943	G	WW	1									
3 2110770 003	12/1/15	0920	G	WW	1									
4 2110770 004	12/1/15	1100	G	WW	1									
5														
6														
7														
8														
9														
10														

Project Comments:
LOGGED BY(signature): Date: Time:
REVIEWED BY(signature): Date: Time:

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1	12/2/15	1602	ALS Environmental	12/5/15	1000
3			4		
5			6		
7			8		
9			10		

Receipt Information (completed by Receiving Lab)
Cooler Temp: Therm. ID:
No. of Coolers:

	Y	N	Initial
Custody Seals Present?			
(If present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Counter tracking #:

Sample/COC Comments
Subcontract: ALS Ft. Collins

ALSI Field Services: ☐Pickup ☐Labor
☐Composite Sampling ☐Rental Equipment
☐Other:

Data Deliverables: [ ] Standard [ ] CLP-like [ ] USACE
Special Processing: [ ] USACE [ ] Navy [ ]
State Samples Collected In: [ ] NY [ ] NJ [ ] PA [ ] NC [ ] other
Reportable to PADEP? [ ] Yes
PWSID #:
Sample Disposal: Lab [ ] Special [ ]
EDDs: Format Type:

*G=Grab; C=Composite **Matrix - Al=Air; DW=Drinking Water; GW=Groundwater; OI=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

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1 2 3 4

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ALS

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS Penn Workorder No: 1512056
Project Manager: ARL JRK Initials: AMM Date: 12/3/15

1. Does this project require any special handling in addition to standard ALS procedures?		YES	(NO)
2. Are custody seals on shipping containers intact?	(NONE)	YES	NO
3. Are Custody seals on sample containers intact?	(NONE)	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		(YES)	NO
5. Are the COC and bottle labels complete and legible?		(YES)	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		(YES)	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	(YES)	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	(YES)	NO
9. Are all aqueous non-preserved samples pH 4-9?	(N/A)	YES	NO
10. Is there sufficient sample for the requested analyses?		(YES)	NO
11. Were all samples placed in the proper containers for the requested analyses?		(YES)	NO
12. Are all samples within holding times for the requested analyses?		(YES)	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		(YES)	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ___ < green pea ___ > green pea	(N/A)	YES	NO
15. Do any water samples contain sediment? Amount of sediment: ___ dusting X moderate ___ heavy	N/A	(YES)	NO
16. Were the samples shipped on ice?		YES	(NO)
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	(RAD ONLY)	YES	NO

Cooler #:	1						
Temperature (°C):	AMB						
No. of custody seals on cooler:	0						
DOT Survey Acceptance Information: External µR/hr reading:	10						
Background µR/hr reading:	11						

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? (YES) NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO (NA) Contact: _____ Date/Time: _____

Project Manager Signature / Date: 12-3-15

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

Page 1 of 2

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

Warning: Use only the printed original label for shipping. Using a photocopy of this label for shipping purposes is fraudulent and could result in additional billing charges, along with the cancellation of your FedEx account number.
Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

Client:	ALS Environmental	**Date:**	*22-Dec-15*
Project:	2110770	**Work Order:**	1512056
Sample ID:	2110770001	**Lab ID:**	1512056-1
Legal Location:		**Matrix:**	WATER
Collection Date:	12/1/2015 09:43	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC			**PAI 724**		Prep Date: **12/9/2015**	PrepBy: **ECP**
GROSS ALPHA	ND (+/- 1.2)	U	2.6	pCi/l	NA	12/11/2015 10:43
GROSS BETA	**10.5 (+/- 2.4)**		**2.8**	**pCi/l**	NA	12/11/2015 10:43

Client:	ALS Environmental	**Date:**	*22-Dec-15*
Project:	2110770	**Work Order:**	1512056
Sample ID:	2110770002	**Lab ID:**	1512056-2
Legal Location:		**Matrix:**	WATER
Collection Date:	12/1/2015 09:43	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **12/9/2015**	PrepBy: **ECP**
GROSS ALPHA	ND (+/- 1)	U	2.5	pCi/l	NA	12/11/2015 10:43
GROSS BETA	**9.5 (+/- 2.2)**		**2.7**	**pCi/l**	NA	12/11/2015 10:43

Client:	ALS Environmental	**Date:**	*22-Dec-15*
Project:	2110770	**Work Order:**	1512056
Sample ID:	2110770003	**Lab ID:**	1512056-3
Legal Location:		**Matrix:**	WATER
Collection Date:	12/1/2015 09:20	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **12/9/2015**	PrepBy: **ECP**
GROSS ALPHA	ND (+/- 1.2)	U	2.3	pCi/l	NA	12/11/2015 10:43
GROSS BETA	**8.2 (+/- 2.1)**		**2.7**	**pCi/l**	NA	12/11/2015 10:43

Client:	ALS Environmental	**Date:**	*22-Dec-15*
Project:	2110770	**Work Order:**	1512056
Sample ID:	2110770004	**Lab ID:**	1512056-4
Legal Location:		**Matrix:**	WATER
Collection Date:	12/1/2015 11:00	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Gross Alpha/Beta by GFPC		**PAI 724**			Prep Date: **12/9/2015**	PrepBy: **ECP**
GROSS ALPHA	2.7 (+/- 1.5)	LT	2.4	pCi/l	NA	12/11/2015 10:43
GROSS BETA	**4.2 (+/- 1.6)**		**2.7**	**pCi/l**	NA	12/11/2015 10:43

Client:	ALS Environmental	**Date:**	*22-Dec-15*
Project:	2110770	**Work Order:**	1512056
Sample ID:	2110770004	**Lab ID:**	1512056-4
Legal Location:		**Matrix:**	WATER
Collection Date:	12/1/2015 11:00	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

' - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.

G - Sample density differs by more than 15% of LCS density.

D - DER is greater than Control Limit

M - Requested MDC not met.

LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).

U or ND - Indicates that the compound was analyzed for but not detected.

E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.

M - Duplicate injection precision was not met.

N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analytes when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.

Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.

* - Duplicate analysis (relative percent difference) not within control limits.

-S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.

B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.

E - Analyte concentration exceeds the upper level of the calibration range.

J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).

A - A tentatively identified compound is a suspected aldol-condensation product.

X - The analyte was diluted below an accurate quantitation level.

* - The spike recovery is equal to or outside the control criteria used.

+ - The relative percent difference (RPD) equals or exceeds the control criteria.

G - A pattern resembling gasoline was detected in this sample.

D - A pattern resembling diesel was detected in this sample.

M - A pattern resembling motor oil was detected in this sample.

C - A pattern resembling crude oil was detected in this sample.

4 - A pattern resembling JP-4 was detected in this sample.

5 - A pattern resembling JP-5 was detected in this sample.

H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.

L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.

Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

Batch ID: **AB151209-3-2** Instrument ID **LB4100-C** Method: **Gross Alpha/Beta by GFPC**

LCS Sample ID: **AB151209-3** Units: **pCi/l** Analysis Date: **12/10/2015 13:22**
Client ID: Run ID: **AB151209-3A** Prep Date: **12/9/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	235 (+/- 43)	7	225.4		104	70-130					P,M3
GROSS BETA	204 (+/- 35)	12	203.7		100	70-130					P,M3

LCSD Sample ID: **AB151209-3** Units: **pCi/l** Analysis Date: **12/10/2015 13:22**
Client ID: Run ID: **AB151209-3A** Prep Date: **12/9/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	249 (+/- 45)	8	225.4		111	70-130		235	0.2	2.1	P,M3
GROSS BETA	201 (+/- 35)	12	203.7		98.8	70-130		204	0.05	2.1	P,M3

MB Sample ID: **AB151209-3** Units: **pCi/l** Analysis Date: **12/20/2015 09:01**
Client ID: Run ID: **AB151209-3A** Prep Date: **12/9/2015** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
GROSS ALPHA	ND	0.85									U
GROSS BETA	ND	1.11									U

The following samples were analyzed in this batch:

1512056-1	1512056-2	1512056-3
1512056-4	1511473-9	

ATTACHMENT G

Historical Receiving Water Sampling for the Chester and Ridley Creeks

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
7/20/2010 (Test Run)	CC1	DO	8.38	mg/L		Multimeter Probe	7/20/2010 16:21 PM
		Temperature	25.9	°C			7/20/2010 16:21 PM
		Conductivity	461	µS			7/20/2010 16:21 PM
		pH	7.81	pH			7/20/2010 16:21 PM
		BOD-5	<3	mg/L	3	SM 5210 B	7/21/10 7:45 AM
		TSS	4	mg/L	4	SM 2540D	7/26/10 12:34 PM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 11:44 AM
		Digestion, TKN-TP	7/22/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.42	mg/L	0.05	EPA 365.2	7/23/10 11:30 AM
		Fecal Coliform, MF	3400	colonies/100mL	N/A	SM 9222 D	7/20/10 5:49 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:29 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:29 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 10:59 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:29 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:29 P.M.
		Zinc, Total, ICP	0.011	mg/L	0.005	EPA 200.7	2/4/2011 10:59 P.M.
	CC3	DO	6.6	mg/L			7/20/2010 15:05:00 PM
		Temperature	25	°C			7/20/2010 15:05:00 PM
		Conductivity	447	µS			7/20/2010 15:05:00 PM
		pH	7.54	pH			7/20/2010 15:05:00 PM
		BOD-5	<3	mg/L	3	SM 5210 B	7/21/10 7:45 AM
		TSS	6	mg/L	4	SM 2540D	7/26/10 12:34 PM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 11:44 AM
		Digestion, TKN-TP	7/22/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.39	mg/L	0.05	EPA 365.2	7/23/10 11:30 AM
		Fecal Coliform, MF	7400	colonies/100mL	N/A	SM 9222 D	7/20/10 5:49 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:33 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:33 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 11:05 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:33 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:33 P.M.
		Zinc, Total, ICP	0.011	mg/L	0.005	EPA 200.7	2/4/2011 11:05 P.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
7/20/2010 (Test Run)	RC1	DO	8.53	mg/L			7/20/2010 15:55 PM
		Temperature	25.6	°C			7/20/2010 15:55 PM
		Conductivity	311	µS			7/20/2010 15:55 PM
		pH	8.05	pH			7/20/2010 15:55 PM
		BOD-5	<3	mg/L	3	SM 5210 B	7/21/10 7:45 AM
		TSS	5	mg/L	4	SM 2540D	7/26/10 12:34 PM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 11:44 AM
		Digestion, TKN-TP	7/22/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.13	mg/L	0.05	EPA 365.2	7/23/10 11:30 AM
		Fecal Coliform, MF	1300	colonies/100mL	N/A	SM 9222 D	7/20/10 5:49 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:52 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:52 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 11:11 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:52 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:52 P.M.
		Zinc, Total, ICP	0.012	mg/L	0.005	EPA 200.7	2/4/2011 11:11 P.M.
	RC3	DO	7.39	mg/L			7/20/2010 15:25 AM
		Temperature	26	°C			7/20/2010 15:25 AM
		Conductivity	333	µS			7/20/2010 15:25 AM
		pH	7.57	pH			7/20/2010 15:25 AM
		BOD-5	<3	mg/L	3	SM 5210 B	7/21/10 7:45 AM
		TSS	13	mg/L	4	SM 2540D	7/26/10 12:34 PM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 11:44 AM
		Digestion, TKN-TP	7/22/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.16	mg/L	0.05	EPA 365.2	7/23/10 11:30 AM
		Fecal Coliform, MF	3200	colonies/100mL	N/A	SM 9222 D	7/20/10 5:49 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:56 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:56 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 11:17 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 2:56 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 2:56 P.M.
		Zinc, Total, ICP	0.014	mg/L	0.005	EPA 200.7	2/4/2011 11:17 P.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
7/23/2010 (Run 1)	CC1	DO	8.44	mg/L		Multimeter Probe	7/23/10 10:05 AM
		Temperature	25.2	°C			7/23/10 10:05 AM
		Conductivity	483	µS			7/23/10 10:05 AM
		pH	7.81	pH			7/23/10 10:05 AM
		BOD-5	<3	mg/L	3	SM 5210 B	7/23/10 4:00 PM
		TSS	<4	mg/L	4	SM 2540D	7/29/10 10:09 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 3:30 PM
		Digestion, TKN-TP	07/30/010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.36	mg/L	0.05	EPA 365.2	7/30/10 10:01 AM
		Fecal Coliform, MF	1400	colonies/100mL	N/A	SM 9222 D	7/23/10 2:55 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:00 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:00 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 11:23 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:00 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:00 P.M.
		Zinc, Total, ICP	0.016	mg/L	0.005	EPA 200.7	2/4/2011 11:23 P.M.
	CC3	DO	5.86	mg/L			7/23/10 9:10 AM
		Temperature	25.7	°C			7/23/10 9:10 AM
		Conductivity	390	µS			7/23/10 9:10 AM
		pH	7.54	pH			7/23/10 9:10 AM
		BOD-5	<9	mg/L	3	SM 5210 B	7/23/10 4:00 PM
		TSS	18	mg/L	4	SM 2540D	7/29/10 10:09 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 3:30 PM
		Digestion, TKN-TP	7/30/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.09	mg/L	0.05	EPA 365.2	7/30/10 10:01 AM
		Fecal Coliform, MF	580	colonies/100mL	N/A	SM 9222 D	7/23/10 2:55 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:04 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:04 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/4/2011 11:34 P.M.
		ICP-OES	2/4/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:04 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:04 P.M.
		Zinc, Total, ICP	0.011	mg/L	0.005	EPA 200.7	2/4/2011 11:34 P.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
7/23/2010 (Run 1)	RC1	DO	9.18	mg/L			7/23/10 9:50 AM
		Temperature	24.4	°C			7/23/10 9:50 AM
		Conductivity	332	µS			7/23/10 9:50 AM
		pH	8.03	pH			7/23/10 9:50 AM
		BOD-5	<3	mg/L	3	SM 5210 B	7/23/10 4:00 PM
		TSS	<4	mg/L	4	SM 2540D	7/29/10 10:09 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 3:30 PM
		Digestion, TKN-TP	7/30/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.16	mg/L	0.05	EPA 365.2	7/30/10 10:01 AM
		Fecal Coliform, MF	590	colonies/100mL	N/A	SM 9222 D	7/23/10 2:55 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:28 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:28 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/5/2011 12:09 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:28 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:28 P.M.
		Zinc, Total, ICP	0.006	mg/L	0.005	EPA 200.7	2/5/2011 12:09 A.M.
	RC3	DO	6.12	mg/L			7/23/10 9:25 AM
		Temperature	28.6	°C			7/23/10 9:25 AM
		Conductivity	366	µS			7/23/10 9:25 AM
		pH	7.39	pH			7/23/10 9:25 AM
		BOD-5	5	mg/L	3	SM 5210 B	7/23/10 4:00 PM
		TSS	22	mg/L	4	SM 2540D	7/29/10 10:09 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	7/26/10 3:30 PM
		Digestion, TKN-TP	7/30/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.07	mg/L	0.05	EPA 365.2	7/30/10 10:01 AM
		Fecal Coliform, MF	540	colonies/100mL	N/A	SM 9222 D	7/23/10 2:55 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:32 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:32 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/5/2011 12:15 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:32 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:32 P.M.
		Zinc, Total, ICP	0.014	mg/L	0.005	EPA 200.7	2/5/2011 12:15 A.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
8/12/2010 (Attempted Wet Run, Rained but not hard enough)	CC1	DO	5.65	mg/L		Multimeter Probe	8/12/10 10:02 AM
		Temperature	25.1	°C			8/12/10 10:02 AM
		Conductivity	597	µS			8/12/10 10:02 AM
		pH	7.39	pH			8/12/10 10:02 AM
		BOD-5	229	mg/L	3	SM 5210 B	8/12/10 2:50 PM
		TSS	7	mg/L	4	SM 2540D	8/17/10 2:10 PM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	8/18/10 10:49 AM
		Digestion, TKN-TP	8/17/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.57	mg/L	0.05	EPA 365.2	8/17/10 1:39 PM
		Fecal Coliform, MF	9700	colonies/100mL	N/A	SM 9222 D	8/12/10 2:38 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:36 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:36 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Copper, Total, ICP	0.007	mg/L	0.005	EPA 200.7	2/5/2011 12:21 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:36 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:36 P.M.
		Zinc, Total, ICP	0.019	mg/L	0.005	EPA 200.7	2/5/2011 12:21 A.M.
	CC3	DO	5.42	mg/L			8/12/10 9:09 AM
		Temperature	25.1	°C			8/12/10 9:09 AM
		Conductivity	651	µS			8/12/10 9:09 AM
		pH	7.47	pH			8/12/10 9:09 AM
		BOD-5	<3	mg/L	3	SM 5210 B	8/13/10 11:00 AM
		TSS	12	mg/L	4	SM 2540D	8/17/10 2:10 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	8/18/10 10:49 AM
		Digestion, TKN-TP	8/17/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.5	mg/L	0.05	EPA 365.2	8/17/10 1:39 PM
		Fecal Coliform, MF	830	colonies/100mL	N/A	SM 9222 D	8/12/10 2:38 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:56 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:56 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Copper, Total, ICP	0.006	mg/L	0.005	EPA 200.7	2/5/2011 12:26 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:56 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:56 P.M.
		Zinc, Total, ICP	0.018	mg/L	0.005	EPA 200.7	2/5/2011 12:26 A.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
8/12/2010 (Attempted Wet Run, Rained but not hard enough)	RC1	DO	6.85	mg/L			8/12/10 9:49 AM
		Temperature	24.4	°C			8/12/10 9:49 AM
		Conductivity	407	µS			8/12/10 9:49 AM
		pH	7.38	pH			8/12/10 9:49 AM
		BOD-5	<3	mg/L	3	SM 5210 B	8/13/10 11:00 AM
		TSS	<4	mg/L	4	SM 2540D	8/17/10 2:10 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	8/18/10 10:49 AM
		Digestion, TKN-TP	8/17/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.3	mg/L	0.05	EPA 365.2	8/17/10 1:39 PM
		Fecal Coliform, MF	720	colonies/100mL	N/A	SM 9222 D	8/12/10 2:38 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:59 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:59 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/5/2011 12:32 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 3:59 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 3:59 P.M.
		Zinc, Total, ICP	0.012	mg/L	0.005	EPA 200.7	2/5/2011 12:32 A.M.
	RC3	DO		mg/L			8/12/10 9:22 AM
		Temperature	25.4	°C			8/12/10 9:22 AM
		Conductivity		µS			8/12/10 9:22 AM
		pH	7.2	pH			8/12/10 9:22 AM
		BOD-5	<3	mg/L	3	SM 5210 B	8/13/10 11:00 AM
		TSS	8	mg/L	4	SM 2540D	8/17/10 2:10 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	8/18/10 10:49 AM
		Digestion, TKN-TP	8/17/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.27	mg/L	0.05	EPA 365.2	8/17/10 1:39 PM
		Fecal Coliform, MF	880	colonies/100mL	N/A	SM 9222 D	8/12/10 2:38 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:03 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:03 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Copper, Total, ICP	<0.005	mg/L	0.005	EPA 200.7	2/5/2011 12:38 A.M.
		ICP-OES	2/5/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:03 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:03 P.M.
		Zinc, Total, ICP	0.01	mg/L	0.005	EPA 200.7	2/5/2011 12:38 A.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
9/30/2010	CC1	DO	8.36	mg/L		Multimeter Probe	9/30/10 10:12 AM
		Temperature	21	°C			9/30/10 10:12 AM
		Conductivity	202	µS			9/30/10 10:12 AM
		pH	7.76	pH			9/30/10 10:12 AM
		BOD-5	<4	mg/L	3	SM 5210 B	10/1/10 11:15 AM
		TSS	158	mg/L	4	SM 2540D	10/4/10 1:50 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	10/2/10 11:50 AM
		Digestion, TKN-TP	10/5/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.46	mg/L	0.05	EPA 365.2	10/11/10 11:58 AM
		Fecal Coliform, MF	>10000	colonics/100mL	N/A	SM 9222 D	9/30/10 2:32 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:23 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:23 P.M.
		Chromium, Total, MS	0.016	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Copper, Total, ICP	0.017	mg/L	0.005	EPA 200.7	2/8/2011 3:27 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.013	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.019	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 4:23 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 4:23 P.M.
		Zinc, Total, ICP	0.051	mg/L	0.005	EPA 200.7	2/8/2011 3:27 P.M.
	CC3	DO	7.33	mg/L			9/30/10 10:28 AM
		Temperature	21.5	°C			9/30/10 10:28 AM
		Conductivity	206	µS			9/30/10 10:28 AM
		pH	7.73	pH			9/30/10 10:28 AM
		BOD-5	8	mg/L	3	SM 5210 B	10/1/10 11:15 AM
		TSS	56	mg/L	4	SM 2540D	10/4/10 1:50 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	10/2/10 11:50 AM
		Digestion, TKN-TP	10/5/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.21	mg/L	0.05	EPA 365.2	10/11/10 11:58 AM
		Fecal Coliform, MF	>10000	colonics/100mL	N/A	SM 9222 D	9/30/10 2:32 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:07 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:07 P.M.
		Chromium, Total, MS	0.005	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Copper, Total, ICP	0.008	mg/L	0.005	EPA 200.7	2/8/2011 3:50 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.006	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.003	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:07 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:07 P.M.
		Zinc, Total, ICP	0.027	mg/L	0.005	EPA 200.7	2/8/2011 3:50 P.M.

Dry Events

Sample Date	Site	Test	Result	Units	RDL	Method	Analysis Date
9/30/2010	RC1	DO	7.49	mg/L			9/30/10 9:48 AM
		Temperature	21.4	°C			9/30/10 9:48 AM
		Conductivity	209	µS			9/30/10 9:48 AM
		pH	6.3	pH			9/30/10 9:48 AM
		BOD-5	<4	mg/L	3	SM 5210 B	10/1/10 11:15 AM
		TSS	58	mg/L	4	SM 2540D	10/4/10 1:50 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	10/2/10 11:50 AM
		Digestion, TKN-TP	10/5/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.26	mg/L	0.05	EPA 365.2	10/11/10 11:58 AM
		Fecal Coliform, MF	>10000	colonies/100mL	N/A	SM 9222 D	9/30/10 2:32 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:10 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:10 P.M.
		Chromium, Total, MS	0.005	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Copper, Total, ICP	0.015	mg/L	0.005	EPA 200.7	2/8/2011 3:56 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.008	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.006	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:10 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:10 P.M.
		Zinc, Total, ICP	0.034	mg/L	0.005	EPA 200.7	2/8/2011 3:56 P.M.
	RC3	DO	7.09	mg/L			9/30/10 9:53 AM
		Temperature	21.6	°C			9/30/10 9:53 AM
		Conductivity	172.5	µS			9/30/10 9:53 AM
		pH	7.52	pH			9/30/10 9:53 AM
		BOD-5	6	mg/L	3	SM 5210 B	10/1/10 11:15 AM
		TSS	44	mg/L	4	SM 2540D	10/4/10 1:50 PM
		Ammonia as N	<.2		0.2	SM 4500 NH3 G	10/2/10 11:50 AM
		Digestion, TKN-TP	10/5/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.2	mg/L	0.05	EPA 365.2	10/11/10 11:58 AM
		Fecal Coliform, MF	>10000	colonies/100mL	N/A	SM 9222 D	9/30/10 2:32 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:14 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:14 P.M.
		Chromium, Total, MS	0.003	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Copper, Total, ICP	0.009	mg/L	0.005	EPA 200.7	2/8/2011 4:02 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.004	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.004	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:14 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:14 P.M.
		Zinc, Total, ICP	0.029	mg/L	0.005	EPA 200.7	2/8/2011 4:02 P.M.

Wet Events

T+0							
Sample Date	**Site**	**Test**	**Result**	**Units**	**RDL**	**Method**	**Analysis Date**
10/14/2010	CC1	DO	8.5	mg/L		Multimeter Probe	12:54 P.M.
		Temperature	14.5	°C			12:54 P.M.
		Conductivity	497	µS			12:54 P.M.
		pH	7.6				12:54 P.M.
		BOD-5	<4	mg/L	3	SM 5210 B	10/15/2010 11:00 A.M.
		TSS	<4	mg/L	4	SM 2540D	10/18/2010 9:31 A.M.
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/2010 1:04 P.M.
		Digestion, TKN-TP	10/18/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.31	mg/L	0.05	EPA 365.2	10/19/2010 12:39 P.M.
		Fecal Coliform, MF	240	colonies/100mL	N/A	SM 9221 E	10/14/2010 5:35 P.M.
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:18 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:18 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Copper, Total, ICP	0.007	mg/L	0.005	EPA 200.7	2/8/2011 4:08 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:18 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:18 P.M.
		Zinc, Total, ICP	0.02	mg/L	0.005	EPA 200.7	2/8/2011 4:08 P.M.
	CC3	DO	7.2	mg/L			11:45 A.M.
		Temperature	15.1	°C			11:45 A.M.
		Conductivity	480	µS			11:45 A.M.
		pH	7.34				11:45 A.M.
		BOD-5	<4	mg/L	3	SM 5210 B	10/15/2010 11:00 A.M.
		TSS	<4	mg/L	4	SM 2540D	10/18/2010 9:31 A.M.
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/2010 1:01 P.M.
		Digestion, TKN-TP	10/19/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.33	mg/L	0.05	EPA 365.2	10/19/2010 12:39 P.M.
		Fecal Coliform, MF	350	colonies/100mL	N/A	SM 9221 E	10/14/2010 5:21 P.M.
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:22 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:22 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Copper, Total, ICP	0.007	mg/L	0.005	EPA 200.7	2/8/2011 4:25 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:22 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:22 P.M.
		Zinc, Total, ICP	0.025	mg/L	0.005	EPA 200.7	2/8/2011 4:25 P.M.

Wet Events

T+0							
Sample Date	**Site**	**Test**	**Result**	**Units**	**RDL**	**Method**	**Analysis Date**
10/14/2010	RC1	DO	7.6	mg/L			12:24 PM
		Temperature	13.6	°C			12:24 PM
		Conductivity	345	µS			12:24 PM
		pH	7.69				12:24 PM
		BOD-5	<4	mg/L	3	SM 5210 B	10/15/2010 11:00 A.M.
		TSS	<4	mg/L	4	SM 2540D	10/18/2010 9:31 A.M.
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/2010 1:04 P.M.
		Digestion, TKN-TP	10/19/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.17	mg/L	0.05	EPA 365.2	10/19/2010 12:39 P.M.
		Fecal Coliform, MF	240	colonies/100mL	N/A	SM 9221 E	10/14/2010 5:32 P.M.
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:26 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:26 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Copper, Total, ICP	0.006	mg/L	0.005	EPA 200.7	2/8/2011 4:31 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Silver, Total, MS	0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:26 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:26 P.M.
		Zinc, Total, ICP	0.013	mg/L	0.005	EPA 200.7	2/8/2011 4:31 P.M.
	RC3	DO	8.4	mg/L			11:56 A.M.
		Temperature	13.6	°C			11:56 A.M.
		Conductivity	349	µS			11:56 A.M.
		pH	7.11				11:56 A.M.
		BOD-5	8	mg/L	3	SM 5210 B	10/15/2010 11:00 A.M.
		TSS	<4	mg/L	4	SM 2540D	10/18/2010 9:31 A.M.
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/2010 1:04 P.M.
		Digestion, TKN-TP	10/19/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.16	mg/L	0.05	EPA 365.2	10/19/2010 12:39 P.M.
		Fecal Coliform, MF	>1600	colonies/100mL	N/A	SM 9221 E	10/14/2010 5:29 P.M.
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:30 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:30 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Copper, Total, ICP	0.006	mg/L	0.005	EPA 200.7	2/8/2011 4:37 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.004	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:30 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:30 P.M.
		Zinc, Total, ICP	0.013	mg/L	0.005	EPA 200.7	2/8/2011 4:37 P.M.

Wet Events After Storm

T+0							
Sample Date	**Site**	**Test**	**Result**	**Units**	**RDL**	**Method**	**Analysis Date**
10/14/2010	CC1	DO	9.3	mg/L		Multimeter Probe	3:53 P.M.
		Temperature	14.3	°C			3:53 P.M.
		Conductivity	442	µS			3:53 P.M.
		pH	7.52				3:53 P.M.
		BOD-5	15	mg/L	3	SM 5210 B	10/15/10 11:00 AM
		TSS	13	mg/L	4	SM 2540D	10/18/10 9:31 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/10 1:04 PM
		Digestion, TKN-TP	10/18/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.31	mg/L	0.05	EPA 365.2	10/19/10 12:39 PM
		Fecal Coliform, MF	1600	colonies/100mL	N/A	SM 9221 E	10/14/10 5:20 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:34 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:34 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Copper, Total, ICP	0.011	mg/L	0.005	EPA 200.7	2/8/2011 4:43 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.003	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:34 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:34 P.M.
		Zinc, Total, ICP	0.031	mg/L	0.005	EPA 200.7	2/8/2011 4:43 P.M.
	CC3	DO	6.7	mg/L			3:08 P.M.
		Temperature	16.4	°C			3:08 P.M.
		Conductivity	218	µS			3:08 P.M.
		pH	6.95				3:08 P.M.
		BOD-5	7	mg/L	3	SM 5210 B	10/15/10 11:00 AM
		TSS	28	mg/L	4	SM 2540D	10/18/10 9:31 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/10 1:04 PM
		Digestion, TKN-TP	10/18/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.12	mg/L	0.05	EPA 365.2	10/19/10 12:39 PM
		Fecal Coliform, MF	240	colonies/100mL	N/A	SM 9221 E	10/14/10 5:26 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:54 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:54 P.M.
		Chromium, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Copper, Total, ICP	0.008	mg/L	0.005	EPA 200.7	2/8/2011 4:48 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:54 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:54 P.M.
		Zinc, Total, ICP	0.017	mg/L	0.005	EPA 200.7	2/8/2011 4:48 P.M.

Wet Events After Storm

T+0							
Sample Date	**Site**	**Test**	**Result**	**Units**	**RDL**	**Method**	**Analysis Date**
		DO	9.3	mg/L		Multimeter Probe	3:53 P.M.
10/14/2010	RC1	DO	8.9	mg/L			3:40 P.M.
		Temperature	14.3	°C			3:40 P.M.
		Conductivity	287	µS			3:40 P.M.
		pH	7.39				3:40 P.M.
		BOD-5	11	mg/L	3	SM 5210 B	10/15/10 11:00 AM
		TSS	4	mg/L	4	SM 2540D	10/18/10 9:31 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/10 1:04 PM
		Digestion, TKN-TP	10/18/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.13	mg/L	0.05	EPA 365.2	10/19/10 12:39 PM
		Fecal Coliform, MF	1600	colonies/100mL	N/A	SM 9221 E	10/14/10 5:23 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:58 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:58 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Copper, Total, ICP	0.008	mg/L	0.005	EPA 200.7	2/8/2011 5:00 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 5:58 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 5:58 P.M.
		Zinc, Total, ICP	0.022	mg/L	0.005	EPA 200.7	2/8/2011 5:00 P.M.
	RC3	DO	8.3	mg/L			3:17 P.M.
		Temperature	16.4	°C			3:17 P.M.
		Conductivity	204	µS			3:17 P.M.
		pH	6.72				3:17 P.M.
		BOD-5	13	mg/L	3	SM 5210 B	10/15/10 11:00 AM
		TSS	10	mg/L	4	SM 2540D	10/18/10 9:31 AM
		Ammonia as N	<0.2		0.2	SM 4500 NH3 G	10/21/10 1:04 PM
		Digestion, TKN-TP	10/18/2010	Date completed	N/A	EPA 351.2	
		Total Phosphorous as P	0.09	mg/L	0.05	EPA 365.2	10/19/10 12:39 PM
		Fecal Coliform, MF	80	colonies/100mL	N/A	SM 9221 E	10/14/10 5:16 PM
		Antimony, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Arsenic, Total , MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Beryllium, Total , MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 6:21 P.M.
		Cadmium, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 6:21 P.M.
		Chromium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Copper, Total, ICP	0.007	mg/L	0.005	EPA 200.7	2/8/2011 5:34 P.M.
		ICP-OES	2/8/2011	Date completed	N/A	EPA 200.7	
		Lead, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Metals Preparation, D2002	2/2/2011	Date completed	N/A	EPA 200.2	
		Nickel, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Selenium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Silver, Total, MS	<0.001	mg/L	0.001	EPA 200.8	2/4/2011 6:21 P.M.
		Thallium, Total, MS	<0.002	mg/L	0.002	EPA 200.8	2/4/2011 6:21 P.M.
		Zinc, Total, ICP	0.017	mg/L	0.005	EPA 200.7	2/8/2011 5:34 P.M.

ATTACHMENT H

Development of the Initial Parameters Considered List

DEVELOPMENT OF THE INITIAL PARAMETERS CONSIDERED LIST

REFERENCES FOR THE LIST								SUMMARY
From 2014 PA Integrated Water Quality Monitoring and Assessment Report [aka 303(d) List]	**From PA Code CH 93, 25 §93.7 for TSF, WWF & MF Designations**	**From DRBC for Zone 4**	**From DRBC's 2014 Delaware River and Bay Water Quality Assessment**	**FROM NPDES PERMIT - required sampling of CSO discharges**	**FROM NPDES PERMIT - required sampling of Stormwater Outfall #28 at Plant**	**FROM NPDES PERMIT - required sampling of Plant's Effluent at Outfall 001**	**FROM EPA's CSO Guidance Document (Pg. 2-32)**	**INITIAL LIST OF PARAMETERS CONSIDERED**
PCBs (Fish Consumption)	Alkalinity	Alkalinity	Aluminum (Aquatic Life)	Ammonia	CBOD5	Ammonia	Indicator Bacteria	Bacteria - Enterococcus
Siltation (TSS)	Ammonia	Bacteria - Enterococcus	PCBs (Fish Consumption)	Biological Oxygen Demand	Chemical Oxygen Demand	Bacteria - Fecal Coliform	BOD	Bacteria - Fecal Coliform
	Bacteria - Fecal Coliform	Bacteria - Fecal Coliform		Fecal Coliform	Dissolved Iron	Cadmium	Metals	Alkalinity
	Total Residual Chlorine (TRC)	Dissolved Oxygen (DO)		Phosphorus	pH	CBOD20	Nutrients	Aluminum (Aquatic Life)
	Dissolved Oxygen (DO)	pH		TSS	Oil and Grease	CBOD5	pH	Ammonia
	Fecal Coliform Bacteria	Phenols			TKN	Chlorine	TDS	Biological Oxygen Demand (BOD)
	Iron (Fe)	Radioactivity - alpha emitters			Total Phosphorus	Chlorodibromomethane	TSS	Cadmium
	Osmotic Pressure	Radioactivity - beta emitters			TSS	Copper	Dissolved Oxygen (DO)	CBOD20
	pH	Synthetic Detergents				Cyanide	Toxics	CBOD5
	Temperature	Temperature				Dichlorobromomethane	Biological Assessment	Chlorine
		Threshold Odor Number (TON)				Lead	Sediment	Chlorodibromomethane
		Total Dissolved Solids (TDS)				Nitrate		Copper
		Turbidity				Nitrite		Cyanide
						Oil and Grease		Dichlorobromomethane
						PCBs		Dissolved Oxygen (DO)
						pH		Iron (Fe)
						TDS		Lead
						Total Kjeldahl Nitrogen (TKN)		Metals
						TSS		Nitrate
						Zinc		Nitrite
								Nutrients
								Oil and Grease
								PCBs (Fish Consumption)
								pH
								Phenols
								Phosphorus
								Radioactivity - alpha emitters
								Radioactivity - beta emitters
								Synthetic Detergents
								Temperature
								Threshold Odor Number (TON)
								Total Kjeldahl Nitrogen (TKN)
								Total Dissolved Solids (TDS)
								Total Phosphorus
								Total Residual Chlorine (TRC)
								Total Suspended Solids (TSS)
								Toxics
								Turbidity
								Zinc

ATTACHMENT I

Final Parameters Considered List with STORET Data

DELCORA LTCPU
POI Sampling Results Comparison
1/15/2016

Parameter of Interest (POIs)	Units	Upper Delaware 100% WQS	WET WEATHER CPS WET WELL SAMPLING RESULTS		STORET/ Dry Upper Delaware River Sampling results				Lower Delaware 100% WQS	STORET/ Dry Lower Delaware River Sampling results				STORET/ Wet Lower Delaware River Sampling results	Chester 100% WQS	WET WEATHER CSO 19 SAMPLING RESULTS		Historical Chester Creek Sampling results						STORET/ Chester Creek Wet Sampling results	Ridley 100% WQS	WET WEATHER CSO 18 SAMPLING RESULTS		Historical Ridley Creek Sampling results						[redacted]
Sampling Date Sampling location			Nov 19, 2015 CPS1	Dec 1, 2015 CPS1	9/15/2014 892062 1.16 miles Upstream of Outfall 14	10/20/2014 892062 1.16 miles Upstream of Outfall 14	4/21/2015 892062 1.16 miles Upstream of Outfall 14	5/19/2015 892062 1.16 miles Upstream of Outfall 14		9/15/2014 332049 2.82 miles Downstream of Outfall 2	10/20/2014 332049 2.82 miles Downstream of Outfall 2	4/21/2015 332049 2.82 miles Downstream of Outfall 2	5/19/2015 332049 2.82 miles Downstream of Outfall 2	12/3/2014 WQN0182 1.98 miles Downstream of Outfall 2		Nov 19, 2015 14TH & CROZER	Dec 1, 2015 14TH & CROZER	8/12/2010 Baseline/ Upstream of 14TH & CROZER	9/30/2010 Baseline/ Upstream of 14TH & CROZER	10/14/2010 Baseline/ Upstream of 14TH & CROZER	8/12/2010 Downstream of 14TH & CROZER	9/30/2010 Downstream of 14TH & CROZER	10/14/2010 Downstream of 14TH & CROZER	5/12/2010 DRBC422094 0.09 miles Downstream of Outfall 12		Nov 19, 2015 SUN & HANCOCK	Dec 1, 2015 SUN & HANCOCK	8/12/2010 Baseline/ Upstream of SUN & HANCOCK	9/30/2010 Baseline/ Upstream of SUN & HANCOCK	10/14/2010 Baseline/ Upstream of SUN & HANCOCK	8/12/2010 Downstream of SUN & HANCOCK	9/30/2010 Downstream of SUN & HANCOCK	10/14/2010 Downstream of SUN & HANCOCK	5/12/2010 DRBC422120 0.13 miles Downstream of Outfall 15
Benzene	ug/L	14	ND	ND					0.61						14	ND	ND								14	ND	ND							
Bromodichloromethane	ug/L	17	ND	ND					0.55						17	ND	ND								17	ND	ND							
Chlorodibromomethane	ug/L	13	ND	ND					0.4						13	ND	ND								13	ND	ND							
Chloroform	ug/L	470	ND	ND					1900						470	ND	ND							0.5	470	ND	ND							0.5
Ethylbenzene	ug/L	2100	ND	ND					530						2100	ND	ND							0.5	2100	ND	ND							0.5
Methyl t-Butyl Ether	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND							0.5	No Standard	ND	ND							0.5
Methylene Chloride	ug/L	590	ND	ND					4.6						590	ND	ND								590	ND	ND							
Tetrachloroethene	ug/L	3.3	ND	ND					0.69						3.3	ND	ND								3.3	ND	ND							
Toluene	ug/L	1700	ND	ND					1300						1700	ND	ND							0.5	1700	ND	ND							0.5
Total Xylenes, Acute	ug/L	1100	ND	ND					1100						1100	ND	ND								1100	ND	ND							
Total Xylenes, Chronic	ug/L	210	ND	ND					210						210	ND	ND								210	ND	ND							
Benzo(a)anthracene, Acute	ug/L	0.5	ND	ND	ND	ND			0.0038	ND	ND				0.5	ND	ND								0.5	ND	ND							
Benzo(a)anthracene, Chronic	ug/L	0.1	ND	ND	ND	ND			0.0038	ND	ND				0.1	ND	ND								0.1	ND	ND							
Chrysene	ug/L	18	ND	ND					0.0038	ND	ND				18	ND	ND								18	ND	ND							
bis(2-Ethylhexyl)phthalate	ug/L	2.2	12.0	7.3					1.2						2.2	4.4	8.0								2.2	11.8	4.9							
N-Nitroso-di-n-propylamine	ug/L	0.51	ND	ND			ND	ND	0.005	ND	ND				0.51	ND	ND								0.51	ND	ND							
Phenanthrene, Acute	ug/L	5	ND	ND					5						5	ND	ND								5	ND	ND							
Phenanthrene, Chronic	ug/L	1	ND	ND					1						1	ND	ND								1	ND	ND							
Dieldrin	ug/L	0.000054	ND	0.020					0.000052						0.000054	ND	ND								0.000054	ND	ND							
Total Polychlorinated Biphenyl (PCB)	ug/L	0.000016	0.0	|					0.000016						0.000016	0.0	|								0.000016	0.0	|						
Aroclor-1016	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1221	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1232	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1242	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1248	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1254	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Aroclor-1260	ug/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Ammonia-N	mg/L	10.45[a]	7.47	20.0					10.45[a]						10.45[a]	4.85	13.4								10.45[a]	1.63	3.63							
Biochemical Oxygen Demand	mg/L	No Standard	57.7	94.0					No Standard						No Standard	51.9	81.9								No Standard	26.2	70.7							
Carbonaceous BOD	mg/L	No Standard	81.5	92.3					No Standard						No Standard	66.7	63.4								No Standard	17.3	49.4							
Carbonaceous BOD 20 Day	mg/L	No Standard	7.7	151					No Standard						No Standard	12.8	72.2								No Standard	ND	96.8							
Cyanide, Acute	mg/L	22	ND	ND					22						22	ND	ND								22	ND	ND							
Cyanide, Chronic	mg/L	5.2	ND	ND					5.2						5.2	ND	ND								5.2	ND	ND							
Dissolved Oxygen	mg/L	3.5	2.5	2.5	6.56	8.59	10.39	6.84	3.5	7.17	8.14	10.32	7.20	13.04	3.5	4.3	1.5	5.65	8.36	8.50	5.42	7.33	7.20		3.5	5.4	4.4	6.85	7.49	7.6		7.09	8.4	
Halogen, Total Organic (TOX)	ug/L	No Standard	26.0	36.1					No Standard						No Standard	26.8	41.2								No Standard	ND	ND							
Hexavalent Chromium, Acute	mg/L	16	ND	ND					16						16	ND	ND								16	ND	ND							
Hexavalent Chromium, Chronic	mg/L	10	ND	ND					10						10	ND	ND								10	ND	ND							
Nitrate-N	mg/L	No Standard	ND	0.90					No Standard						No Standard	0.85	2.0								No Standard	ND	ND							
Nitrite-N	mg/L	No Standard	ND	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Odor	T.O.N.	24	30	5					24						24	20	10								24	2	2							
Oil/Grease Hexane Extractable	mg/L	No Standard	14.8	12.4					No Standard						No Standard	7.2	8.4								No Standard	ND	2.6							
Oil/Grease Silica Gel Treated	mg/L	No Standard	ND	ND					No Standard						No Standard	2.3	ND								No Standard	ND	ND							
Phenolics	mg/L	0.020	0.068	0.028	ND	ND			0.020	ND	ND				0.020	0.016	0.016								0.020	0.012	0.009							
Phosphorus, Total	mg/L	No Standard	2.1	2.5					No Standard						No Standard	1.4	2.3								No Standard	0.56	1.4							
Sulfide, Total	mg/L	No Standard	1.3	ND					No Standard						No Standard	ND	ND								No Standard	ND	ND							
Surfactants (MBAS)	mg/L	1.000	0.557	0.505					1.000						1.000	0.485	0.383								1.000	0.123	0.067							
Total Dissolved Solids	mg/L	No Standard	186	277					No Standard						No Standard	150	230								No Standard	39	26							
Total Kjeldahl Nitrogen	mg/L	No Standard	21.2	23.5					No Standard						No Standard	14.1	21.0								No Standard	5.3	8.3							
Total Nitrogen	mg/L	No Standard	21.2	24.4					No Standard						No Standard	15.0	23.0								No Standard	5.30	8.30							
Total Suspended Solids	mg/L	No Standard	108	186	30	36	21	30	No Standard	27	35	22	19	124	No Standard	140	112	7	158	4	12	56	4	10	No Standard	76	200	<4	58	<4	8	44	<4	
Turbidity	NTU	150.0	126	81.9	26	29	16	16	150.0	26	33	17	14		150.0	37.2	57.4								150.0	26.2	80.6							
Hardness	mg/L	No Standard	85.2	127					No Standard						No Standard	58.1	102								No Standard	18.9	31.5							
Trivalent Chromium, Acute	mg/L	0.4994	ND	ND					0.4994						0.4994	ND	ND								0.4994	ND	ND							
Trivalent Chromium, Chronic	mg/L	0.0239	ND	ND					0.0239						0.0239	ND	ND								0.0239	ND	ND							
Aluminum, Acute	mg/L	0.75	1.2	0.40					0.75					2.875	0.75	0.64	0.25								0.75	0.47	0.44							
Aluminum, Chronic	mg/L	0.09	1.2	0.40					0.09					2.875	0.09	0.64	0.25								0.09	0.47	0.44							
Antimony, Total	mg/L	0.0056	ND	ND					0.0056						0.0056	0.0013	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.0056	0.0023	0.0018	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Arsenic, Acute	mg/L	0.34	ND	ND					0.01						0.34	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.34	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Arsenic, Chronic	mg/L	0.15	ND	ND					0.01						0.15	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.15	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Cadmium, Acute	mg/L	0.0010[b]	ND	ND					0.0010[b]						0.0010[b]	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		0.0010[b]	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Cadmium, Chronic	mg/L	0.0001[b]	ND	ND					0.0001[b]						0.0001[b]	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		0.0001[b]	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chromium, Total	mg/L	No Standard	0.011	0.0014					No Standard	ND					No Standard	0.0094	ND	<0.002	0.016	<0.002	<0.002	0.005	<0.002		No Standard	0.0032	0.0031	<0.002	0.005	<0.002	<0.002	0.003	<0.002	
Copper, Acute	mg/L	0.011[b]	0.042	0.041			0.0028	0.0032	0.011[b]	0.005	0.0068			0.0103	0.010[c]	0.033	0.029	0.007	0.017	0.007	0.006	0.008	0.007	<0.010	0.010[c]	0.025	0.032	<0.005	0.015	0.006	<0.005	0.009	0.006	<0.010
Copper, Chronic	mg/L	0.007[b]	0.042	0.041			0.0028	0.0032	0.007[b]					0.0103	0.007[c]	0.033	0.029	0.007	0.017	0.007	0.006	0.008	0.007	<0.010	0.007[c]	0.025	0.032	<0.005	0.015	0.006	<0.005	0.009	0.006	<0.010
Iron, Total	mg/L	0.3	2.9	1.3					0.3					4.2	0.30	0.76	0.47							0.37	0.3	0.72	1.5							0.561
Lead, Acute	mg/L	0.0380	0.028	0.0096			0.0016	0.0023	0.0380	ND	ND			0.0069	0.0380	0.016	0.0060	0.002	0.013	0.002	0.002	0.006	0.002		0.0380	0.0081	0.029	<0.002	0.008	<0.002	<0.002	0.004	<0.002	
Lead, Chronic	mg/L	0.0054	0.028	0.0096			0.0016	0.0023	0.0054					0.0069	0.0054	0.016	0.0060	0.002	0.013	0.002	0.002	0.006	0.002		0.0054	0.0081	0.029	<0.002	0.008	<0.002	<0.002	0.004	<0.002	
Mercury, Total	mg/L	0.000051	0.00020	ND			ND	0.000022	0.00005	ND	ND				0.000051	ND	ND								0.000051	ND	0.0011							
Molybdenum, Total	mg/L	No Standard	0.0013	0.0012					No Standard						No Standard	0.0027	ND								No Standard	0.0031	ND							
Selenium, Acute	mg/L	0.02	ND	ND					0.02						0.02	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.02	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Selenium, Chronic	mg/L	0.0046	ND	ND					0.0046						0.0046	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.0046	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Silver, Total	mg/L	0.0019[b]	ND	ND					0.0019[b]						0.0019[b]	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.0019[b]	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Thallium, Total	mg/L	0.00047	ND	ND					0.00024						0.00047	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		0.00047	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Zinc, Total	mg/L	0.098[b]	0.22	0.13	0.0042	0.0138	0.0033	0.0112	0.098[b]	0.0020	0.0087	0.0032	0.0102	0.025	0.088[b]	0.11	0.067	0.019	0.051	0.020	0.018	0.027	0.025	0.012	0.088[b]	0.14	0.20	0.012	0.034	0.013	0.01	0.029	0.013	0.011
Enterococcus	CFU/100ml	88	241960	199000					33						88	77000	173000								88	9160	34500							
Fecal Coliform	CFU/100ml	770	2600000	3700000	160	170	160	93	200	83	120		110		770	470000	1030000	9700	10000	240	930	10000	350		770	1260000	2100000	720	>10000	240	880	>10000	1600	

	LEGEND:
	Value Exceeds WQS
ND	Non Detection
ND	Screening of POIs
	303(d) list Impairement
I	Value Greater than or Equal to Method Detection Limit but Below Reportable Detection Limit (RDL)
	No Standard but Present in Combined Sewer Discharge

	Footnotes
a	Value for pH = 7.1 found in DRBC Water Quality Regulations, Section 4.20.5 Paragraph A.3
b	Value for Average Ca, Mg Hardness = 84 mg/l. Average value is based on EPA STORET station data from 2010-2015 in Delaware River
c	Value for Average Ca, Mg Hardness = 74 mg/l found in DRBC Water Quality Regulations, Section 4.20.5 Paragraph A.2 in Chester and Ridley Creeks

ATTACHMENT J

Summary of STORET Data Exceedances

DELCORA LTCPU
Summary of STORET Data Showing Exceedance in All Receiving Bodies
2010-2015

Parameter	Number of Storet Observations (2010-2015)				Number of Exceedances (2010-2015)				Number of Non Detects (2010-2015)				Note
Location	Delaware		Chester	Ridley	Delaware		Chester	Ridley	Delaware		Chester	Ridley	
Station ID (Upstream or Downstream of Outfall)	892062 (Upstream of Outfall 14)	WQN0182, 332049 (Downstream of Outfall 2)	422094 (Downstream of Outfall 12)	422120 (Downstream of Outfall 15)	892062 (Upstream of Outfall 14)	WQN0182, 332049 (Downstream of Outfall 2)	422094 (Downstream of Outfall 12)	422120 (Downstream of Outfall 15)	892062 (Upstream of Outfall 14)	WQN0182, 332049 (Downstream of Outfall 2)	422094 (Downstream of Outfall 12)	422120 (Downstream of Outfall 15)	
bis(2-Ethylhexyl)phthalate	0	0	0	0	0	0	0	0	0	0	0	0	
Dieldrin	0	0	0	0	0	0	0	0	0	0	0	0	
Total Polychlorinated Biphenyl	0	0	0	0	0	0	0	0	0	0	0	0	
Ammonia-N	0	25	0	0	0	0	0	0	0	0	0	0	
Biochemical Oxygen Demand	0	0	0	0	0	0	0	0	0	0	0	0	No Standard
Carbonaceous BOD	0	0	0	0	0	0	0	0	0	0	0	0	No Standard
Carbonaceous BOD 20 Day	0	0	0	0	0	0	0	0	0	0	0	0	No Standard
Dissolved Oxygen	34	61	0	0	0	0	0	0	0	0	0	0	
Nitrate-N	0	0	0	0	0	0	0	0	0	0	0	0	No Standard
Nitrite-N	0	0	0	0	0	0	0	0	0	0	0	0	
Odor	0	0	0	0	0	0	0	0	0	0	0	0	
Phenolics	7	10	0	0	0	0	0	0	7	8	0	0	
Phosphorus, Total	0	10	1	1	0	0	0	0	0	0	0	0	No Standard
Surfactants (MBAS)	0	0	0	0	0	0	0	0	0	0	0	0	
Total Dissolved Solids	34	64	1	1	0	0	0	0	0	0	0	0	No Standard
Total Kjeldahl Nitrogen	0	0	1	1	0	0	0	0	0	0	0	0	No Standard
Total Nitrogen	0	0	0	0	0	0	0	0	0	0	0	0	No Standard
Total Suspended Solids	34	64	1	1	0	0	0	0	0	0	0	0	No Standard
Turbidity	34	35	0	0	0	0	0	0	0	0	0	0	
Hardness	36	66	0	0	0	0	0	0	0	0	0	0	No Standard
Aluminum, Acute	0	29	0	0	0	**14**	0	0	0	0	0	0	
Aluminum, Chronic	0	29	0	0	0	**29**	0	0	0	0	0	0	
Antimony, Total	4	0	0	0	0	0	0	0	4	0	0	0	
Arsenic, Acute	0	0	0	0	0	0	0	0	0	0	0	0	
Arsenic, Chronic	0	0	0	0	0	0	0	0	0	0	0	0	
Copper, Acute	36	67	1	1	0	**3**	0	0	10	6	1	1	
Copper, Chronic	36	67	1	1	0	**6**	**1**	**1**	10	6	0	0	
Iron, Total	0	29	1	1	0	**29**	**1**	**1**	0	0	0	0	
Lead, Acute	36	67	0	0	0	0	0	0	31	37	0	0	
Lead, Chronic	36	67	0	0	0	**4**	0	0	31	37	0	0	
Mercury, Total	10	16	0	0	**1**	0	0	0	6	10	0	0	
Zinc, Total	36	67	1	1	0	0	0	0	5	5	0	0	
Enterococcus*	0	0	0	0	**0**	**0**	**0**	**0**	0	0	0	0	
Fecal Coliform*	34	35	0	0	**0**	**0**	**0**	**0**	0	0	0	0	

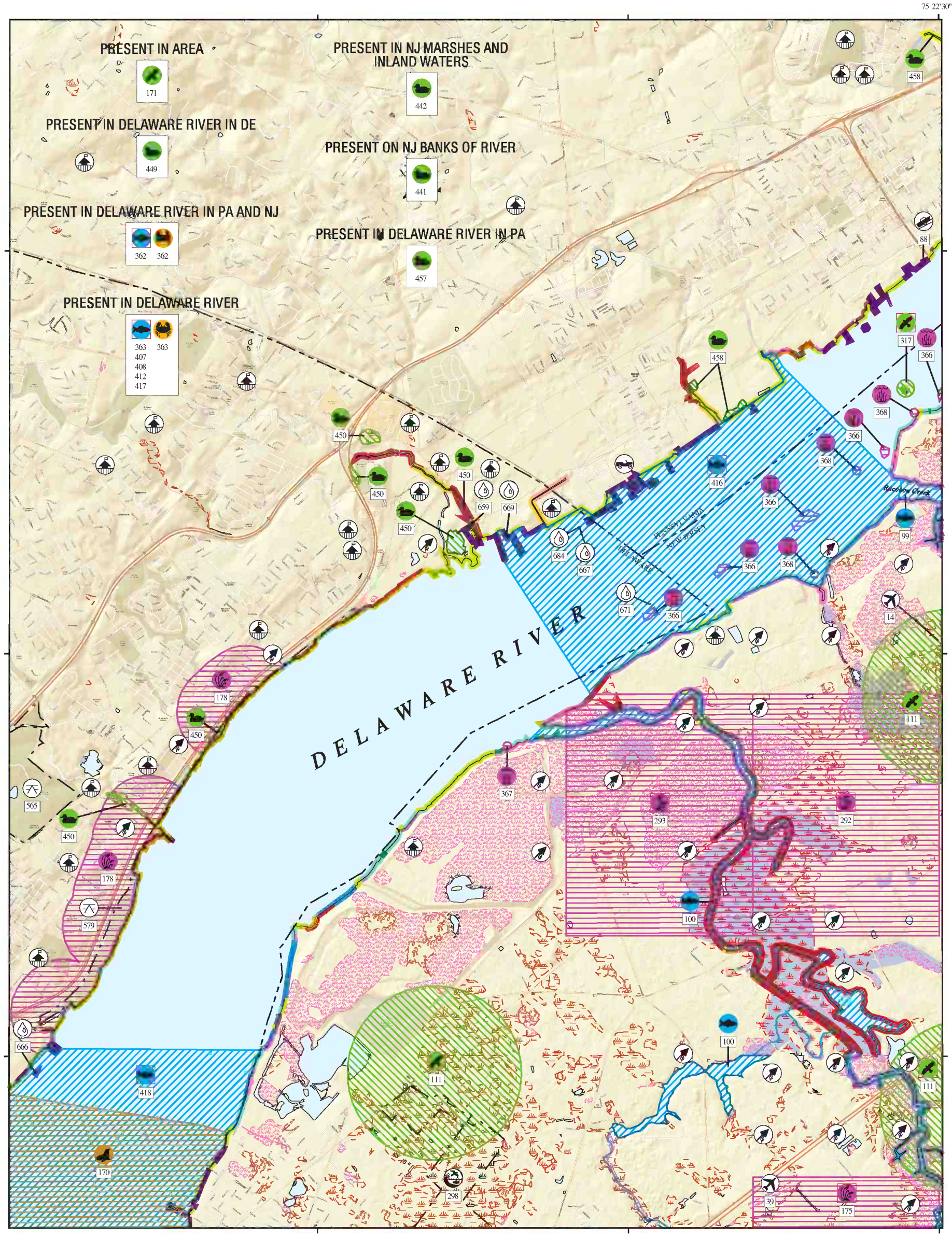
*Fecal Coliform was identified as a parameter exceeding water quality standards (WQS) for Chester and Ridley Creeks based on historical data from 2010 (see Attachment J). Sufficient historical data indicating WQS exceedance for all receiving waterbodies was unavailable, however Enterococcus and Fecal Coliform are considered typical parameters associated with CSOs and for this reason are included as POCs.

	LEGEND
	Pollutant Of Concern (POC)
	Parameter of Potential Concern (POPC)

ATTACHMENT K

NOAA Environmental Sensitivity Index Maps

ENVIRONMENTAL SENSITIVITY INDEX MAP



SHORELINE HABITATS (ESI)

- 1B EXPOSED, SOLID MAN- MADE STRUCTURES
- 2A EXPOSED WAVE- CUT PLATFORMS IN CLAY, MUD, OR BEDROCK
  2B EXPOSED SCARPS AND STEEP SLOPES IN CLAY OR MUD
- 3A FINE- TO MEDIUM- GRAINED SAND BEACHES
  3B SCARPS AND STEEP SLOPES IN SAND
- 4 COARSE- GRAINED SAND BEACHES
- 5 MIXED SAND AND GRAVEL (SHELL) BEACHES
- 6A GRAVEL BEACHES
- 6B RIPRAP
- 7 EXPOSED TIDAL FLATS
- 8A SHELTERED SCARPS IN CLAY OR MUD
- 8B SHELTERED, SOLID MAN- MADE STRUCTURES
- 8C SHELTERED RIPRAP
  8E PEAT SHORELINES
- 9A SHELTERED TIDAL FLATS
  9B VEGETATED LOW BANKS
- 10A SALT- AND BRACKISH- WATER MARSHES
- 10B FRESHWATER MARSHES
- 10C SWAMPS
- 10D SCRUB- SHRUB WETLANDS

N W E S

SCALE 1:45000

1 .5 0 1 KILOMETER

1 .5 0 1 MILE

1 .5 0 1 NAUTICAL MILE

Not For Navigation

Published: March 2014

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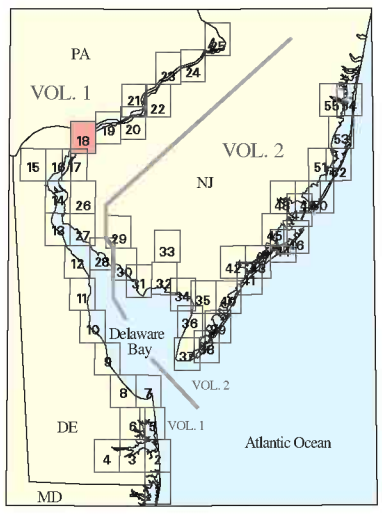
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Emergency Response Division



Delaware Bay ESI - Volume 1 **ESI-18**

Delaware/New Jersey/Pennsylvania: ESIMAP 18

BIOLOGICAL RESOURCES:

BIRD:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Nesting	Migrating	Molting
111	Endangered raptor 2	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X	JAN-JUL	-	-
171	Osprey							X	X	X	X	X	X	X	X			MAR-AUG	MAR-MAR SEP-OCT	-
317	Threatened raptor	T		NJ				X	X	X	X	X	X	X	X			APR-AUG	SEP-OCT	-
441	Bufflehead				10S	X	X	X	X	X					X	X	X	-	MAR-APR OCT-DEC	-
	Canada goose				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Common goldeneye				10S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Hooded merganser				10S	X	X	X							X	X	X	-	FEB-MAR OCT-DEC	-
	Red-breasted merganser				10S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ring-necked duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ruddy duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Snow goose				1000S	X	X	X	X	X				X	X	X	X	-	FEB-MAY SEP-OCT	-
442	American black duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-APR SEP-DEC	-
	American coot				100S	X	X	X	X	X			X	X	X	X	X	-	FEB-MAR SEP-NOV	-
	American wigeon				100S	X	X	X	X	X			X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Bufflehead				10S	X	X	X	X	X					X	X	X	-	MAR-APR OCT-DEC	-
	Canada goose				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Common goldeneye				10S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Common merganser				100S	X	X	X	X							X	X	-	FEB-MAR NOV-DEC	-
	Gadwall				100S	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	MAR-APR OCT-NOV	-
	Green-winged teal				100S	X	X	X	X	X			X	X	X	X	X	-	FEB-MAR SEP-NOV	-
	Hooded merganser				10S	X	X	X							X	X	X	-	FEB-MAR OCT-DEC	-
	Mallard				1000S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	-	-
	Mute swan				10S	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
	Northern pintail				100S	X	X	X	X				X	X	X	X	X	-	FEB-APR AUG-SEP	-
	Northern shoveler				10S	X	X	X	X	X				X	X	X	X	-	MAR-APR SEP-OCT	-
	Red-breasted merganser				10S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ring-necked duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ruddy duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Snow goose				1000S	X	X	X	X	X				X	X	X	X	-	FEB-MAY SEP-OCT	-
	Tundra swan				100S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
449	Bufflehead				10S	X	X	X	X	X					X	X	X	-	MAR-MAR OCT-NOV	-
	Canada goose				10000S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-APR SEP-NOV	-
	Ring-necked duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	FEB-MAR OCT-NOV	-
	Scaup				1000S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Snow goose				100S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
450	American black duck				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	OCT-APR	-
	American coot				1000S	X	X	X	X	X				X	X	X	X	-	FEB-APR OCT-NOV	-
	American wigeon				10S	X	X	X	X	X				X	X	X	X	-	MAR-APR SEP-OCT	-
	Bufflehead				10S	X	X	X	X	X					X	X	X	-	MAR-MAR OCT-NOV	-
	Canada goose				10000S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-APR SEP-NOV	-
	Common merganser				10S	X	X	X	X							X	X	-	FEB-MAR NOV-DEC	-
	Gadwall				100S	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	MAR-APR OCT-NOV	-
	Green-winged teal				100S	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	MAR-APR AUG-SEP	-
	Mallard				100S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUL	FEB-MAY OCT-DEC	-
	Mute swan				10S	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
	Northern pintail				100S	X	X	X	X				X	X	X	X	X	-	FEB-MAY SEP-DEC	-
	Northern shoveler				100S	X	X	X	X				X	X	X	X	X	-	MAR-APR OCT-NOV	-
	Ring-necked duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	FEB-MAR OCT-NOV	-
	Scaup				1000S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Snow goose				100S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
	Wood duck				10S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	FEB-MAR OCT-DEC	-
457	Bufflehead				100S	X	X	X	X	X	X				X	X	X	-	MAR-MAY OCT-DEC	-
	Canada goose				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	FEB-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X				X	X	X	X	-	FEB-APR SEP-NOV	-
	Common goldeneye				10S	X	X	X	X	X					X	X	X	-	FEB-APR NOV-DEC	-
	Long-tailed duck				10S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
	Mergansers				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Northern shoveler				10S	X	X	X	X	X			X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X			X	X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
458	American black duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Bufflehead				100S	X	X	X	X	X	X				X	X	X	-	MAR-MAY OCT-DEC	-
	Canada goose				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	FEB-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X	X			X	X	X	X	-	FEB-APR SEP-NOV	-
	Common goldeneye				10S	X	X	X	X	X	X				X	X	X	-	FEB-APR NOV-DEC	-
	Green-winged teal				100S	X	X	X	X	X	X		X	X	X	X	X	-	MAR-MAY AUG-NOV	-
	Long-tailed duck				10S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
	Mallard				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	FEB-MAY SEP-DEC	-
	Mergansers				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Northern pintail				100S	X	X	X	X	X	X			X	X	X	X	-	FEB-APR SEP-DEC	-
	Northern shoveler				10S	X	X	X	X	X	X		X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X			X	X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Tundra swan				100S	X	X	X	X						X	X	X	-	FEB-APR OCT-DEC	-

FISH:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Eggs	Larvae	Juveniles	Adults
99	Alewife				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-JUN
	American eel				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	American shad				HIGH SPAWNING			X	X	X	X	X	X	X	X			MAR-JUN	APR-JUN	MAY-JUL	JUN-NOV	MAR-JUN OCT-NOV
	Blueback herring				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAY-JUL	JAN-DEC	MAR-JUN OCT-NOV
100	Alewife				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-JUN
	American eel				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	Blueback herring				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAY-JUL	JAN-DEC	MAR-JUN OCT-NOV
362	Alewife				HIGH SPAWNING			X	X	X	X	X	X	X				MAR-MAY	MAR-MAY	APR-JUN	JUN-AUG	MAR-OCT
	American eel				LOW	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	American shad				HIGH SPAWNING			X	X	X	X	X	X	X	X			MAR-JUN	APR-JUN	MAY-JUL	JUN-NOV	MAR-NOV
	Atlantic croaker				MED						X	X	X	X	X			-	-	-	JUL-OCT	JUN-NOV
	Atlantic menhaden				HIGH						X	X	X					-	-	-	JUN-JUL	JUN-AUG
	Bay anchovy				MED								X	X	X	X		-	-	-	AUG-OCT	AUG-NOV
	Blueback herring				HIGH			X	X	X	X	X	X	X	X			MAR-JUN	MAR-JUN	MAR-JUN	JUN-NOV	MAR-NOV
	Channel catfish				PRESENT						X	X	X	X	X	X		-	-	-	JUL-SEP	JUN-NOV
	Gizzard shad				LOW						X	X	X	X	X	X		-	-	-	JUN-OCT	JUL-NOV
	Hickory shad				LOW			X	X	X	X							MAR-JUN	MAR-JUN	MAR-JUN	-	MAR-JUN
	Hickory shad	E		PA	LOW			X	X	X	X							MAR-JUN	MAR-JUN	MAR-JUN	-	MAR-JUN
	Spot				HIGH SPRING							X	X	X				-	-	-	JUL-SEP	JUL-SEP

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. DNREC, NJDEP ENSP, and PGC provided information for some of the federally and state listed species and species of conservation concern for display in the ESI atlas and accompanying digital data in 2013-2014. These data represent existing information known to these agencies at the time of the request and should never be substituted for consultation with these agencies. This atlas was developed using NJDEP GIS digital data for archaeological and historic sites, but this secondary product has not been verified by NJDEP and is not state-authorized. Archaeological and historical site information for Delaware was provided by DE Division of Historical and Cultural Affairs.

Delaware/New Jersey/Pennsylvania: ESIMAP 18 (cont.)

BIOLOGICAL RESOURCES: (cont.)

FISH: (cont.)

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Eggs	Larvae	Juveniles	Adults
362	Striped bass				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	APR-JUL	JAN-DEC	APR-NOV
	White perch				HIGH	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	APR-JUL	JAN-DEC	JAN-DEC
	Yellow perch				LOW					X	X	X	X	X				-	-	-	JUN-AUG	JUN-OCT
363	Alewife				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-OCT
	American eel				MED	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	American shad				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JAN-DEC	MAR-OCT
	Atlantic croaker				HIGH			X	X	X	X	X	X	X	X	X		-	-	-	JUL-OCT	APR-NOV
	Atlantic menhaden				HIGH				X	X	X	X	X	X	X			-	-	-	JUN-OCT	MAY-OCT
	Bay anchovy				MED			X	X	X	X	X	X	X	X	X		-	-	-	APR-NOV	APR-NOV
	Blueback herring				HIGH	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	APR-JUN	JAN-DEC	APR-NOV
	Bluefish				LOW					X	X	X	X	X				-	-	-	JUN-OCT	-
	Channel catfish				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JUN-OCT	JAN-DEC
	Gizzard shad				LOW					X	X	X	X	X	X			-	-	-	JUN-OCT	JUL-NOV
	Hickory shad				MED			X	X	X	X	X	X	X	X			-	-	-	MAY-OCT	MAR-JUN OCT-NOV
	Hickory shad	E		PA	MED			X	X	X	X	X	X	X	X			-	-	-	MAY-OCT	MAR-JUN OCT-NOV
	Spot				MED				X	X	X	X	X	X				-	-	-	JUN-OCT	MAY-OCT
	Striped bass				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	APR-JUL	JAN-DEC	APR-NOV
	Weakfish				PRESENT					X	X	X	X	X				-	-	-	JUN-OCT	-
	White perch				HIGH	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	APR-JUL	JAN-DEC	JAN-DEC
	Yellow perch				LOW					X	X	X	X	X	X			-	-	-	JUN-NOV	JUN-NOV
407	Shortnose sturgeon	F	E	DE	MED				X	X	X	X	X	X	X			-	-	-	APR-OCT	APR-OCT
	Shortnose sturgeon	F	E	NJ	MED				X	X	X	X	X	X	X						APR-OCT	APR-OCT
	Shortnose sturgeon	F	E	PA	MED				X	X	X	X	X	X	X						APR-OCT	APR-OCT
408	Shortnose sturgeon	F	E	DE	EGG	X	X	X								X	X	-	-	-	NOV-MAR	-
	Shortnose sturgeon	F	E	NJ	EGG	X	X	X								X	X	-	-	-	NOV-MAR	-
	Shortnose sturgeon	F	E	PA	EGG	X	X	X								X	X	-	-	-	NOV-MAR	-
412	Atlantic sturgeon	F	E	DE	EGG				X	X	X							APR-JUN	APR-JUN	MAY-JUN	APR-JUN	APR-JUN
	Atlantic sturgeon	F	E	NJ	EGG				X	X	X							APR-JUN	APR-JUN	MAY-JUN	APR-JUN	APR-JUN
	Atlantic sturgeon	F	E	PA	EGG				X	X	X							APR-JUN	APR-JUN	MAY-JUN	APR-JUN	APR-JUN
416	Atlantic sturgeon	F	E	DE	EGG YCY	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	MAY-JUN	JAN-DEC	MAR-NOV
	Atlantic sturgeon	F	E	NJ	EGG YCY	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	MAY-JUN	JAN-DEC	MAR-NOV
	Atlantic sturgeon	F	E	PA	EGG YCY	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	MAY-JUN	JAN-DEC	MAR-NOV
417	Atlantic sturgeon	F	E	DE	PRESENT	X	X	X			X	X	X	X	X	X		-	-	-	JUL-MAR	MAR-MAR JUL-NOV
	Atlantic sturgeon	E	E	NJ	PRESENT	X	X	X			X	X	X	X	X	X		-	-	-	JUL-MAR	MAR-MAR JUL-NOV
	Atlantic sturgeon	E	E	PA	PRESENT	X	X	X			X	X	X	X	X	X		-	-	-	JUL-MAR	MAR-MAR JUL-NOV
418	Atlantic sturgeon	E	E	DE	PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JAN-DEC	MAR-NOV
	Atlantic sturgeon	F	E	NJ	PRESENT	X	X	X	X	X	X	X	X	X	X	X	X				JAN-DEC	MAR-NOV

HABITAT:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D
175	Endangered plant	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X
178	Rare plant					X	X	X	X	X	X	X	X	X	X	X	X
292	Endangered plant	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X
	Sensitive joint-vetch	E	T	NJ		X	X	X	X	X	X	X	X	X	X	X	X
293	Sensitive joint vetch	E	T	NJ		X	X	X	X	X	X	X	X	X	X	X	X
366	Eelgrass (water celery)					X	X	X	X	X	X	X	X	X	X	X	X
367	Eelgrass (water celery)					X	X	X	X	X	X	X	X	X	X	X	X
368	Submerged aquatic vegetation					X	X	X	X	X	X	X	X	X	X	X	X

INVERTEBRATE:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Eggs	Larvae	Juveniles	Adults
362	Blue crab				LOW						X	X	X	X	X	X		-	-	-	JUN-OCT	JUN-NOV
363	Blue crab				LOW	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JAN-DEC	JAN-DEC

MARINE MAMMAL:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Mating	Calving	Pupping	Molting
170	Gray seal				OCCASIONAL	X	X	X	X	X						X	X	-	-	-	-
	Harbor seal				COMMON	X	X	X	X							X	X	-	-	-	-
	Harp seal				OCCASIONAL	X	X	X	X	X						X	X	-	-	-	-
	Hooded seal				VERY RARE	X	X	X	X	X						X	X	-	-	-	-

HUMAN USE RESOURCES:

AIRPORT:

HUN#	Name	Contact	Phone
14	BRIDGEPORT-CAHILL FIELD		
39	SPITFIRE AERODROME		

BOAT RAMP:

HUN#	Name	Contact	Phone
88	FLOWER STREET- CHESTER CITY BOAT RAMP	CITY OF CHESTER	

MANAGEMENT AREA:

HUN#	Name	Contact	Phone
298	GAME BRANCH	NJ DEPT OF NATURAL LANDS TRUST	

PARK:

HUN#	Name	Contact	Phone
565	BELLEVUE STATE PARK	DELAWARE STATE PARKS	
579	FOX POINT STATE PARK	DELAWARE STATE PARKS	

WATER INTAKE:

HUN#	Name	Contact	Phone
659	CLAYMONT STEEL, INC.		
666	DUPONT EDGEMOOR PLANT		
667	FPL ENERGY		
669	GENERAL CHEMICAL		
671	LOGAN GENERATING CORP.		
684	SUNOCO INC (R&M)		

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ENVIRONMENTAL SENSITIVITY INDEX MAP

75 15'00"

39 52'30"

PRESENT IN PA MARSHES AND INLAND WATERS
458

PRESENT IN HEINZ NWR
248

PRESENT IN AREA
111 175

PRESENT IN NJ MARSHES AND INLAND WATERS
442

PRESENT IN DELAWARE RIVER
362 362
407
408
412
417

PRESENT IN DELAWARE RIVER IN PA
457

PRESENT ON NJ BANKS OF RIVER
441

LITTLE TINICUM ISLAND

DELAWARE RIVER

CRAB POINT

BRAMELL POINT

PENNSYLVANIA
NEW JERSEY

Raccoon Creek

Delaware Bay

Atlantic Ocean

PA
VOL. 1
VOL. 2
NJ
DE
MD

SHORELINE HABITATS (ESI)

- 1B EXPOSED, SOLID MAN- MADE STRUCTURES
- 2A EXPOSED WAVE- CUT PLATFORMS IN CLAY, MUD, OR BEDROCK
  2B EXPOSED SCARPS AND STEEP SLOPES IN CLAY OR MUD
- 3A FINE- TO MEDIUM- GRAINED SAND BEACHES
  3B SCARPS AND STEEP SLOPES IN SAND
- 4 COARSE- GRAINED SAND BEACHES
- 5 MIXED SAND AND GRAVEL (SHELL) BEACHES
- 6A GRAVEL BEACHES
- 6B RIPRAP
- 7 EXPOSED TIDAL FLATS
- 8A SHELTERED SCARPS IN CLAY OR MUD
- 8B SHELTERED, SOLID MAN- MADE STRUCTURES
- 8C SHELTERED RIPRAP
  8E PEAT SHORELINES
- 9A SHELTERED TIDAL FLATS
  9B VEGETATED LOW BANKS
- 10A SALT- AND BRACKISH- WATER MARSHES
- 10B FRESHWATER MARSHES
- 10C SWAMPS
- 10D SCRUB- SHRUB WETLANDS

N
W E
S

SCALE 1:45000

1 .5 0 1 KILOMETER

1 .5 0 1 MILE

1 .5 0 1 NAUTICAL MILE

Not For Navigation

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National Ocean Service
Office of Response and Restoration
Emergency Response Division

Delaware Bay ESI - Volume 1 **ESI-19**

Delaware/New Jersey/Pennsylvania: ESIMAP 19

BIOLOGICAL RESOURCES:

BIRD:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Nesting	Migrating	Molting
111	Endangered raptor 2	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X	JAN-JUL	-	-
	Endangered raptor 2	T		PA		X	X	X	X	X	X	X	X	X	X	X	X	JAN-JUL	-	-
247	American bittern	E		PA	COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAY-AUG	-	-
	American black duck				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	American coot				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	-	-
	American woodcock				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	-	-
	Bald eagle	T		PA	UNCOMMON	X	X	X	X	X	X	X	X	X	X	X	X	FEB-APR	-	-
	Barn owl				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	JAN-DEC	-	-
	Black tern	E		PA	OCCASIONAL				X	X	X	X	X					-	-	-
	Black-bellied plover				COMMON			X	X	X	X	X	X	X				-	MAY-OCT	-
	Black-crowned night-heron	E		PA	ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	MAR-APR JUL-DEC	-
	Blackpoll warbler	E		PA	COMMON					X	X		X	X	X			-	MAY-JUN AUG-OCT	-
	Blue-winged teal				COMMON			X	X	X	X	X	X	X	X	X	X	MAY-JUN	MAR-MAY AUG-OCT	-
	Canada goose				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	FEB-APR SEP-NOV	-
	Common moorhen				UNCOMMON			X	X	X	X	X	X	X	X			MAY-SEP	-	-
	Common snipe				COMMON	X	X	X	X	X		X	X	X	X	X	X	-	MAR-MAY JUL-NOV	-
	Common tern	E		PA	RARE				X	X	X	X	X	X	X			-	APR-MAY AUG-SEP	-
	Double-crested cormorant				COMMON	X		X	X	X	X	X	X	X	X	X	X	-	MAR-MAY AUG-DEC	-
	Forster's tern				COMMON				X	X	X	X	X	X	X	X		-	APR-MAY JUL-OCT	-
	Great blue heron				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-MAY	-
	Great egret	E		PA	ABUNDANT			X	X	X	X	X	X	X	X	X	X	APR-JUL	MAR-MAY JUL-DEC	-
	Greater scaup				COMMON	X	X	X	X			X	X	X	X	X	X	-	NOV-APR	-
	Greater yellowlegs				COMMON			X	X	X		X	X	X	X	X		-	MAR-MAY JUL-NOV	-
	Green heron							X	X	X	X	X	X	X	X			-	-	-
	Green-winged teal				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	JUL-AUG	MAR-MAY AUG-NOV	-
	Herring gull				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
	Hooded merganser				OCCASIONAL	X	X	X	X	X	X	X	X	X	X	X	X	MAY-AUG	MAR-APR OCT-JAN	-
	Killdeer				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-MAR AUG-NOV	-
	King rail	E		PA	OCCASIONAL			X	X	X	X	X	X	X	X			MAY-AUG	-	-
	Laughing gull				COMMON			X	X	X	X	X	X	X	X	X		-	APR-MAY AUG-OCT	-
	Least bittern	E		PA	COMMON				X	X	X	X	X	X	X			MAY-AUG	-	-
	Little blue heron				COMMON				X	X	X	X	X	X				-	-	-
	Loggerhead shrike	E		PA	RARE			X	X			X	X	X	X	X		-	MAR-APR AUG-SEP	-
	Mallard				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	FEB-MAY SEP-DEC	-
	Marsh wren				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAY-AUG	-	-
	Northern harrier	T		PA	COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUN	OCT-FEB	-
	Northern pintail				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUN	FEB-APR SEP-DEC	-
	Northern shoveler				COMMON	X	X	X	X	X	X		X	X	X	X	X	MAY-JUN	MAR-APR SEP-NOV	-
	Osprey	T		PA	OCCASIONAL			X	X	X	X	X	X	X	X				MAR MAY AUG OCT	
	Peregrine falcon	E		PA	RARE	X	X	X	X	X	X	X	X	X	X	X	X			
	Pied-billed grebe				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAY-AUG	MAR-MAY AUG-AUG	-
	Piping plover	E	E	PA	RARE				X	X	X	X	X	X				-	-	-
	Ring-billed gull				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	-	OCT-MAR	-
	Ruddy duck				COMMON	X	X	X	X				X	X	X			-	MAR-APR OCT-NOV	-
	Sedge wren	E		PA	RARE				X	X	X	X	X	X				JUN-AUG	-	-
	Semipalmated plover				COMMON				X	X	X	X	X	X				-	APR-OCT	-
	Semipalmated sandpiper				COMMON				X	X	X	X	X	X				-	APR-OCT	-
	Short-eared owl	E		PA	OCCASIONAL	X	X	X	X				X	X	X			-	MAR-APR OCT-NOV	-
	Snowy egret				ABUNDANT			X	X	X	X	X	X	X	X			APR-AUG	MAR-MAY JUL-SEP	-
	Solitary sandpiper				COMMON				X	X		X	X	X				-	APR-MAY JUL-OCT	-
	Sora				OCCASIONAL			X	X	X	X	X	X	X				MAY-JUL	-	-
	Spotted sandpiper				COMMON				X	X	X	X	X	X				MAY-JUN	APR-MAY JUL-OCT	-
	Swamp sparrow					X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	-	-
	Upland sandpiper	E		PA	RARE				X	X	X	X	X	X				-	APR-MAY JUL-SEP	-
	Virginia rail				OCCASIONAL			X	X	X	X	X	X	X				MAY-AUG	-	-
	Wood duck				ABUNDANT	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	MAR-APR SEP-NOV	-
	Yellow-bellied flycatcher	E		PA	UNCOMMON				X	X		X	X	X				-	MAY-JUN AUG-OCT	-
	Yellow-crowned night-heron	E		PA	RARE				X	X	X	X	X	X				-	-	-
317	Threatened raptor	T		NJ					X	X	X	X	X	X	X			APR AUG	SEP OCT	
330	Peregrine falcon	E		PA	1 NEST	X	X	X	X	X	X	X	X	X	X	X	X	FEB JUL	MAR MAY	
441	Bufflehead				10S	X	X	X	X	X				X	X	X		-	MAR-APR OCT-DEC	-
	Canada goose				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X					X	X		-	MAR-APR NOV-DEC	-
	Common goldeneye				10S	X	X	X	X	X					X	X		-	MAR-APR NOV-DEC	-
	Hooded merganser				10S	X	X	X						X	X	X		-	FEB-MAR OCT-DEC	-
	Red-breasted merganser				10S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ring-necked duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Ruddy duck				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Snow goose				1000S	X	X	X	X	X				X	X	X	X	-	FEB-MAY SEP-OCT	-
442	American black duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-APR SEP-DEC	-
	American coot				100S	X	X	X	X	X			X	X	X	X	X	-	FEB-MAR SEP-NOV	-
	American wigeon				100S	X	X	X	X	X			X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Bufflehead				10S	X	X	X	X	X					X	X	X	-	MAR-APR OCT-DEC	-
	Canada goose				1000S	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Common goldeneye				10S	X	X	X	X	X						X	X	-	MAR-APR NOV-DEC	-
	Common merganser				100S	X	X	X	X							X	X	-	FEB-MAR NOV-DEC	-
	Gadwall				100S	X	X	X	X	X	X	X	X	X	X	X	X	MAY-JUL	MAR-APR OCT-NOV	-
	Green-winged teal				100S	X	X	X	X	X			X	X	X	X	X	-	FEB-MAR SEP-NOV	-
	Hooded merganser				10S	X	X	X						X	X	X		-	FEB-MAR OCT-DEC	-
	Mallard				1000S	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	-	-
	Mute swan				10S	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
	Northern pintail				100S	X	X	X	X			X	X	X	X	X		-	FEB-APR AUG-SEP	-
	Northern shoveler				10S	X	X	X	X	X			X	X	X	X		-	MAR-APR SEP-OCT	-
	Red-breasted merganser				10S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
	Ring-necked duck				100S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
	Ruddy duck				100S	X	X	X	X					X	X	X		-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
	Snow goose				1000S	X	X	X	X	X				X	X	X	X	-	FEB-MAY SEP-OCT	-
	Tundra swan				100S	X	X	X	X					X	X	X		-	FEB-APR OCT-NOV	-
443	Bufflehead				10S	X	X	X	X	X				X	X	X		-	MAR-APR OCT-DEC	-
	Canada goose				10000S	X	X	X	X	X	X	X	X	X	X	X	X	-	MAR-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X					X	X		-	MAR-APR NOV-DEC	-
	Common goldeneye				10S	X	X	X	X	X					X	X		-	MAR-APR NOV-DEC	-
	Red-breasted merganser				10S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
	Ring-necked duck				10S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
	Ruddy duck				10S	X	X	X	X					X	X	X		-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X					X	X	X		-	MAR-APR OCT-DEC	-
457	Bufflehead				100S	X	X	X	X	X	X			X	X	X		-	MAR-MAY OCT-DEC	-
	Canada goose				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	FEB-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X	X		X	X	X	X		-	FEB-APR SEP-NOV	-
	Common goldeneye				10S	X	X	X	X	X				X	X	X		-	FEB-APR NOV-DEC	-
	Long-tailed duck				10S	X	X	X	X					X	X	X		-	FEB-APR OCT-NOV	-

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. DNREC, NJDEP ENSP, and PGC provided information for some of the federally and state listed species and species of conservation concern for display in the ESI atlas and accompanying digital data in 2013-2014. These data represent existing information known to these agencies at the time of the request and should never be substituted for consultation with these agencies. This atlas was developed using NJDEP GIS digital data for archaeological and historic sites, but this secondary product has not been verified by NJDEP and is not state-authorized. Archaeological and historical site information for Delaware was provided by DE Division of Historical and Cultural Affairs.

Delaware/New Jersey/Pennsylvania: ESIMAP 19 (cont.)

BIOLOGICAL RESOURCES: (cont.)

BIRD: (cont.)

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Nesting	Migrating	Molting
457	Mergansers				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Northern shoveler				10S	X	X	X	X	X			X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X			X	X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
458	American black duck				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Bufflehead				100S	X	X	X	X	X	X				X	X	X	-	MAR-MAY OCT-DEC	-
	Canada goose				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUL	FEB-APR SEP-NOV	-
	Canvasback				100S	X	X	X	X	X				X	X	X	X	-	FEB-APR SEP-NOV	-
	Common goldeneye				10S	X	X	X	X	X					X	X	X	-	FEB-APR NOV-DEC	-
	Green-winged teal				100S	X	X	X	X	X			X	X	X	X	X	-	MAR-MAY AUG-NOV	-
	Long-tailed duck				10S	X	X	X	X						X	X	X	-	FEB-APR OCT-NOV	-
	Mallard				1000S	X	X	X	X	X	X	X	X	X	X	X	X	APR-AUG	FEB-MAY SEP-DEC	-
	Mergansers				100S	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	FEB-APR OCT-DEC	-
	Northern pintail				100S	X	X	X	X	X				X	X	X	X	-	FEB-APR SEP-DEC	-
	Northern shoveler				10S	X	X	X	X	X			X	X	X	X	X	-	MAR-APR AUG-NOV	-
	Ruddy duck				1000S	X	X	X	X	X	X			X	X	X	X	-	MAR-APR OCT-NOV	-
	Scaup				100S	X	X	X	X						X	X	X	-	MAR-APR OCT-DEC	-
	Tundra swan				100S	X	X	X	X						X	X	X	-	FEB-APR OCT-DEC	-

FISH:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Eggs	Larvae	Juveniles	Adults
99	Alewife				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-JUN
	American eel				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	American shad				HIGH SPAWNING			X	X	X	X	X	X	X	X			MAR-JUN	APR-JUN	MAY-JUL	JUN-NOV	MAR-JUN OCT-NOV
	Blueback herring				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAY-JUL	JAN-DEC	MAR-JUN OCT-NOV
100	Alewife				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-JUN
	American eel				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	Blueback herring				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAY-JUL	JAN-DEC	MAR-JUN OCT-NOV
248	Alewife				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	MAR-MAY	MAR-MAY	APR-JUN	JAN-DEC	MAR-JUN
	American eel				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	Atlantic croaker				PRESENT				X	X	X	X	X	X				-	-	-	JUL-OCT	JUN-NOV
	Atlantic menhaden				PRESENT				X	X	X							-	-	-	JUN-JUL	JUN-AUG
	Blueback herring				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAY-JUL	JAN-DEC	MAR-JUN OCT-NOV
	Channel catfish				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JUN-OCT	JAN-DEC
	Gizzard shad				PRESENT				X	X	X	X	X	X				-	-	-	JUN-OCT	JUL-NOV
	Hickory shad				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAR-JUN	JAN-DEC	MAR-JUN OCT-NOV
	Hickory shad	E		PA	PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	MAR-JUN	JAN-DEC	MAR-JUN OCT-NOV
	Largemouth bass				PRESENT			X	X	X	X	X	X	X				APR-MAY	APR-MAY	APR-MAY	MAY-JUL	APR-NOV
	Smallmouth bass				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-
	Spot				PRESENT						X	X	X					-	-	-	JUL-SEP	JUL-SEP
	Striped bass				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	-	APR-JUN	APR-JUL	JAN-DEC	MAR-DEC
	White perch				PRESENT	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	APR-JUL	JAN-DEC	JAN-DEC
	Yellow perch				PRESENT					X	X	X	X	X				-	-	-	JUN-AUG	JUN-OCT
362	Alewife				HIGH SPAWNING			X	X	X	X	X	X	X				MAR-MAY	MAR-MAY	APR-JUN	JUN-AUG	MAR-OCT
	American eel				LOW	X	X	X	X	X	X	X	X	X	X	X	X	-	-	DEC-APR	JAN-DEC	JAN-DEC
	American shad				HIGH SPAWNING			X	X	X	X	X	X	X	X			MAR-JUN	APR-JUN	MAY-JUL	JUN-NOV	MAR-NOV
	Atlantic croaker				MED					X	X	X	X	X				-	-	-	JUL-OCT	JUN-NOV
	Atlantic menhaden				HIGH					X	X	X						-	-	-	JUN-JUL	JUN-AUG
	Bay anchovy				MED							X	X	X	X			-	-	-	AUG-OCT	AUG-NOV
	Blueback herring				HIGH			X	X	X	X	X	X	X	X			MAR-JUN	MAR-JUN	MAR-JUN	JUN-NOV	MAR-NOV
	Channel catfish				PRESENT					X	X	X	X	X	X			-	-	-	JUL-SEP	JUN-NOV
	Gizzard shad				LOW					X	X	X	X	X	X			-	-	-	JUN-OCT	JUL-NOV
	Hickory shad				LOW			X	X	X	X							MAR-JUN	MAR-JUN	MAR-JUN	-	MAR-JUN
	Hickory shad	E		PA	LOW			X	X	X	X							MAR-JUN	MAR-JUN	MAR-JUN	-	MAR-JUN
	Spot				HIGH SPRING							X	X	X				-	-	-	JUL-SEP	JUL-SEP
	Striped bass				HIGH SPAWNING	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	APR-JUL	JAN-DEC	APR-NOV
	White perch				HIGH	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	MAR-JUN	APR-JUL	JAN-DEC	JAN-DEC
	Yellow perch				LOW						X	X	X	X	X			-	-	-	JUN-AUG	JUN-OCT
407	Shortnose sturgeon	E	E	NJ	MED				X	X	X	X	X	X	X			-	-	-	APR-OCT	APR-OCT
	Shortnose sturgeon	E	E	PA	MED				X	X	X	X	X	X	X			-	-	-	APR-OCT	APR-OCT
408	Shortnose sturgeon	E	E	NJ	EIGE	X	X	X								X	X	-	-	-	NOV-MAR	-
	Shortnose sturgeon	F	E	PA	EIGE	X	X	X								X	X				NOV MAR	
412	Atlantic sturgeon	E	E	NJ	EIGE				X	X	X							APR JUN	APR JUN	MAY JUN	APR JUN	APR JUN
	Atlantic sturgeon	E	E	PA	EIGE				X	X	X							APR-JUN	APR-JUN	MAY-JUN	APR-JUN	APR-JUN
416	Atlantic sturgeon	E	E	NJ	EIGE YCY	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	MAY-JUN	JAN-DEC	MAR-NOV
	Atlantic sturgeon	E	E	PA	EIGE YCY	X	X	X	X	X	X	X	X	X	X	X	X	APR-JUN	APR-JUN	MAY-JUN	JAN-DEC	MAR-NOV
417	Atlantic sturgeon	E	E	NJ	PRESENT	X	X	X			X	X	X	X	X	X	X	-	-	-	JUL-MAR	MAR-MAR JUL-NOV
	Atlantic sturgeon	E	E	PA	PRESENT	X	X	X			X	X	X	X	X	X	X	-	-	-	JUL-MAR	MAR-MAR JUL-NOV

HABITAT:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D
175	Endangered plant	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X
247	Field dodder	T		PA		X	X	X	X	X	X	X	X	X	X	X	X
	Forked rush	E		PA		X	X	X	X	X	X	X	X	X	X	X	X
	Walter's barnyard grass	E		PA		X	X	X	X	X	X	X	X	X	X	X	X
294	Endangered plant	E		NJ		X	X	X	X	X	X	X	X	X	X	X	X
	Swamp-pink	E	T	NJ		X	X	X	X	X	X	X	X	X	X	X	X
298	Swamp-pink	E	T	NJ		X	X	X	X	X	X	X	X	X	X	X	X
366	Eelgrass (water celery)					X	X	X	X	X	X	X	X	X	X	X	X
368	Submerged aquatic vegetation					X	X	X	X	X	X	X	X	X	X	X	X
371	Submerged aquatic vegetation					X	X	X	X	X	X	X	X	X	X	X	X

INVERTEBRATE:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Spawning	Eggs	Larvae	Juveniles	Adults
283	Eastern elliptio				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JAN-DEC	JAN-DEC
	Eastern floater				COMMON	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	JAN-DEC	JAN-DEC
362	Blue crab				LOW					X	X	X	X	X	X			-	-	-	JUN-OCT	JUN-NOV

REPTILE:

RAR#	Species	S	F	ST	Conc.	J	F	M	A	M	J	J	A	S	O	N	D	Nesting	Hatching	Internesting	Juveniles	Adults
247	Eastern redbelly turtle	T		PA	UNCOMMON	X	X	X	X	X	X	X	X	X	X	X	X	JUN-JUL	-	-	-	-
	Southern leopard frog	E		PA	COMMON	X	X	X	X	X	X	X	X	X	X	X	X	MAR-JUN	-	-	-	-

==========

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. DNREC, NJDEP ENSP, and PGC provided information for some of the federally and state listed species and species of conservation concern for display in the ESI atlas and accompanying digital data in 2013-2014. These data represent existing information known to these agencies at the time of the request and should never be substituted for consultation with these agencies. This atlas was developed using NJDEP GIS digital data for archaeological and historic sites, but this secondary product has not been verified by NJDEP and is not state-authorized. Archaeological and historical site information for Delaware was provided by DE Division of Historical and Cultural Affairs.

Delaware/New Jersey/Pennsylvania: ESIMAP 19 (cont.)

HUMAN USE RESOURCES:

BOAT RAMP:

HUN#	Name	Contact	Phone
123	RIDLEY TOWNSHIP MARINA	RIDLEY TOWNSHIP MARINA	

HELIPORT:

HUN#	Name	Contact	Phone
168	BOEING HELICOPTERS CENTER 3 SOUTH		
181	CROZER-CHESTER		
207	PIAC		

MANAGEMENT AREA:

HUN#	Name	Contact	Phone
316	LOGAN POND WMA	NJ DIV OF FISH AND WILDLIFE	
339	NEHONSEY BROOK PRESERVE	NJ DEPT OF NATURAL LANDS TRUST	

MARINA:

HUN#	Name	Contact	Phone
395	BRIDGEPORT BOAT YARD(ON RACCOON CREEK)	ALLEN	856/467-0943
442	ISLAND MARINA	ISLAND MARINA	
492	RICHARD'S BUTTONWOOD MARINA	JAMES RICHARDS 215-397-7583	856/467-9173

WILDLIFE REFUGE:

HUN#	Name	Contact	Phone
691	JOHN HEINZ NTL WILDLIFE REFUGE TINICUM	USFWS	

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. DNREC, NJDEP ENSP, and PGC provided information for some of the federally and state listed species and species of conservation concern for display in the ESI atlas and accompanying digital data in 2013-2014. These data represent existing information known to these agencies at the time of the request and should never be substituted for consultation with these agencies. This atlas was developed using NJDEP GIS digital data for archaeological and historic sites, but this secondary product has not been verified by NJDEP and is not state-authorized. Archaeological and historical site information for Delaware was provided by DE Division of Historical and Cultural Affairs.

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GREELEY AND HANSEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

OCT 1 3 2016

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Revised Identification of Sensitive Area Analysis (RISAA) dated May 13, 2016. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA hereby approves the RISAA.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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APPENDIX D

H&H Model Update and Calibration Plan

- DELCORA Hydrologic and Hydraulic Model Update and Calibration Plan (Final) dated October 2015
- USEPA Approval of the Hydrologic and Hydraulic Model Update and Calibration Plan dated March 1, 2016

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan

Hydrologic and Hydraulic Model Update and Calibration Plan. (Final)

October 2015

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Hydrologic and Hydraulic Model Update and Calibration Plan.

DELCORA MANAGEMENT		
Executive Director	Signature	Date: 10/14/15
DELCORA ENGINEERING		
Director of Engineering	Signature	Date: 10/14/15
(type in other as needed / delete row if unused)	Signature	Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	Date: 10/14/15
(type in other as needed / delete row if unused)	Signature	Date
	Signature	Date
	Signature	Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

1.1 DELCORA's System

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the safe collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in **Figure 1-1**. The total service area served by DELCORA is approximately 82,977 acres, as shown on **Figure 1-2,** which illustrates that DELCORA serves a significant and widespread portion of Delaware County. The combined sewer area simulated in the original model, also shown in **Figure 1-2**, is located within the Chester City. It comprises approximately 49% of the Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to the Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are to be directed to the PWD-SWPCP. As such, dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

Under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall 001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow (CSO) outfalls (002-026, 032, 033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

There are a total of 26 combined sewer overflow (CSO) outfalls listed with 25 discharge points (Outfalls 009 and 010 both discharge at Outfall 009) in DELCORA's existing NPDES Permit.

Figure 1-1 DELCORA's Conveyance System

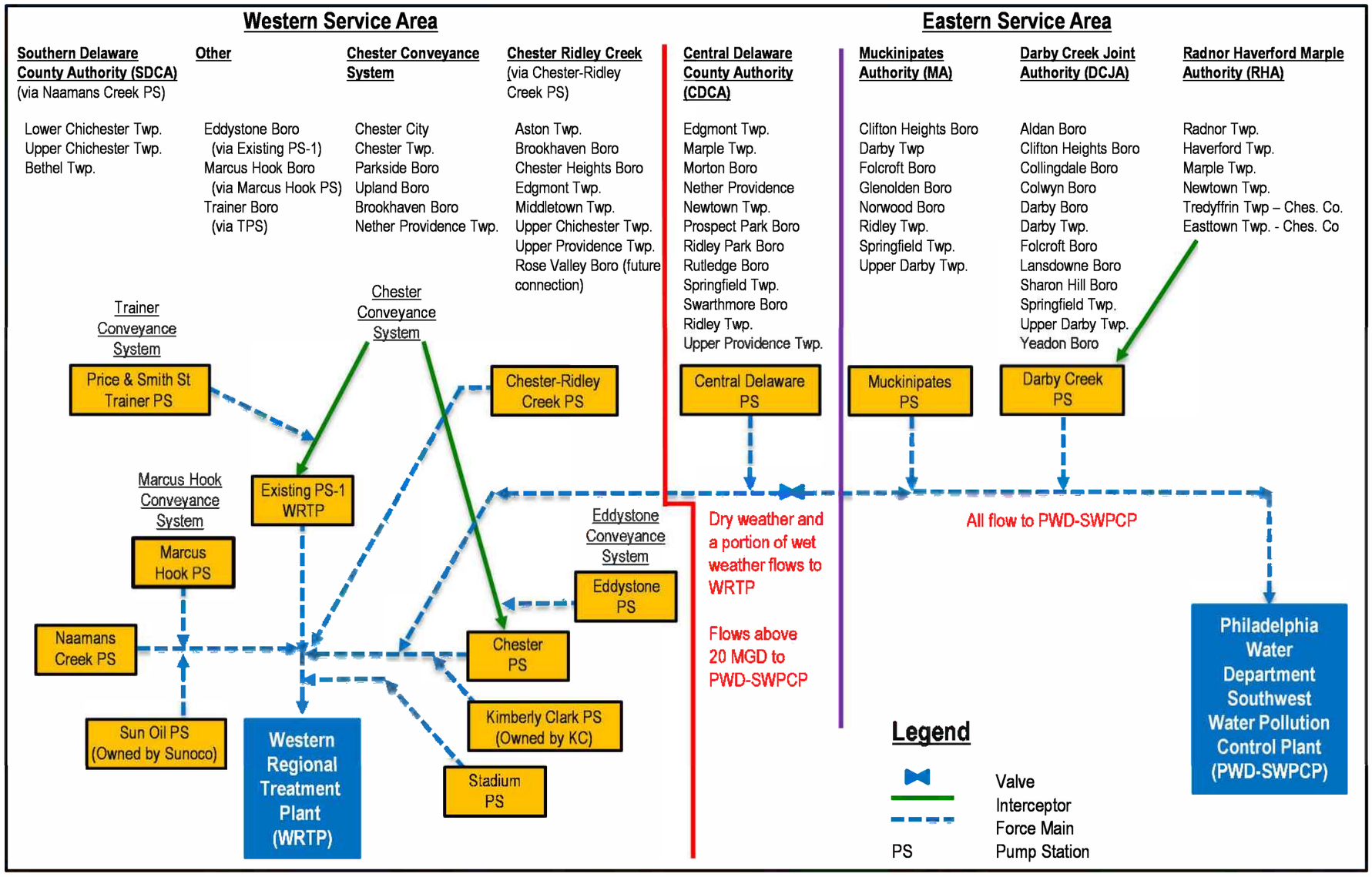
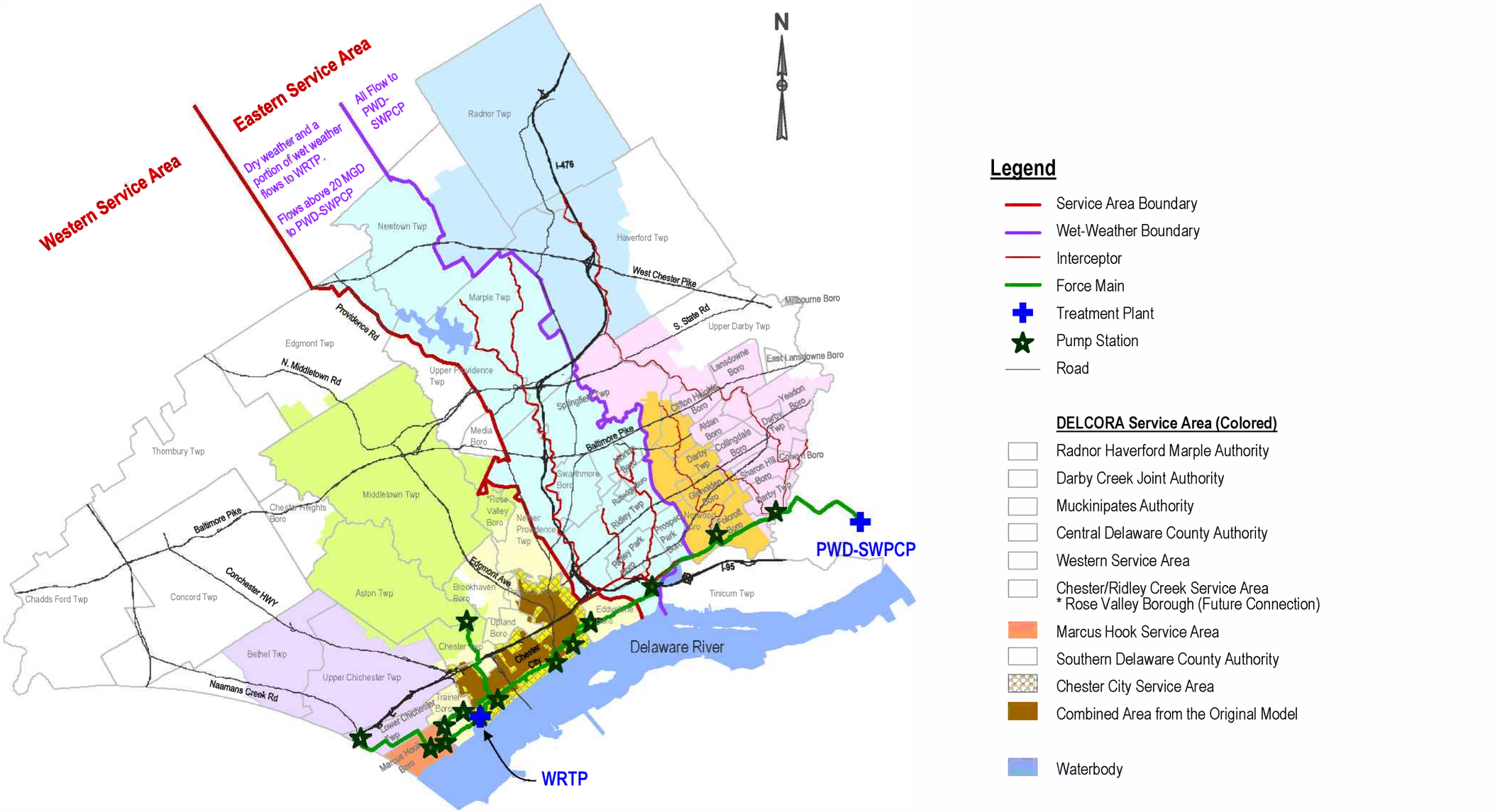


Figure 1-2 DELCORA's Service Area



Legend

- Service Area Boundary
- Wet-Weather Boundary
- Interceptor
- Force Main
- Treatment Plant
- Pump Station
- Road

DELCORA Service Area (Colored)

- Radnor Haverford Marple Authority
- Darby Creek Joint Authority
- Muckinipates Authority
- Central Delaware County Authority
- Western Service Area
- Chester/Ridley Creek Service Area
  * Rose Valley Borough (Future Connection)
- Marcus Hook Service Area
- Southern Delaware County Authority
- Chester City Service Area
- Combined Area from the Original Model

- Waterbody

1.2 DELCORA's Consent Decree

DELCORA prepared and submitted their original Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the PADEP in 1999. This LTCP was subsequently approved by the PADEP, and DELCORA had started to implement the CSO control elements selected in the LTCP. In 2009, the United States Environmental Protection Agency (USEPA) informed DELCORA that the original LTCP was not in compliance with the requirements of the USEPA's CSO Policy. As such, DELCORA prepared and submitted a revised LTCP in April 2012. Subsequent to the receipt of the revised LTCP, DELCORA and the USEPA had corresponded various times including requests for additional information from the USEPA in accordance with Section 308 of the Clean Water Act. A Consent Decree was issued by the USEPA to DELCORA in June 2015. The Consent Decree requires a new LTCP to be prepared based on an agreed upon schedule, which will include interim deliverables and milestones that must be met.

According to the Consent Decree between the US EPA, PADEP, and DELCORA, DELCORA's Hydrologic and Hydraulic Model (H&H Model) will be updated to meet the requirements in Section V.A.14 of the Consent Decree. A detailed plan to update, calibrate and validate the H&H model shall be submitted not later than sixty (60) days after August 17, 2015, the lodging date.

1.3 Contents in This Plan

This Model Update and Calibration Plan (Plan) was prepared based on the requirements listed in the Consent Decree. **Table 1-1** lists individual sections of the Plan and contents.

Table 1-1 DELCORA H&H Model Update and Calibration Plan

Section	Description
Section 1 Introduction	This section introduces DELCORA's system and Consent Decree, as well as individual sections of the Plan.
Section 2 Review of the Original H&H Model	This section summarizes review of the original H&H model, assesses the model's adequacy for use in DELCORA's Long Term Control Plan Update (LTCPU), identifies gaps with the original model in meeting the requirements in the Consent Decree, and determines refinement needs for the model update.
Section 3 DELCORA H&H Model Update	This section describes general methodology used in model update, and provides detail model update needs for service area delineation, combined area delineation, model network extension, regulator, and model inputs.
Section 4 Additional Rainfall and Flow Monitoring	This section provides an overview of the existing rain gauge and flow meter conditions, describes the additional rain gauges and flow monitoring needs and a monitoring work plan.

Section	Description
Section 5 DELCORA H&H Model Calibration and Validation	This section provides detailed data analysis needed for model calibration and validation, lists criteria for dry weather and wet weather calibration, and illustrates calibration and validation results.
Section 6 Model Development and Implementation Schedule.	This section provides a schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to the Consent Decree.

Section 2 Review of the Original H&H Model

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was updated and expanded over the years to account for changes in the CSO system, but it was not re-calibrated during the development of the 2012 LTCP.

The project team will update the model as needed to reflect current hydrologic and hydraulic conditions of DELCORA's collection system. The updated model will then be calibrated and validated with the additional rainfall and flow monitoring data before being applied to evaluate CSO control alternatives for DELCORA's Long Term Control Plan Update.

In order to appropriately update the original H&H model, it has been reviewed to address the following

- Assess adequacy of the original model for use in DELCORA's LTCPU,
- Identify gaps with the original model in meeting the requirements in the Consent Decree, and
- Determine refinements needed for the model update.

2.1 General Observation

The original H&H model was built with EPASWMM Version 5. It includes one (1) rain gage, 67 subcatchments, 29 outfall nodes, 736 storage nodes, 735 conduit links, and 34 orifice links. The detail layout of the model is shown in **Figure 2-1**. The model was set up to simulate monthly CSO discharges with reasonable continuity error in EPASWMM 5.0.

Major observations of the original model and comments are summarized in **Table 2-1**.

Figure 2-1 The Original Model Layout

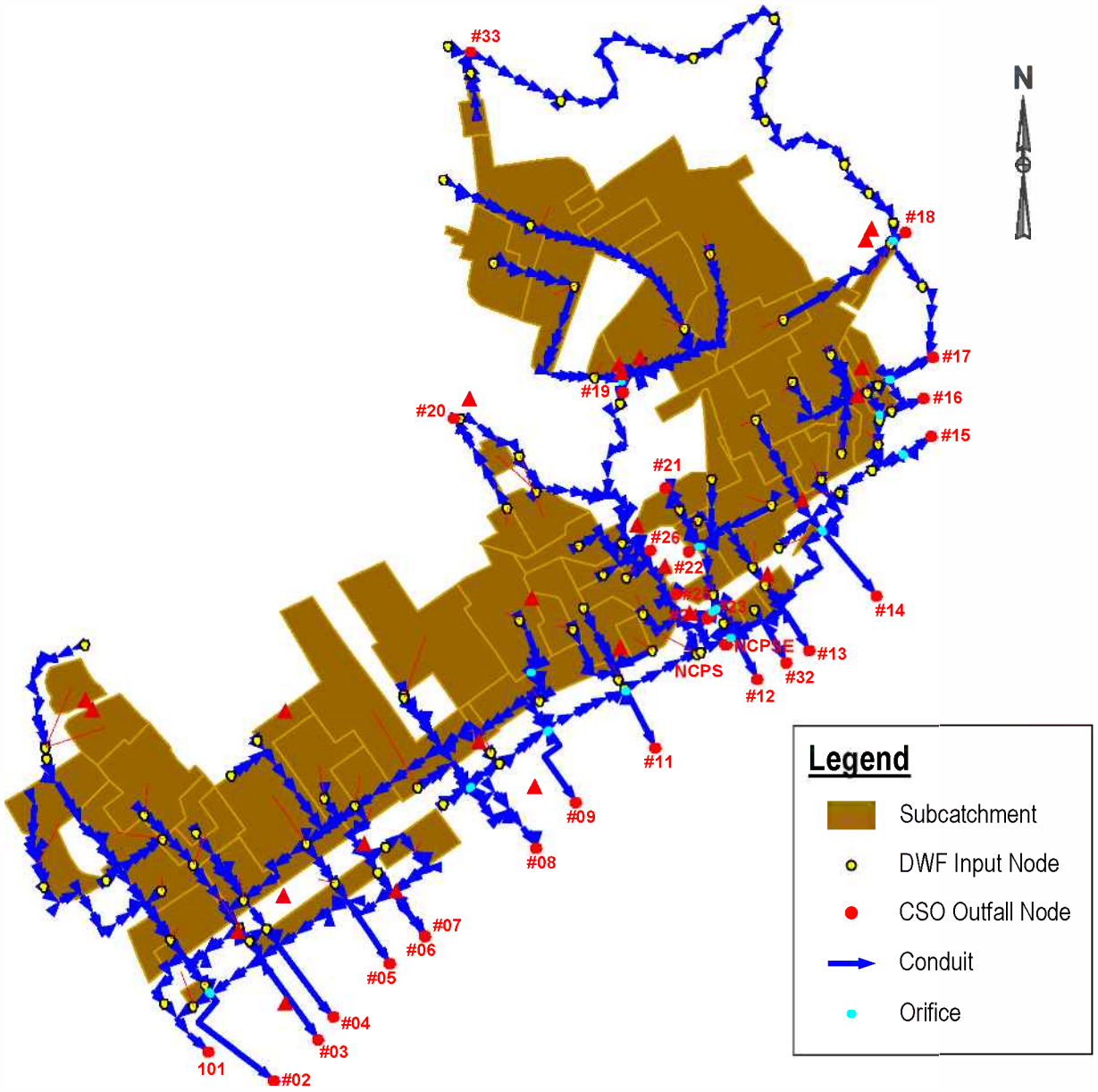


Table 2-1 Review Summary of the Original Model

Review Item	Observation	Comments
Model Software	- EPA SWMM 5.0	
Vertical Datum	- NAVD 88	- To be verified
General Sub Models	- EPASWMM for the runoff model - Horton Equation for the infiltration model - Hydrodynamic wave for the flow routing model	- All these choices are commonly seen in collection system modeling practices
Rain Gauge	- One (1) rain gage, located at the Western Regional Treatment Plant (WRTP)	- One rain gauge is not sufficient for the entire service area in the model
Service Area	- 67 subcatchments, all for combined area - One set of Horton infiltration parameters are applied to most of the subcatchments (66 out of 67 subcatchments) - The infiltration parameters applied in the model is equivalent to infiltration parameters for soil type C/D	- All service area including separated area that contribute flow to the DELCORA collection system should be included in the model - Combined area delineation will be checked to include any changes along the years - Soil type need to be checked to verify Horton infiltration parameters in all subcatchments
Sewer Manhole	- 736 storage nodes. - All sewer manholes are simulated as storage units in the model. - The majority of the storage units (732 out of the 736) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - All storage units are set-up with a ponding area of 9,999 sf. to allow excess water to collect atop of the nodes and be re-introduced into the system as conditions permit.	- Sewer manholes will be simulated as common junction node - This will help with SSO evaluation in the collection system
CSO Outfall	- 29 outfall nodes - All CSO outfalls are free outfall	- All outfalls are located in the Delaware River in the tidal reach, a tidal stage instead of free outfall should be assigned to the outfalls - Outfall ID 101 has dry weather input of 1.76 cfs, it represents WRTP in the model

Review Item	Observation	Comments
Sewer Mains	- 735 conduit links. - Negative slopes at Nodes 73803 and 70709 not matching the GIS. - Pipe connectivity is not consistent with the GIS in Subcatchment EA1, 25A. - Pipe size and connectivity is not consistent with the GIS around Node: 5201242, 5201234. - Pipe size is not consistent with the GIS around Node: 52018-52015. - Pipe size is not consistent with the GIS around Node: 531-527, 522-517, 516-513, 510020301-5100202, 403-NCPS, 40801-40801A, 32405-32404, and 1110402-11103. - Pipe size and slope are not consistent with the GIS around Node: 422-4140. - NREG06 outfall pipe direction is opposite.	- All the negative slopes and inconsistencies need to be checked with the most updated GIS and record drawings during the model update
CSO Regulators	- 34 orifice links. - All CSO regulators are simulated using orifices to intercept dry weather flows and partial wet weather flows to the collection system, and with elevated conduits to convey extra flows to the CSO outfalls. - Approximately 75% of the orifices (25 out of 34) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - None of the regulator diverting weir structures is simulated in the model.	- Diverting weir structures need to be added in the model - The slopes of all overflow pipes connected to the CSO outfalls need to verified - All orifice opening dimensions verified will be verified - All the RTC rules regulating orifice opening will be verified with actual operation
Pump Station	- No pump station is included in the model	- All pump stations that contribute flow to the DELCORA collection system should be added to the model, with related force mains
Dry Weather Flow	- 94 dry weather flow (DWF) inputs - Total DWF is 7.01 MGD - No diurnal curve - DWF does not include all the separated service areas that contribute to the DELCORA system -	- DWF should be updated to include all the service areas that contribute to the DELCORA system - Weekday and weekend diurnal curve should be included in the model to effectively simulate dry weather diurnal pattern
RDII	- No rainfall-derived infiltration/inflow (RDII) element was found in the model	- RDII should be included in the model to estimate reasonable wet weather inflow from RDII

2.2 Limitation of the Original Model and Update Needs

A thorough review of the original model reveals major gaps in its ability to meet the requirements in the Consent Decree, including the following:

- The model was created to estimate CSO overflows from the combined area, but some of the communities that contribute Rainfall Derived Infiltration and Inflow (RDII) from the separated areas to the DELCORA collection system were not included in the model. To accurately reflect the collection system, all service areas should be included in the simulation. As such, the model network will need to be expanded to the separated service areas.
- Based on discussions with Weston, the roofs are not connected to the sewer system in the separated area. Therefore, the wet weather flow from the separated areas is RDII instead of surface runoff as in the combined area. However, the RDII can contribute a significant portion of wet weather flow to a collection system, especially from areas with old/leaky sewers. The RDII component should be evaluated and included in the model for all individual sewer service areas.
- The model does not include any pump stations. All related pump stations and force mains that convey flows to the DELCORA system will need to be included in the model, with appropriate pump curves and pump operating rules.
- All CSO regulators and outfall pipes need to be revisited in the model. The regulator simulated in the original model does not include any flow diverting weirs, and the invert of the outfall pipes were adjusted to match the diverting weir crest level. The regulators will be set-up in the model based on the real configuration, including regulating gates, overflow weirs, and overflow pipes with correct slopes. This will be done by a review of the record drawings for the regulators, as well as field survey, if needed.
- The dry weather input in the model will need to be updated with additional rainfall and flow monitoring data that covers the entire service area. Weekday and weekend diurnal curves will need to be included in the model to accurately reflect dry weather peaks and valleys.
- Sewer manhole will be simulated as a junction node instead of a storage node, with a proper surcharge level to reflect actual manhole cover type. Storage nodes will only be used for actual storage facilities such as pump station wet wells or any storage unit proposed in the CSO control alternatives.

Section 3 DELCORA H&H Model Update

The original H&H Model will be updated based on the review results and current collection system conditions. The updated model will be calibrated and applied to evaluate CSO control alternatives for DELCORA's LTCPU.

The purpose of this section is to introduce the model update methodology and detail model refinement needs.

3.1 Model Update Methodology

3.1.1 Hydrologic Representation

Per Section V.A.14b of the Consent Decree (Page 15), " *The updated H&H Model shall specifically include hydrologic representation of all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012.*"

Instead of including only the combined area for the subcatchments as in the original model, the updated model will have subcatchments for both combined and separated service areas. All the areas that contribute dry weather flow and/or wet weather flow to DELCORA's CSOs and/or the WRTP will be included in the service area for the model.

Wet weather flows generated from both surface runoff from the combined area and RDII will be simulated in the updated model.

3.1.2 Hydraulic Representation

Per Section V.A.14c of the Consent Decree (Page 16), " *The H&H Model shall accurately represent the response of the Model Area to wet weather events, including the flows that result from wet weather events to and from DELCORA's CSOs and to the WRTP. To accomplish this, the model shall explicitly include all interceptors, diversion structures, CSOs, pump stations and major trunk sewers within the Collection System, as well as such pipes and appurtenances within the areas outside the Collection System that are needed to ensure adequate H&H Model accuracy. The H&H Model shall also include all sewers required for model continuity and/or that hydraulically impact or are downstream of known chronic unpermitted releases. DELCORA shall investigate and collect current system attribute information as necessary to update the H&H Model.*"

Pipe network in the updated model will be extended to the updated service areas for both the combined and separated areas. All hydraulic structures that control flows in the collection system, including pump stations, regulator orifices and weirs, and their operating rules, will be simulated in the updated model.

3.2 Model Refinement

The updated DELCORA H&H model will be created based on NAVD 88 datum. InfoSWMM will be used during the model developing and the calibration phase and the final model can be submitted with either the InfoSWMM or EPASWMM platform.

The model update will be based on information obtained from a variety of sources including DELCORA's input, GIS, Sewer Atlas, record drawings, and field survey. Other documents including flow agreements between DELCORA and individual communities, pump discharge curves, standard/actual operating procedures for CSO regulators, pump station and WRTP, etc. will also be used to set up real time control in the model.

3.2.1 Delineation of Service Area and Combined Area

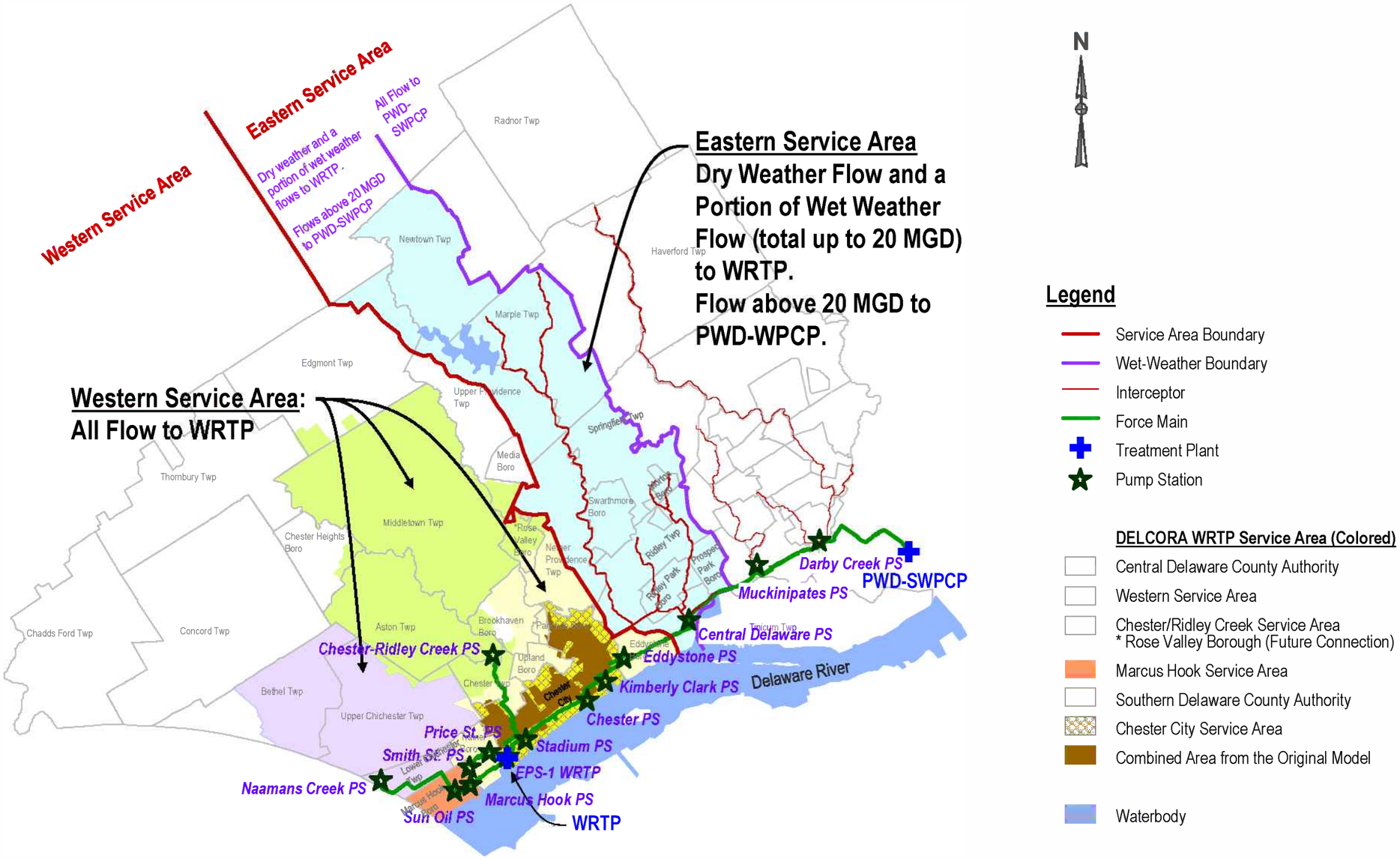
3.2.1.1 Delineation of Service Area

DELCORA serves a significant and widespread portion of Delaware County. Historically, DELCORA Western Regional Treatment Plant (WRTP) received both dry and wet weather flows from the Western Service Area only. In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWD-SWPCP. As such, dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority (CDCA) in the Eastern Service Area also discharge to the WRTP.

Historically, municipalities in the Central Delaware County Authority that contribute flows to the WRTP include Marple Township, Morton Borough, Nether Providence Township, Newtown Township, Prospect Park Borough, Ridley Park Borough, Rutledge Borough, Springfield Township, Swarthmore Borough, Ridley Township, and Upper Providence Township. In October 2012, DELCORA signed an agreement with Edgmont Township to provide sewer service to the eastern portion of the Township. The sanitary sewage of the Township will be collected and transported using the Crum Creek Sewer District System through the CDCA collection and conveyance facilities to the DELCORA System for treatment and ultimate disposal and discharge.

Figure 3-1 shows the entire service area for the WRTP, including the updated Eastern Service Area. Facilities and conveyance schematic is shown in **Figure 1-1**.

Figure 3-1 DELCORA's Western Regional Treatment Plant (WRTP) Service Area



Eastern Service Area

The DELCORA Eastern Service Area is composed of four subareas that are served by conveyance authorities: Radnor Haverford Marple (RHM) Authority, Darby Creek Joint Authority (DCJA), Muckinipates Authority (MA), and Central Delaware County Authority (CDCA) and are delineated in **Figure 1-2**. Each of these authorities has a legal agreement with their member municipalities to dispose of their wastewater. In turn, DELCORA has legal agreements with each of the authorities, except RHM, to receive, treat, and dispose of the collected wastewater. RHM discharges to the DCJA. DELCORA owns and operates three large pump stations that serve DELCORA's Eastern service area; they are the Central Delaware Pump Station, the Muckinipates Pump Station, and the Darby Creek Pump Station. These pump stations were originally designed to pump the wastewater from DELCORA's Eastern Service Area to PWD-SWPCP for treatment.

The Central Delaware Pump Station (serving CDCA) is rated for 40 MGD. It was constructed in the 1970s to discharge all flow through a force main that is routed northeast toward the Muckinipates Pump Station. The operation of the pump station had been modified in 2002 to allow for flow from the CDPS to be discharged to the WRTP. Currently the wastewater flows above 20 MGD are conveyed to PWD-SWPCP. The next pump station is the 24-MGD Muckinipates Pump Station (serving MA). Here, the force main increases to 48 inches in diameter and continues approximately 1.65 miles northeast to the Darby Creek Pump Station. Upon reaching the 60-MGD Darby Creek Pump Station (serving DCJA and RHM), the force main increases in diameter to 66 inches and continues approximately 2.5 miles for ultimate discharge at PWD-SWPCP.

Western Service Area

The DELCORA Western Service Area is shown in **Figure 3-1**. DELCORA owns and operates the collection system in the following communities in the Western Service Area.

- Chester City
- Chester Township (parts of)*
- Marcus Hook Borough
- Parkside Borough
- Rose Valley Borough *
- Upland Borough
- Trainer Borough

*Note:

- DELCORA owns only a portion of Chester Township's collection system, but all flow comes to WRTP as some goes through the CRC PS service area.
- Rose Valley Borough collection system discharges to its own treatment plant (this portion will be discharged to the CRC PS service area in future) and the remaining portion is discharged to the Western Service Area to the WRTP.

DELCORA does not own or operate the collection system in the following communities in the

Western Service Area, however, these communities will be included as part of the service areas in the updated H&H model because they contribute flows to the WRTP.

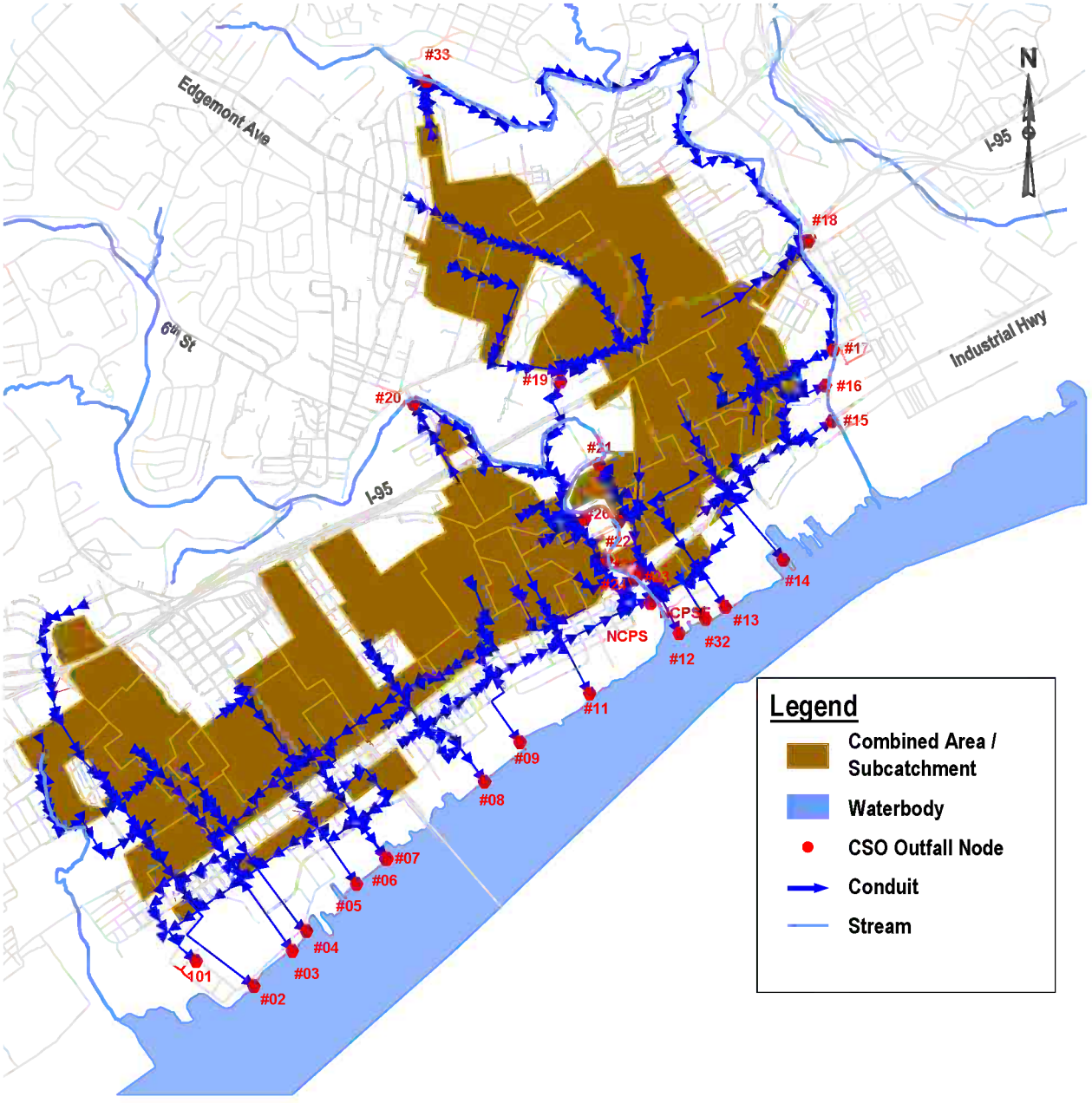
- Brookhaven Borough
- Lower Chichester Township
- Nether Providence Township
- Eddystone Borough

3.2.1.2 Delineation of Combined Area

The entire combined area of DELCORA's collection system is located in the City of Chester. The combined sewer area is shown in **Figure 3-1**. The combined area according to the original model is shown in in **Figure 3-2**.

The combined area delineation will be updated with separation projects completed in recent years. The latest GIS database, survey, and record drawings will be used to perform the desktop combined sewer area check. Field verifications will be conducted as necessary to verify the boundaries and to generate an accurate representation of the combined areas for the updated model.

Figure 3-2 Combined Area Delineation in the Original Model



3.2.2 Model Network

The collection system network in the original model (**Figure 3-2**) will be updated with the following.

- To extend sewers to the updated delineation of the combined and separated areas,
- To include all pump stations that control flows in the DELCORA collection system, and
- To reflect actual configuration of the CSO regulators.

DELCORA's WRTP treats all wastewater from the Southern Delaware County Authority, Marcus Hook Borough, Trainer Borough, Upland Borough, Parkside Borough, Eddystone Borough, Chester Township, the City of Chester, a portion of the wastewater from Brookhaven Borough and Nether Providence Township, as well as the dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority.

A flow diagram presented in **Figure 1-2** shows all the connections on DELCORA's system and related facilities including interceptors, force mains, pump stations and treatment plants. The interconnectivity coupled with the legal agreements that DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates.

3.2.2.1 Sewer Lines and Manholes

3.2.2.2 Regulators

Since the approval of the first LTCP in 1999, DELCORA has under-taken a program to replace and/or rehabilitate CSO regulators and tide gates in the City of Chester CSO system. As indicated in **Table 3-1**, the majority of the City's CSO regulators are Brown & Brown type regulators. The operation of the CSO regulators has been changed from being controlled by the level in the trunk sewer entering the CSO regulator chamber to being controlled by the level in the interceptor. This change is being implemented as part of the CSO regulator replacement program. This ensures that the flow sent to the WRTP for treatment is maximized.

During dry-weather operations, the sewage flow levels entering the CSO regulator chamber are below the top of the diversion weir and will pass through the CSO regulator gate. Once through the CSO regulator gate, the flow will be sent to the WRTP via the interceptors. During wet-weather events, the level in the combined sewer will begin to rise thus raising the float assembly and beginning to close the CSO regulator gate.

Regulator gates, diversion weirs, and operating rules will be simulated in the updated model.

Table 3-1 CSO Regulator Information

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	CSO Regulator Type
002	Front & Booth	Delaware River	Brown & Brown
003	Front & Highland	Delaware River	Brown & Brown
004	Front & Hayes	Delaware River	McNulty
005	Front & Townsend	Delaware River	Brown & Brown
006	Delaware & Jeffrey	Delaware River	Separated, CSO Outfall removed.
007	Delaware & Reaney	Delaware River	Brown & Brown
008	2nd & Tilghman	Delaware River	Brown & Brown
009	2nd & Lloyd	Delaware River	Brown & Brown
010*	5th & Pusey	Delaware River	Brown & Brown
011	2nd & Parker	Delaware River	Brown & Brown
012	2nd & Edgmont	Delaware River	Brown & Brown
013	2nd & Welsh	Delaware River	Brown & Brown
014	3rd & Upland	Delaware River	Brown & Brown
015	4th & Melrose	Ridley Creek	Brown & Brown
016	8th & McDowell	Ridley Creek	Brown & Brown
017	9th & Campbell	Ridley Creek	Brown & Brown
018	Sun Dr. & Hancock	Ridley Creek	Brown & Brown
019	14th & Crozer Hospital	Chester Creek	Brown & Brown
020	Kerlin & Finland	Chester Creek	Brown & Brown
021	9th & Sproul	Chester Creek	Brown & Brown
022	6th & Sproul	Chester Creek	Brown & Brown
023	3rd & Edgmont	Chester Creek	Brown & Brown
024	3rd & Dock	Chester Creek	Brown & Brown
025	5th & Penn	Chester Creek	Brown & Brown
026	7th & Penn	Chester Creek	Brown & Brown
027	2nd & Dock Pump Station	Chester Creek	Overflow pump removed.
032	2nd & Avenue of the States	Delaware River	No CSO Regulator
033	Elkington Blvd. and Ridley Creek	Ridley Creek	No CSO Regulator

Note: CSO 010 discharges at Outfall 009.

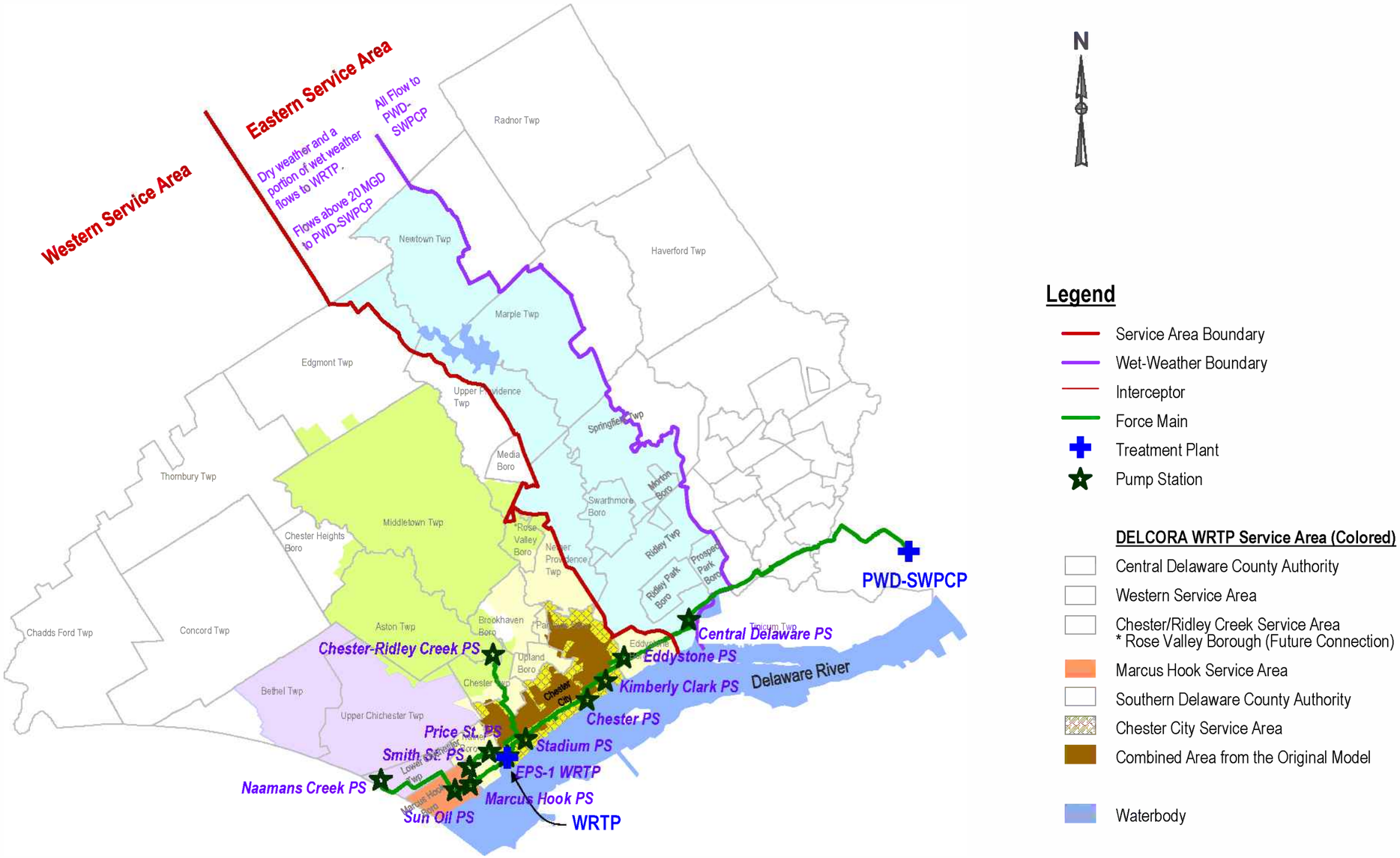
3.2.2.3 Pump Stations

All major pump stations in the Western Service Area and CDPS in the Eastern Service Area will be added in the updated model, as well as force mains connecting the pump stations to the interceptor/WRTP. The list of the pump stations include (**Figure 3-3**):

- Chester PS
- Existing PS-1 WRTP
- Price & Smith Street Trainer PS
- Marcus Hook PS
- Naamans Creek PS
- Sun Oil PS (Owned by Sunoco)
- Kimberly Clark PS (Owned by KC)
- Eddystone PS
- Central Delaware PS
- Chester Ridley Creek PS
- Stadium PS

DELCORA owns or operates a number of lift stations that contribute to the Western Service Area and whose flows are handled by the above list of pumps stations. These lift stations will also be evaluated during the model updating process and included only if they have significant impact on DELCORA's system hydraulics.

Figure 3-3 Pump Stations to be Included in the Updated Model



3.2.3 Model Input

3.2.3.1 Subcatchments

The following subcatchment information is required by the model:

- Area
- Percent of directly connected impervious area (effective impervious area)
- Width
- Slope
- Manning's roughness coefficient (n) for both pervious and impervious areas
- Depression storage for both pervious and impervious areas (initial subtraction)
- Soil and soil infiltration parameters
- Rainfall dependent inflow and infiltration (RDII) parameters
- Base flow

Area
Area of the combined sewer subcatchment is the geographical area of the subcatchment. It will be estimated from the GIS by geometry calculation of the area of the subcatchment.

Percent of Directly Connected Impervious Area
Directly connected impervious area means the impervious area that is effectively connected to the sewer collection system. As a result, runoff from these areas is completely captured by the collection system. Runoff from the rest of the impervious area is deemed not to be captured by the system due to various potential reasons, including drains to pervious area/creek/streams, limited number and capacity of stormwater inlets, and bypassing etc. For model construction, the percent imperviousness calculated based on GIS shapefiles will be used as the initial input and then adjusted during the model calibration process to best simulate the observed hydrologic response over a range of precipitation events.

The initial percent imperviousness for the combined area will be calculated based on the impervious coverage shape file and zoning shape file. An example of percent imperviousness applied to different land uses are shown in **Table 3-2**. This table will be modified with specific land use types observed in the combined area and it will provide the basis of calculating the initial percent imperviousness inputs in a combined sewer subcatchment.

Table 3-2 Percent Imperviousness Applied for Different Land Use Types

Land Use Type	% Imperviousness
Driveway	100%
Parking_Paved	100%
Parking_Unpaved	90%
Roadway	100%
Sidewalk	100%
Building - Connected Rooftops	100%
Building - Commercial and Industrial	80%
Building - Residential; with Disconnected Rooftop	50%

For the separated area, the initial percent imperviousness will be set at 0% because the impervious area in the separated area is not contributing runoff to the sewer collection system, therefore it is not effectively connected. *Subcatchment parameters mentioned hereafter will be set at default values for the separated subcatchments.*

Width

The width of a subcatchment relates to sheet flow path and affects time of concentration and the shape of the runoff hydrograph. The initial estimate of the width will be estimated by the subcatchment area divided by the representative overland flow length. Width is one of the calibration parameters for runoff.

Slope

The slope of a subcatchment should reflect the average slope along the pathway of overland flow to inlet locations. For the combined sewer subcatchments, the slopes will be determined by the elevation difference divided by the length of flow path. GIS contours will be used to estimate elevations.

Manning's roughness coefficient (n)

Manning's roughness coefficient (n) will be estimated for both pervious and impervious overland flow. The initial values will be set to 0.013 for impervious surfaces and 0.15 for pervious surface. A typical range of Manning's n suggested by the SWMM is 0.011-0.024 for impervious area and 0.06-0.80 for pervious area. Roughness is an empirical value and may be treated as a calibration parameter if necessary.

Depression Storage

Depression storage is the rainfall abstraction volume that must be filled prior to the occurrence of runoff. It represents the loss (initial abstraction) caused by surface ponding, surface wetting, etc. The initial values of depression storage will be set to 0.05 for impervious surface and 0.15 for pervious surface. Typical depression storage values are 0.05-0.10 for impervious surfaces and 0.10-0.30 for pervious surfaces. Depression storage is an empirical value and may be treated as a calibration parameter, especially to adjust runoff volumes.

In the model, the subcatchment is divided into three subareas: pervious area with depression storage, impervious area with depression storage, and impervious area without depression storage. The initial percent of the impervious area without depression storage will be set to 0.10.

Soil and Soil Infiltration Parameters
Soil information is needed to estimate infiltration in the pervious area. The rate of infiltration is a function of soil properties and antecedent soil conditions. Three infiltration methods are available in the software: Horton method, Green-Ampt method, or NRCS Curve Number method. The Horton method has been extensively used for similar type of modeling work and it will be used in this modeling effort to estimate infiltration. The required soil parameters for Horton method include:

- Maximum Infiltration rate (in/hr)
- Minimum Infiltration Rate (in/hr)
- Decay Constant (/hr)
- Drying time (d)
- Maximum Infiltration Volume Possible (inch)

Horton's infiltration parameters for Soil B and C will be estimated based on typical values from literature, shown in **Table 3-3**.

Table 3-3 Horton Infiltration Parameters

Horton Infiltration Parameter	Soil B	Soil C
Max Infiltration Rate (in/hr)	3	2
Min Infiltration Rate (in/hr)	0.43	0.13
Decay Constant (1/hr)	4	4
Drying Time (d)	3	8
Max Volume (in)	13.2	12.5

3.2.3.2 Manhole

Sewer manholes will be simulated as junction nodes in the model. The following information is required:

- Node ID
- Invert
- Maximum Depth (approximated as the difference from manhole rim and manhole invert)
- Surcharge Depth

Manhole ID will be inherited from the name of the manhole in the sewer GIS. Manhole input information will be updated based on the latest available GIS information.

Most of the manhole input parameters, including invert and rim will be found or estimated from record drawings, design drawings, and the sewer manhole shape file. If information is not available, then estimations will be made based on city topography and sewer connectivity. Ground elevation estimated from contours will be used as the manhole rim elevation, and manhole inverts will be estimated assuming constant pipe slope as the upstream or downstream pipes.

For water tight manholes or manholes with bolted down covers, a surcharge depth of 50-ft will be applied.

3.2.3.3 Sewer Mains

Sewer mains are the conveyance element and will be simulated as conduits in the model. The following input information is needed:

- Conduit ID
- Shape
- Number of barrels
- Upstream and downstream nodes
- Upstream and downstream offset
- Dimension (length, diameter/depth)
- Manning's roughness coefficient
- Minor loss coefficient (entry loss, exit loss, average loss)
- Flap gate installed or not (set at no flap gate for most of the sewer mains)

Conduit ID will be inherited from the sewer GIS. Manhole input information will be updated based on the latest available GIS information.

Most of the pipe input parameters, including upstream and downstream nodes, dimension, shape, number of barrels, and flap gate information, will be found or estimated from record drawings, design drawings and sewer gravity main GIS shape file. For pipes that do not begin or end at the invert of the upstream or downstream node, an offset value will be provided to describe the difference from the invert of the pipe to the invert of the upstream or downstream node.

Manning's roughness coefficient is related to the pipe material. The initial input of the Manning's n for different materials is summarized in **Table 3-4**. The Manning's n may be changed during calibration to account for minor loss or additional sediment depositions in the pipe.

The initial minor loss for pipe will be set at zero for most pipes. For those pipes with sharp turns, a higher minor loss will be applied.

If sewer main information is not available, sewer length will be estimated in GIS geometry measurement; sewer size will be assumed based on upstream and downstream sewers; sewer upstream and downstream offsets will be estimated based on sewer connectivity assuming constant slope.

Table 3-4 Manning's Roughness Coefficient for Sewer Mains

Pipe Material	Manning's N
Polyvinyl Chloride (PVC)	0.011
Reinforced Concrete Pipe (RCP)	0.013
Ductile Iron (DI)	0.013
Cast Iron (CI)	0.013
Corrugated Metal Pipe (CMP)	0.020
Masonry	0.025
Unknown	0.013

3.2.3.4 CSO Outfalls

CSO outfalls will be simulated as outfall nodes in the model. The following information is required:

- Outfall ID
- Type (free, normal, fixed stage, tidal stage, time series, stage-flow, flap gate)
- Invert
- Boundary conditions

Outfalls are the discharge points in the model. The outfalls can either be free outfalls without any boundary conditions or the outfalls can have a boundary condition that the head needs to overcome for outflow to occur. The outfalls in the DELCORA's collection system are mostly in the tidal river reach. Therefore, appropriate tidal stages will be needed to set boundary conditions. Outfalls can have a flap gate at the end to prevent backflow.

Outfall ID will be named according to the CSO overflow points. For example, the outfall for CSO 02 will be named "Outfall_02". The inverts of outfalls will be estimated based on record drawings and design drawings, and will be confirmed/adjusted from the field survey, if necessary.

3.2.3.5 Flow Diversion Structure

Orifices

Regulator gates will be simulated as orifices in the updated model. The following information is required to model an orifice in the model:

- Orifice ID
- Upstream and downstream nodes
- Type (two types: side, bottom)
- Shape (two shapes: circle, rectangular)
- Dimension (Height, Width, Crest Height)

- Discharge Coefficient
- Flap gate

Orifice ID will be named according to the CSO overflow points. For example, the orifice for CSO 03 will be named "Ori_03". All orifices in the collection system are side orifices. The dimensions will be based on record drawings and will be field verified, if necessary.

Weirs
Diversion weirs will be simulated as weirs in the model. The following information is required to model a weir in the model:

- Weir ID
- Upstream and downstream nodes
- Type (four types: transverse, sideflow, V-notch, trapezoidal)
- Dimension (Height, Weir Length, Weir Crest Height)
- Coefficient of Discharge
- Flap gate
- Number of End Contractions

Weir ID will be named according to the CSO overflow points. For example, the weir for CSO 03 will be named "Weir_03". Weir information will be obtained from record drawings and will be field verified, if necessary.

3.2.3.6 Pump Stations

The wet well in the pump stations will be simulated as storage nodes, and pumps will be simulated as pumps in the model. Dimensions of the storage will be based on record drawings. For pumps, the following information is required:

- Pump ID
- Upstream and downstream nodes
- Pump Type
- Pump Curve
- Startup Depth
- Shutoff Depth

Pump startup depth and shutoff depth will be set up in the model according to the typical pump operation. Pump head-discharge curves will be based on the manufacturer's performance curve. Pump curves at different speeds can be developed based on the Affinity Laws.

3.2.3.7 Dry Weather Flow (DWF)

Average day dry weather flows (DWF) will be allocated to each sewershed based on the flow monitoring data and land use. A dry weather flow diurnal curve will be developed for each meter's service area and applied to all sewersheds within that metershed. The total daily average DWF from all sewersheds add up to the DWF measured at the influent to the WRTP. DWF analysis is described in detail in Section 5.

For simulation of CSO control scenarios, the DWF projection will be performed to account for the future development and population growth in the service area. The future land use map (FLUM) and development densities will be used to project future DWF.

3.2.3.8 Rainfall Derived Infiltration and Inflow (RDII)

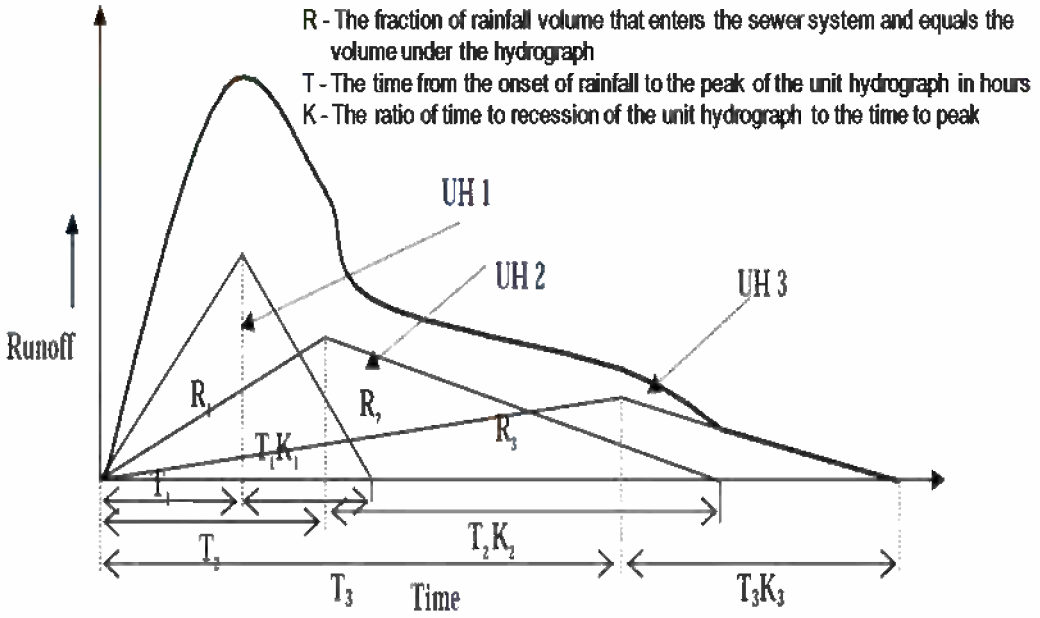
The model will use the RTK unit hydrograph (UH) to estimate RDII into the sewer system. A RTK UH set contains up to three hydrographs (**Figure 3-4**): one for a short-term response (UH1), one for an intermediate-term response (UH2), and one for a long-term response (UH3). UH1 represents the most rapidly responding inflow component and has a short T value, UH2 includes both inflow and infiltration and has a longer T value, and UH3 includes infiltration that may continue long after the storm event has ended and has the longest T value. The unit hydrograph is defined by the following three parameters:

- R: the fraction of rainfall volume that enters the sewer system and equals to the volume under the hydrograph,
- T: the time from the onset of rainfall event to the peak of the unit hydrograph in hours, and
- K: the ratio of time to recession of the unit hydrograph to the time to peak.

The same set of RDII parameters will be applied in the same metershed because of the availability of the flow hydrograph for model calibration. The initial values of RTK will be estimated using the RDII Analyst tool in the InfoSWMM. The RTK values are calibration parameters to be refined during model calibration.

Rainfall and sewershed area information will be needed for RDII calculation. Sewershed area will be estimated based on areas of the parcels with wastewater services and the areas along the sewer pipes outside parcel areas.

Figure 3-4 RTK Unit Hydrographs



Source: M.K. Muleta and P.F. Boulos, Analysis and Calibration of RDII and Design of Sewer Collection Systems, ASCE Conference Proceedings 316, 642 (2008)

Section 4 Additional Rainfall and Flow Monitoring

4.1 Existing Rainfall and Flow Monitoring Data Review

4.1.1 Existing Rainfall Monitoring Data Review

DELCORA operates and maintains four (4) rainfall gauges in Delaware County that record precipitation in 15-minute increments. The gauges are located at the following DELCORA owned facilities:

- Western Regional Treatment Plant (WRTP)
- Central Delaware County Pump Station (CDPS)
- Muckinipates Pump Station (MPS)
- Darby Creek Pump Station (DCPS)

The three rain gauges located at the pump stations were installed in January 2009 and are a tipping bucket style gauge (Texas Electronics, Inc. TR-525I Rainfall Sensor with a six-inch diameter funnel). The accuracy of the gauges are 1.0% up to 2"/hr or less and each tip represents 0.01" of precipitation. The rainfall gauges are connected to a Telog RU-33 units which sums the number of tips in a 5 minute interval and then logs the total. Data is downloaded daily.

The rain gauge located at the WRTP has been in operation since the mid-1990s. The current gauge is a BlueBugBox Weather Station from WeatherBug.

In addition to these four gauges, precipitation records are available from the National Oceanic and Atmospheric Administration (NOAA) station located at the Philadelphia International Airport. Precipitation records for this station go back to 1/1/1900. This data has been obtained and will be used to select the typical year.

The data from the four DELCORA gauges, the NOAA station and other available gauges will also be used as part of the process.

4.1.2 Existing Flow Monitoring Data Review

DELCORA owns and operates a flow monitoring network across Delaware County. The monitoring network includes various types of flow meters located throughout DELCORA's Eastern Service Area and Western Service Area, at the WRTP, in each of the Pump Stations, and at the tie-in points where other municipal collection systems tie-into the CSO system.

At the pump stations, DELCORA uses magnetic flow meters due to their high accuracy (±1%) and repeatability. In the collection system, area-velocity type meters are used due to the number of locations and the ability to install them without collection system retrofit. Typically these meters are accurate to ±5-7%. The metered flow in the collection system meters is read and recorded once every 15 minutes.

Figure 4-1 shows all the existing flow meters in the DELCORA collection system. A description of the flow monitoring system for each of the defined areas is as follows:

- Eastern Service Area – In the Eastern Service Area, there are a total of 117 flow meters deployed in the collection system to record flow data from the contributing municipalities. These flow meters capture approximately 75% of the EDUs in this service area. The data from these flow meters are used to generate an apportionment percentage assigned to each member municipality in the CDCA, MA, and DCJA. The apportionment percentage is used to distribute the treatment and O&M costs of DELCORA and each of the authorities. The majority of the flow meters, one hundred thirteen (113), are area-velocity type meters installed in the collection system pipes and or manholes at key locations. The remaining flow meters are magnetic flow meters and are located at small pump stations in Upper Providence Township and Newtown Township. Flow from all these meter locations eventually passed through one of DELCORA's primary pump stations (CDPS, MPS, and DCPS) which are equipped with magnetic type flow meters to record flow data. The flow meters in the collection system were installed in 2006. The magnetic flow meters located at the pump stations measure and record flow on a continuous basis. The installation dates area listed in **Table 4-1**.

Table 4-1 Installation Date of the Existing Magnetic Flow Meters at Pump Stations

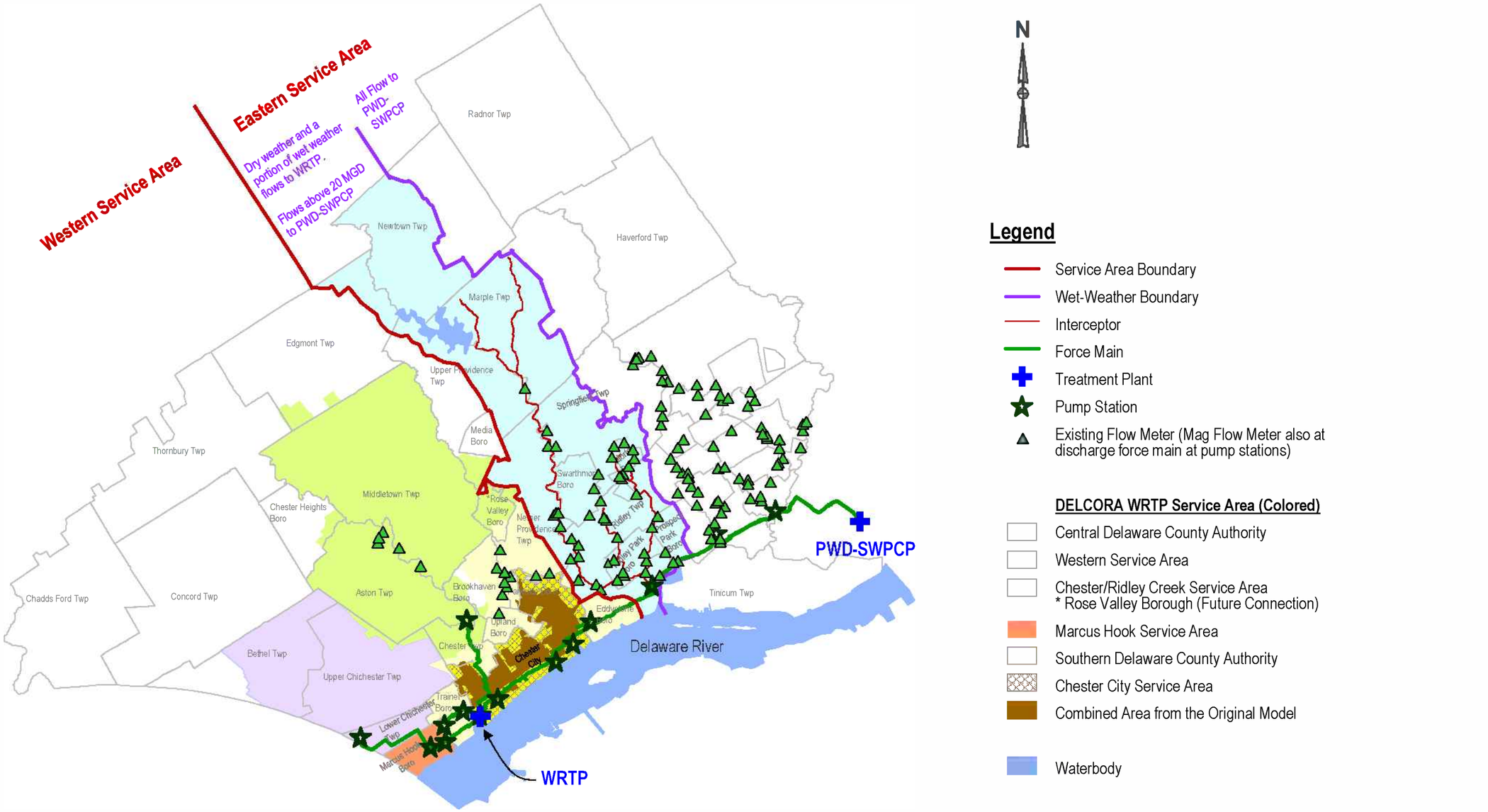
Pump Station	Magnetic Flow Meter Installation Date
Darby Creek PS	1/2008
Muckinipates PS	1/2004
Central Delaware PS	12/2002
WRTP Main Influent PS	1/1998
Chester PS	6/2004
EPS-1	7/2007

- Western Service Area – In the Western Service Area there are a total of eighteen (18) flow meters deployed throughout the collection system that record the flow. All of these meters are area-velocity type flow meters. Ten (10) flow meters are located in the portions of Brookhaven Borough and Nether Providence Township that are connected directly to interceptors in the Chester Collection System and were installed in 2008. The remaining seven (7) meters, located in Rose Valley Borough, Aston Township, and Middletown Township, are located upstream of pump stations with magnetic flow meters.
- Pump Stations – At each of the pump stations shown on **Figure 1-1**, DELCORA has a magnetic flow meter installed on the discharge force main to record flow data. At the CDPS there are two (2) flow meters, one (1) on the force main tributary to the Western Regional Treatment Plant and one (1) on the force main to the City of Philadelphia treatment plant. All of the pump station flow meters measure and record flow on a continuous basis.

- WRTP – There is one flow meter located in the influent pipe line into the WRTP. This flow meter is a magnetic type meter and measures all of the flow to the treatment plant. The flow is recorded continuously.

Data from the pump station magnetic meters, the 10 collection system meters in the Western Service Area, and 61 meters in the Central Delaware County Authority (CDCA) will be used as direct input to the H&H model.

Figure 4-1 DELCORA Existing Flow Meters



4.2 Additional Rainfall and Flow Monitoring Locations

4.2.1 Proposed Rainfall Monitoring Locations

The existing rain gauges in the WRTP service area, including one in the combined area at the WRTP and one in the separated area at the CDCA Pump Station (rain gauges at the Muckinipates PS and Darby Creek PS are out of the WRTP service area), are not sufficient to provide effective spatial coverage of the entire service area. Additional rain gauge is needed for the additional rainfall and flow monitoring program if rain gauge is used as the only source of precipitation data.

Rain gauge network density can be determined from watershed area by the following equation. The number of gauges, N, is,

$N=A^{0.33}$ (U.S. Army Corps of Engineers, 1996)
where A is the watershed area in mi^2

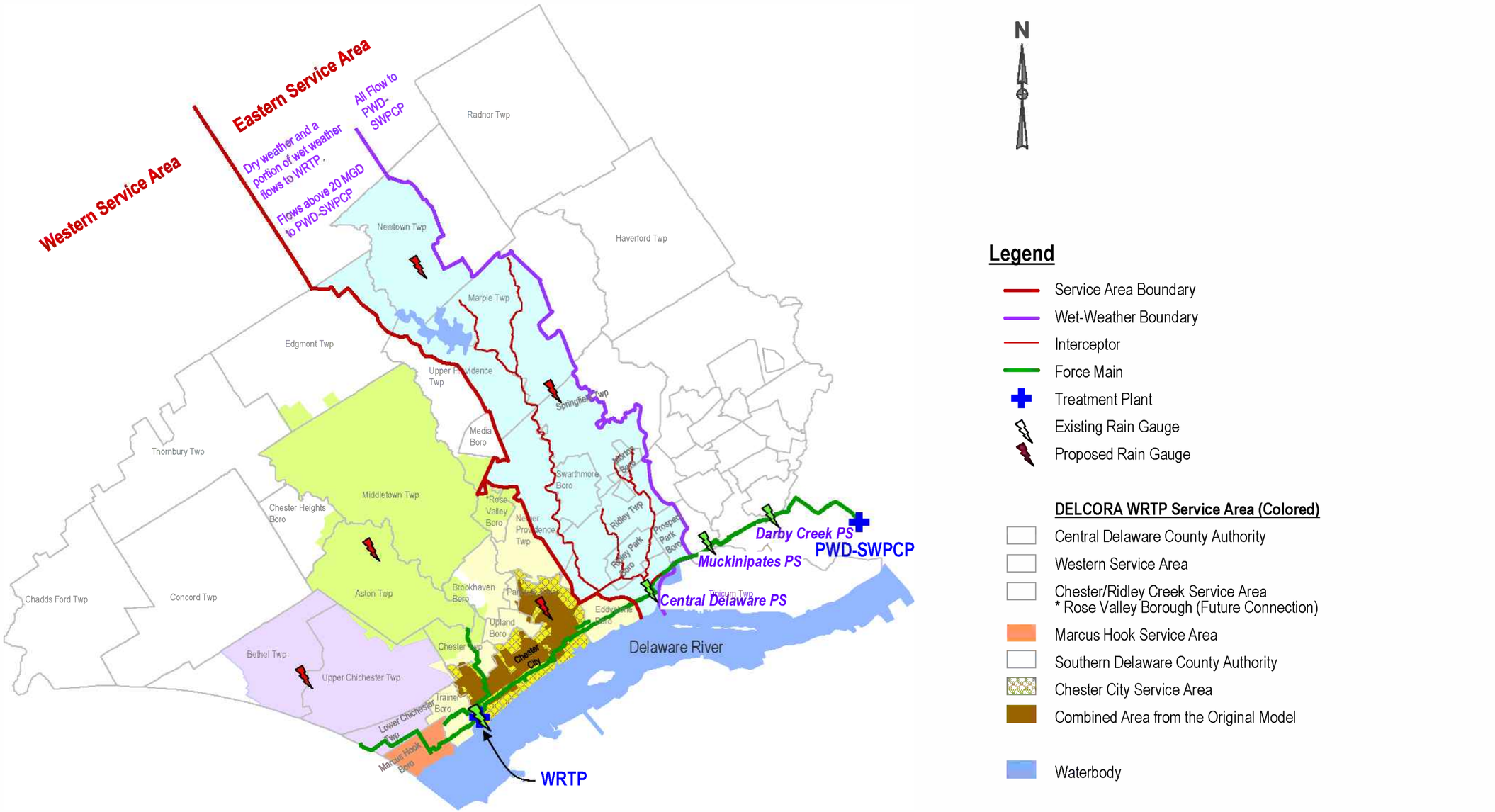
The number of gauges recommended by the Equation is quite small when compared to typical urban rain gauge networks where densities may be as great as one gauge per 10 to 20 km^2.

In this Plan, rain gauge intensity is estimated based on one gauge per 3 km^2 for the combined area and based on the Equation for the separated area. With this, the DELCORA System requires one (1) additional rain gauges in the combined areas and four (4) additional rain gauges in the separated areas.

Figure 4-2 shows the potential locations for the additional rain gauges, locations of the existing rain gauges are also shown.

Another approach of rainfall monitoring is to use the Gauge-Adjusted Radar Rainfall (GARR). A detail comparison of these two approaches will be evaluated during preparation of the Rainfall and Flow Monitoring Work Plan.

Figure 4-2 Proposed Rain Gauge Locations



4.2.2 Proposed Flow Monitoring Locations

In addition to the existing flow meters in the separated area measuring flows from individual contributing municipalities and pump stations, additional flow meters are needed, mainly in the combined area, to characterize surface runoff from the combined area and CSO discharges, meters in the separated area are also needed to characterize RDII from the Western Service Area.

Proposed flow meter locations can be categorized into the following four types: (**Table 4-2**):

- Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. 15 meters are proposed for this category.
- Located on the overflow pipe, this is to measure the CSO overflows and calibrate CSO regulator parameters. Five (5) meters are proposed with four (4) for four largest CSO overflow points, including CSO 19, CSO 08, CSO 05, and CSO 02, and one (1) for a small overflow point CSO 14.
- Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters are proposed for this category.
- Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Four (4) meters are proposed for this category.

In total, 26 additional flow meters are proposed. **Table 4-2** lists approximate flow meter locations and location categories. **Figure 4-3** shows a map of the proposed additional flow meters, with zoom into the combined area in **Figure 4-4**.

Table 4-2 Proposed Additional Flow Meters

Proposed Flow Meter	Approximate Location	Type
In-02	Influent pipe to CSO 02 Regulator	On the influent pipe to regulator
In-03	Influent pipe to CSO 03 Regulator	On the influent pipe to regulator
In-05	Influent pipe to CSO 05 Regulator	On the influent pipe to regulator
In-08	Influent pipe to CSO 08 Regulator	On the influent pipe to regulator
In-10	Influent pipe to CSO 10 Regulator	On the influent pipe to regulator
In-11	Influent pipe to CSO 11 Regulator	On the influent pipe to regulator
In-13	Influent pipe to CSO 13 Regulator	On the influent pipe to regulator
In-14	Influent pipe to CSO 14 Regulator	On the influent pipe to regulator
In-16	Influent pipe to CSO 16 Regulator	On the influent pipe to regulator
In-17	Influent pipe to CSO 17 Regulator	On the influent pipe to regulator
In-18	Influent pipe to CSO 18 Regulator	On the influent pipe to regulator
In-19-1	Influent pipe to CSO 19 Regulator (from East)	On the influent pipe to regulator
In-19-2	Influent pipe to CSO 19 Regulator (from West)	On the influent pipe to regulator
In-25	Influent pipe to CSO 25 Regulator	On the influent pipe to regulator
In-26	Influent pipe to CSO 26 Regulator	On the influent pipe to regulator
Side-1	Side line on Penn St. to 2nd St. Interceptor	On the side-line from the combined area
Side-2	Side line on Highland Ave. to CSO 02 influent pipe	On the side-line from the combined area
Sep-1	Upstream of the CSO 02 Drainage	On the separated area
Sep-2	Upstream of the CSO 05 Drainage	On the separated area
Sep-3	Upstream from Upland Borough	On the separated area
Sep-4	Upstream from Eastern Chester	On the separated area
CSO-02	Outfall pipe from CSO 02 Regulator	On the outfall pipe
CSO-05	Outfall pipe from CSO 05 Regulator	On the outfall pipe
CSO-08	Outfall pipe from CSO 08 Regulator	On the outfall pipe
CSO-14	Outfall pipe from CSO 14 Regulator	On the outfall pipe
CSO-19	Outfall pipe from CSO 19 Regulator	On the outfall pipe

Figure 4-3 Proposed Flow Meters

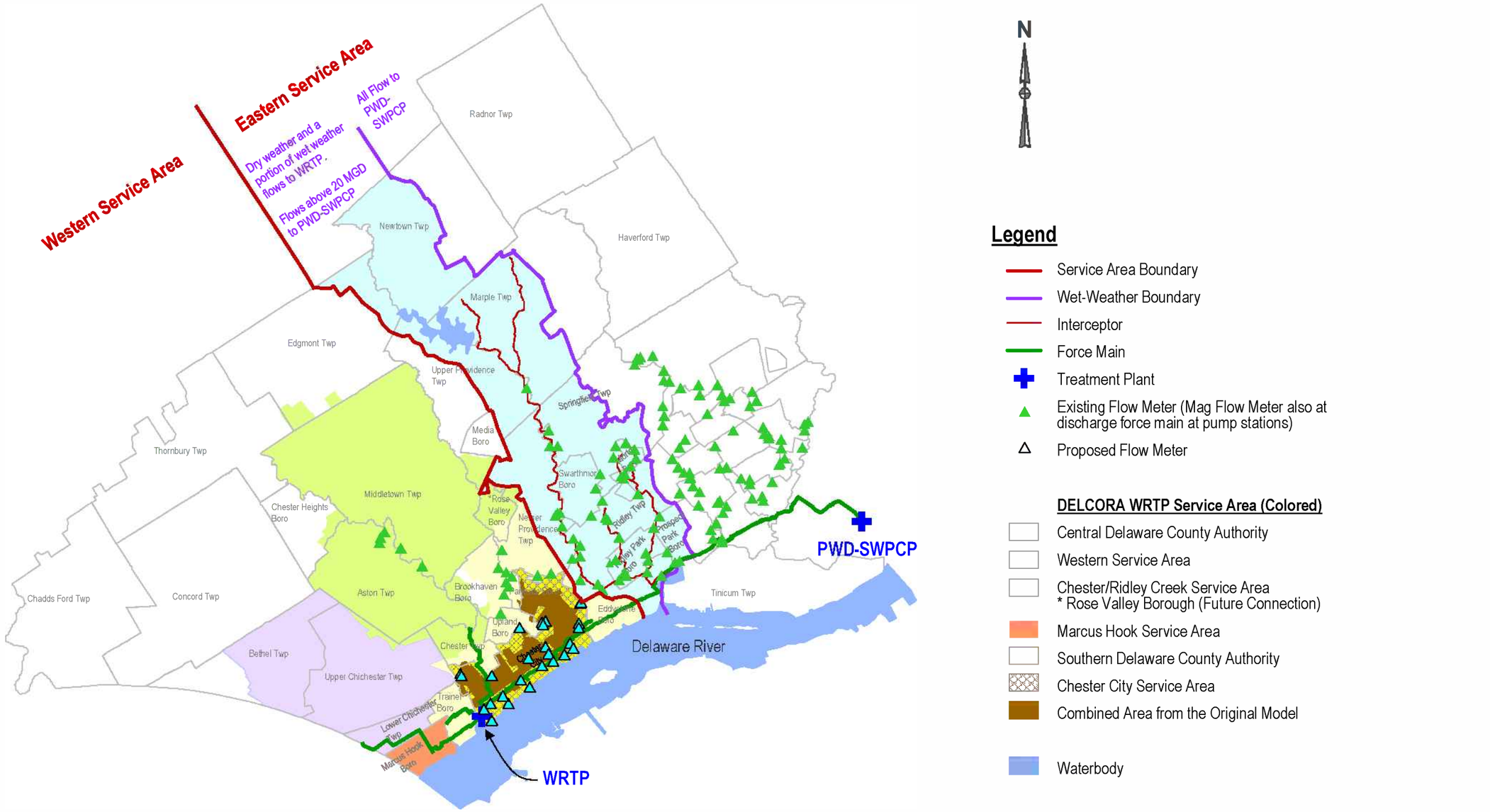
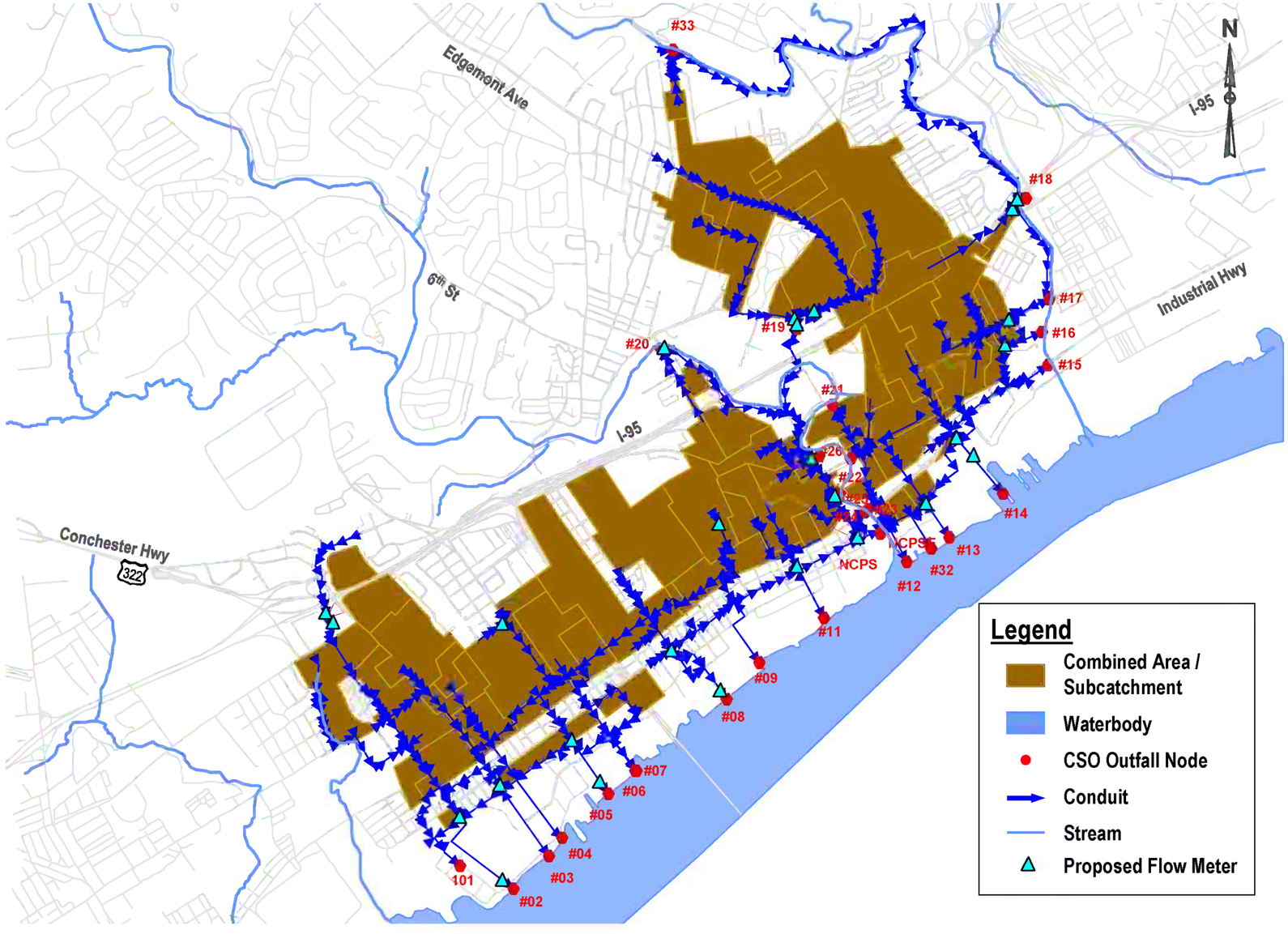


Figure 4-4 Additional Flow Meters (Zoom into the Combined Area)



4.3 Rainfall and Flow Monitoring Work Plan

Per the Consent Decree, the additional rainfall and flow monitoring need to be carried out at least for 12 months. Key tasks of the monitoring program include the following. A detail work plan will be prepared during the first Task (Prepare Rainfall and Flow Monitoring Work Plan).

- Prepare Rainfall and Flow Monitoring Work Plan in October 2015, exact locations of the proposed rain gauge and flow meter will be field verified and finalized during plan development,
- Procure Flow Metering and Rain Gauge Services in November 2015,
- Install and Calibrate Rain Gauge and Flow Meters for Official Data Gathering in November through December 2015,
- Conduct Rainfall and Flow Monitoring continuously for 12-month through Year 2016.
- Monitoring data collection and analysis, within two months after the monitoring program is completed.

Section 5 DELCORA H&H Model Calibration and Validation

5.1 Rainfall and Flow Monitoring Data Analysis

A rainfall and flow monitoring data analysis will be performed for the data collected from the additional rainfall and flow monitoring program listed in Section 4. The purposes of this data analysis are to:

- document rainfall and flow monitoring locations,
- overview monitoring data quality,
- analyze rainfall data to identify dry weather and wet weather conditions and to characterize individual rainfall event for precipitation depth, duration, maximum intensity, and return frequency,
- analyze flow data to determine dry weather flow and diurnal pattern, wet weather flow and peak factor, and system response to wet weather events, and
- determine wet weather events for H&H model calibration and validation.

5.1.1 Rainfall Monitoring Data Analysis

A rain gauge location map will be prepared, together with a Thiessen polygon. A system-wide area-weighted average rainfall will be calculated based on the Thiessen polygons.

Monthly rainfall depth and total rainfall depth will be calculated for each rain gauge to characterize geographical rainfall distribution throughout the collection system.

An inter-event time of 6 hours will be used to identify individual rainfall event. The inter-event time specifies the minimum duration in which precipitation does not occur. Based on this criterion, a dry weather time period and the number of total rainfall events will be identified. The rainfall events during the flow monitoring periods should have a wide variation in terms of total depth, intensity, duration, and antecedent conditions to provide a large dataset for balanced model calibration and validation.

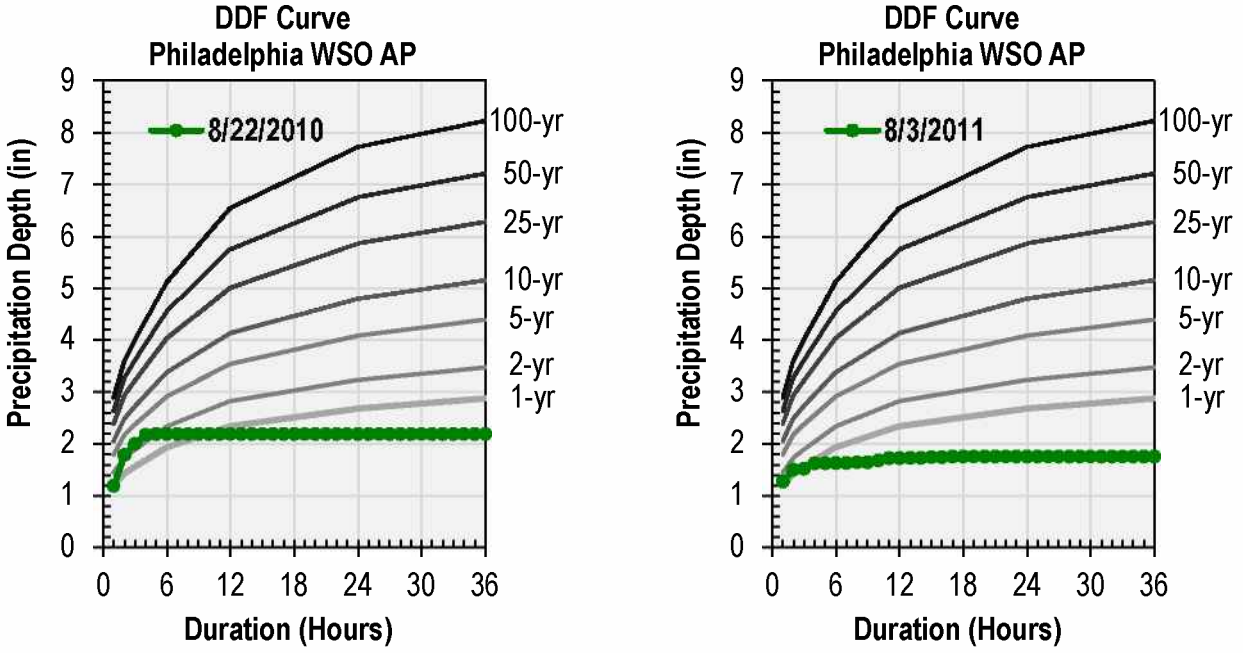
Table 5-1 shows NOAA precipitation frequency estimates for the Philadelphia International Airport. The original NOAA table contains rainfall data for 1-year to 1000-year return frequencies. A regression model can be used to derive the data for once per 3 months (four times a year) and once per 6 months (twice a year) storms. Based on **Table 5-1**, a Depth-Duration-Frequency (DDF) curve can be developed for individual rainfall event. For example, **Figure 5-1** shows the August 22, 2010 rainfall event as a 2-year storm and the August 3, 2011 rainfall event as a 1-yr storm.

All the rainfall events will be characterized by event start time, event end time, rainfall depth, duration, maximum intensity, and return frequency in a summary table. Top 10 rainfall events will be identified as candidate events for model calibration and validation.

Table 5-1 NOAA Philadelphia Precipitation Frequency Estimates

Duration	Precipitation Frequency Estimates (rainfall: in)						
	1	2	5	10	25	50	100
5-min	0.347	0.414	0.486	0.537	0.598	0.64	0.681
10-min	0.555	0.661	0.778	0.858	0.954	1.02	1.08
15-min	0.694	0.831	0.984	1.08	1.21	1.29	1.37
30-min	0.951	1.15	1.4	1.57	1.79	1.94	2.1
1-hr	1.19	1.44	1.79	2.05	2.38	2.63	2.89
2-hr	1.43	1.73	2.17	2.49	2.93	3.27	3.6
3-hr	1.56	1.89	2.37	2.73	3.22	3.61	4.01
6-hr	1.93	2.33	2.91	3.38	4.03	4.56	5.12
12-hr	2.34	2.82	3.54	4.13	5.01	5.75	6.55
24-hr	2.68	3.23	4.08	4.8	5.86	6.75	7.72
2-day	3.07	3.71	4.7	5.51	6.69	7.67	8.73
3-day	3.26	3.93	4.96	5.81	7.03	8.05	9.14
4-day	3.44	4.15	5.22	6.1	7.37	8.42	9.54

Figure 5-1 Rainfall with 1-yr and 2-yr Return Frequency

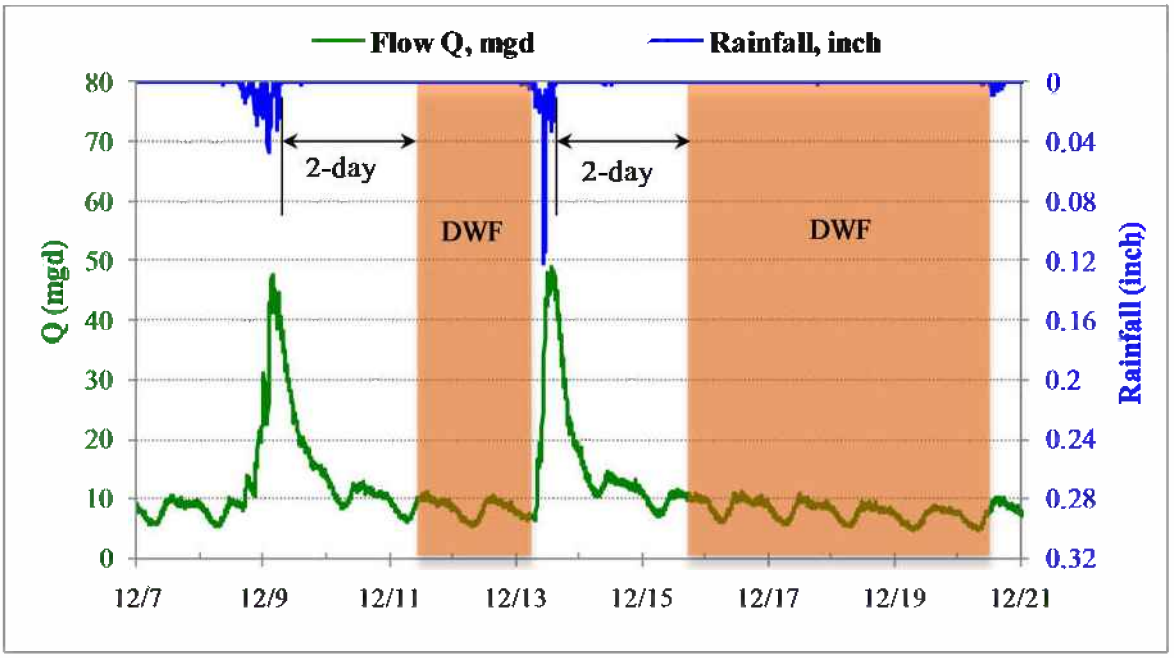


5.1.2 Flow Monitoring Data Analysis

5.1.2.1 Dry Weather Flow (DWF) Analysis

A "dry weather" condition was defined as a period with no precipitation that begins two days after the last wet weather event and lasts until the beginning of the next precipitation event. **Figure 5-2** is an example plot showing both rainfall data and a flow hydrograph. Periods of dry weather flow are also shown in the plot based on the definition. Flow hydrographs will be screened for each metering site to confirm that the data used for the DWF calculation was appropriate. **Figure 5-3** shows an example that some portion of the flow data measured needs to be exempted from the DWF calculation because the data was not consistent with other dry weather flows measured during the monitoring periods.

Figure 5-2 Hydrograph to Show Dry Weather Flow (Example Plot)



Average dry weather flow will be calculated by averaging the monitored flows from the dry weather periods identified in the rainfall data analysis. The overall and monthly DWFs for all monitoring sites will be analyzed.

The dry weather flows vary throughout the day, with the highest flows normally occurring around noon and the lowest rates between midnight and early morning. Flow data from the dry weather periods will be used to develop a flow diurnal pattern for each flow meter site. Diurnal patterns will be analyzed for both weekdays and weekends because they are usually different. In the example plot shown on **Figure 5-4**, the weekend DWF peak and valley have a 3-hour lag compared to the weekday pattern.

Figure 5-3 Data Screening for Dry Weather Flow Calculation (Example Plot)

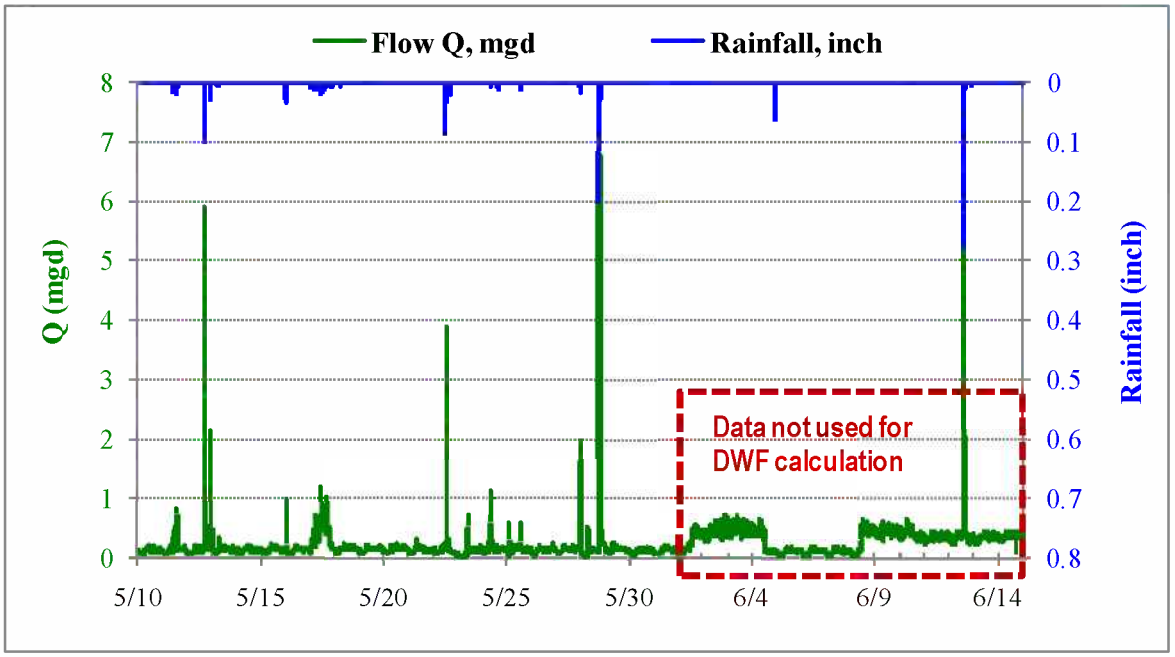
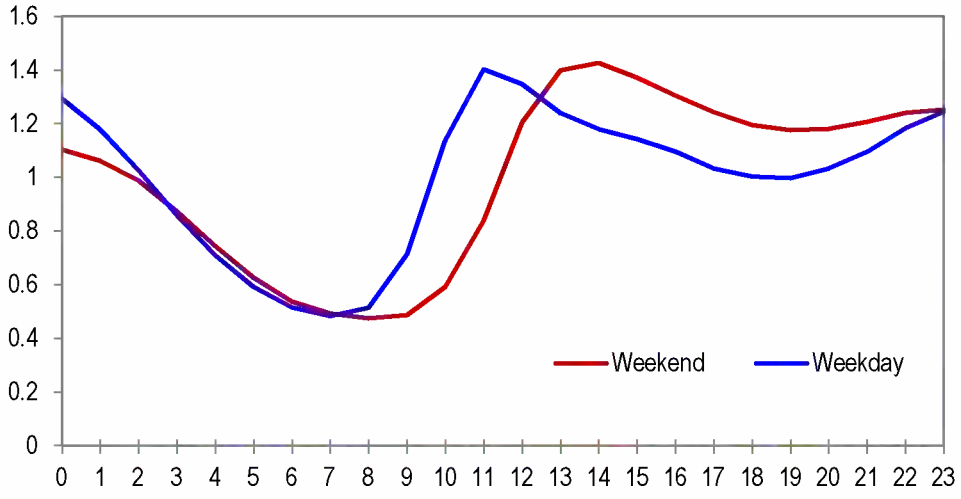


Figure 5-4 Weekday and Weekend Dry Weather Flow Diurnal Pattern (Example Plot)



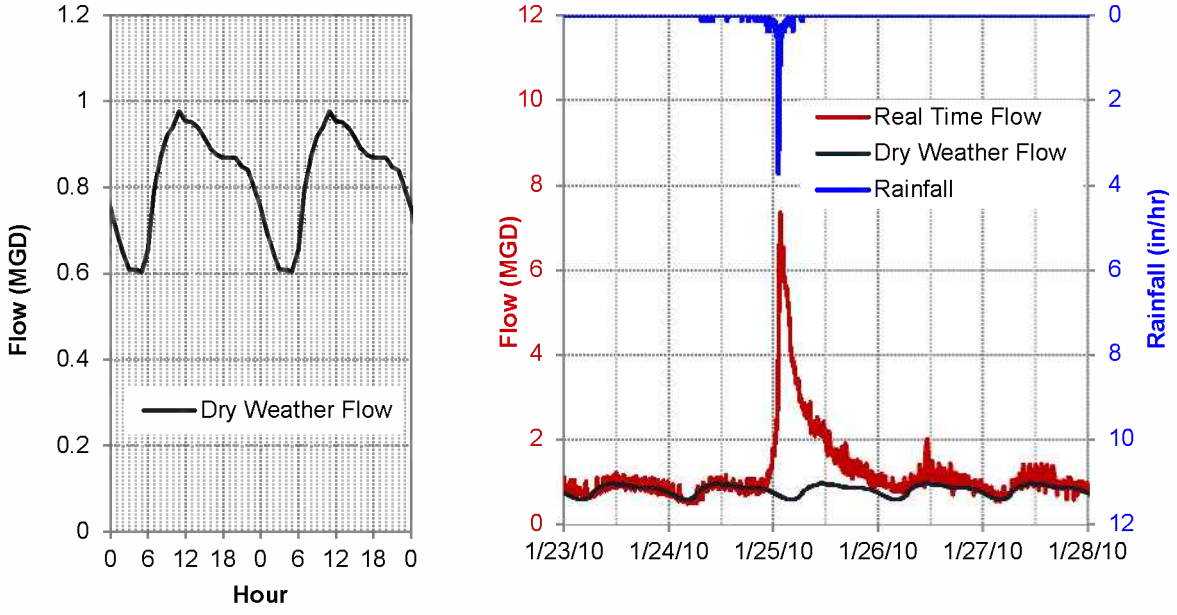
5.1.2.2 Wet Weather Flow Analysis

Wet weather flows are the combination of dry weather flows and additional flows that enter the system during wet weather conditions. The additional flows are from combined area surface runoff and RDII.

Inflow normally occurs when rainfall enters the system through direct connections such as roof leaders, yard drains, catch basins, sump pumps, manhole covers and frame seals or indirect connections with storm sewers. Inflow is usually recognized graphically by large magnitude, short duration spikes immediately following a rain event. Infiltration occurs during wet weather conditions when water enters a sewer system from the ground through means which include, but not limited to, deteriorated pipes, pipe joints, connections, or manholes. It is significantly influenced by the size and duration of the rainfall event. Infiltration is often recognized graphically by a gradual increase in flow after a wet weather event. The increased flow typically sustains for a short period after rainfall has stopped and then gradually drops off.

The peaking factor represents the ratio of the peak wet weather flow to the average dry weather flow. Usually, an hourly peaking factor is used to represent the wet weather peaking factor. Peaking factors will be analyzed for each flow monitoring site. The peaking factors in the separated area can be used to determine the extent of the RDII within a particular basin. **Figure 5-5** is an example flow hydrograph plot showing an hourly peaking factor of approximately 9 for the monitoring site. This high peaking factor indicates that a significant amount of RDII enters the collection system. The immediate flow increase shortly after the rainfall indicates significant inflow into the collection pipes, and the long tail back to the base flow indicates infiltration occurrence at the site as well.

Figure 5-5 Hydrographs of Flow Meters in Separated Area (Example Plot)



5.1.3 Wet Weather Event Selection for Model Calibration and Validation

Based on the rainfall and flow monitoring data analysis, four to six rainfall events will be selected for model calibration. The event selection should cover wide variation in terms of rainfall return frequency, rainfall depth, intensity, duration, antecedent conditions, and back-to-back storms. With this, the calibrated model can be reasonably applied for various hydrologic conditions. The selected calibrating period shall have good wet weather response from most of the flow monitoring locations.

One to two other rainfall events will be selected for model validation.

5.2 Model Calibration and Validation

Model credibility is developed through model calibration and validation. Model calibration involves application of the model to known external inputs (e.g., rainfall), evaluation of the model's ability to replicate monitored conditions (e.g., flow and volume), and adjustment of key model parameters as needed until an acceptable level of agreement is reached between simulated and monitored conditions.

After the model is satisfactorily calibrated it must be validated by running known storms with known flow results and having the model replicate the known events. Storms used in model validation should be independent from the storms used in the model calibration.

5.2.1 Calibration/Validation Criteria

5.2.1.1 Dry Weather Flow Calibration Criteria

A dry weather flow (DWF) analysis will be conducted based on the rainfall and flow monitoring results. DWF distribution in the collection system will be based on land use or water consumption data.

Weekday and weekend diurnal factor will be analyzed and applied for each flow meter service area and a monthly factor will be used, if necessary.

DWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be within 1 hour of the observed,
- The simulated peak flow will be within 10% of the observed flow, and
- The simulated flow volume over 24 hours will be within 10% of observed flow.

5.2.1.2 Wet Weather Flow Calibration Criteria

Wet weather flow (WWF) includes surface runoff from the combined area, RDII from the entire service area, and connected rooftops, if any, from the separated area. RDII parameters will be developed based on the separated area, and surface runoff parameters will be adjusted for the combined area to calibrate the system response to the wet weather conditions.

Four (4) to six (6) wet weather events will be selected for wet weather calibration, depending on the rainfall and flow monitoring results, and various rainfall intensities and volume should also be considered.

WWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be within 1 hour of the observed,
- The simulated peak flow will be within 10% of the observed flow, and
- The simulated flow volume over 24 hours will be within 10% of observed flow.

5.2.2 Model Calibration Approach

The runoff calibration for the combined sewer area is achieved by primarily adjusting width and percent imperviousness. The RDII calibration is achieved by adjusting RTK values. The calibration of hydraulic control structures (weirs and orifices) is achieved by adjustment the discharge coefficients. The conduit hydraulics calibration is achieved by adjusting Manning's n and head loss coefficients. Flow depth, as well as flow rate, is checked while calibrating the hydraulic model.

Once the model is calibrated, different sets of flow monitoring data are used to validate the model calibration. Model calibration and validation is an iterative process.

Percent Imperviousness
The percent imperviousness for combined sewer subcatchment is the key parameter to be adjusted to calibrate runoff to the observed wet weather flow volumes. Site visits of the combined sewer areas may be needed to verify real connectivity. If runoff from a large portion of the impervious surface could not be captured by the combined sewers due to a limited number and size of storm inlets, the percent imperviousness will need to be reduced significantly from its initial value calculated based on impervious land cover. This is done to represent a more reasonable "effectively connected area" and to achieve a satisfactory calibration for runoff volume.

Width
The width for the combined sewer sub catchments, in conjunction with percent imperviousness, will be adjusted to calibrate to the observed wet weather flow peaks.

Depression Storage
The depression storage is another hydrologic parameter for wet weather volume calibration. It can also be adjusted to achieve a satisfactory calibration for the wet weather flow start timing.

RDII Parameters
RDII parameters are to be adjusted to calibrate to the observed wet weather volumes and flow hydrograph shape for the separate sewer areas. The RDII parameters for the combined sewer areas will use the same as those for the immediate upstream separate sewer areas. Then, the runoff parameters will be adjusted to calibrate to the observed data.

Pipe Roughness
Pipe roughness will be adjusted to calibrate to the observed flow depths and velocities at the meter locations.

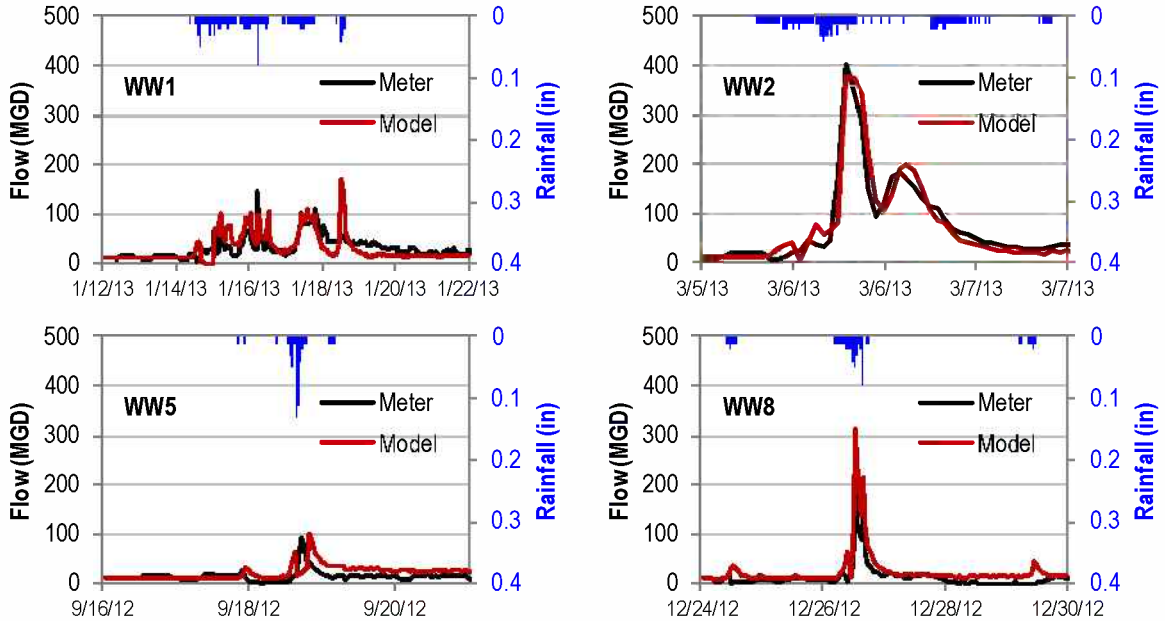
Orifice and Weir
Orifice and weir parameters discharge coefficients will be adjusted to calibrate to the observed overflows at the outfall meter locations.

Minor Loss
Minor loss values will be applied in the model where necessary to refine observed flow/depth relationships at the meter locations.

5.2.3 Model Calibration Results

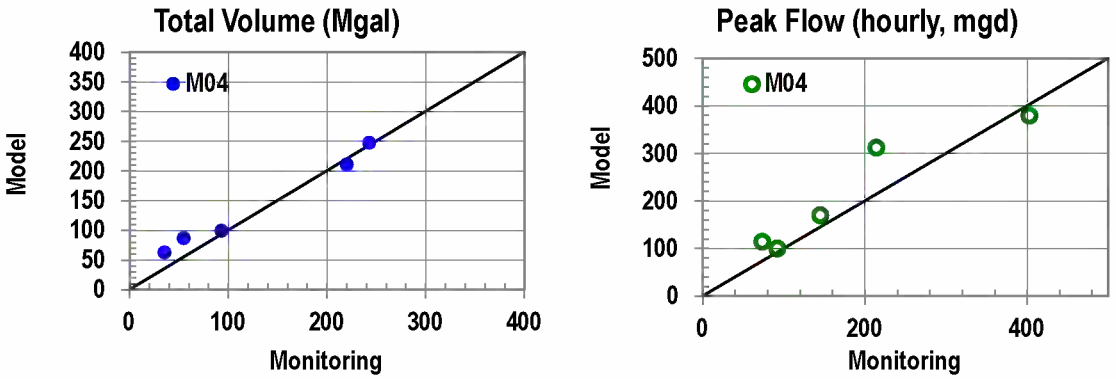
Generally, the model predictions should be in great agreement with the metering data. **Figure 5-6** is an example plot showing metered and modeled flow at one monitoring site for four wet weather events (WW1, WW2, WW5, and WW8). A great agreement between metered and modeled data may not be achievable for each individual wet weather event. The larger storm events will have more weighting factor in the calibration process because the large events are the ones that dominate the total overflow volume.

Figure 5-6 Model Calibration Hydrograph (Example Plot)



Comparisons of the predicted total volume against the monitoring total volume and predicted peak flow against monitoring peak flow will be analyzed and shown in 1:1 ratio plots for all calibrated meters (see example **Figure 5-7**). This is to evaluate the overall calibration and validation from all the events. The event points in **Figure 5-7** are distributed close to the 1:1 ratio line, which means that the model predicted peak flow and wet weather event volume are in a great agreement with the metered data.

Figure 5-7 Model Calibration Hydrograph (Example Plot)

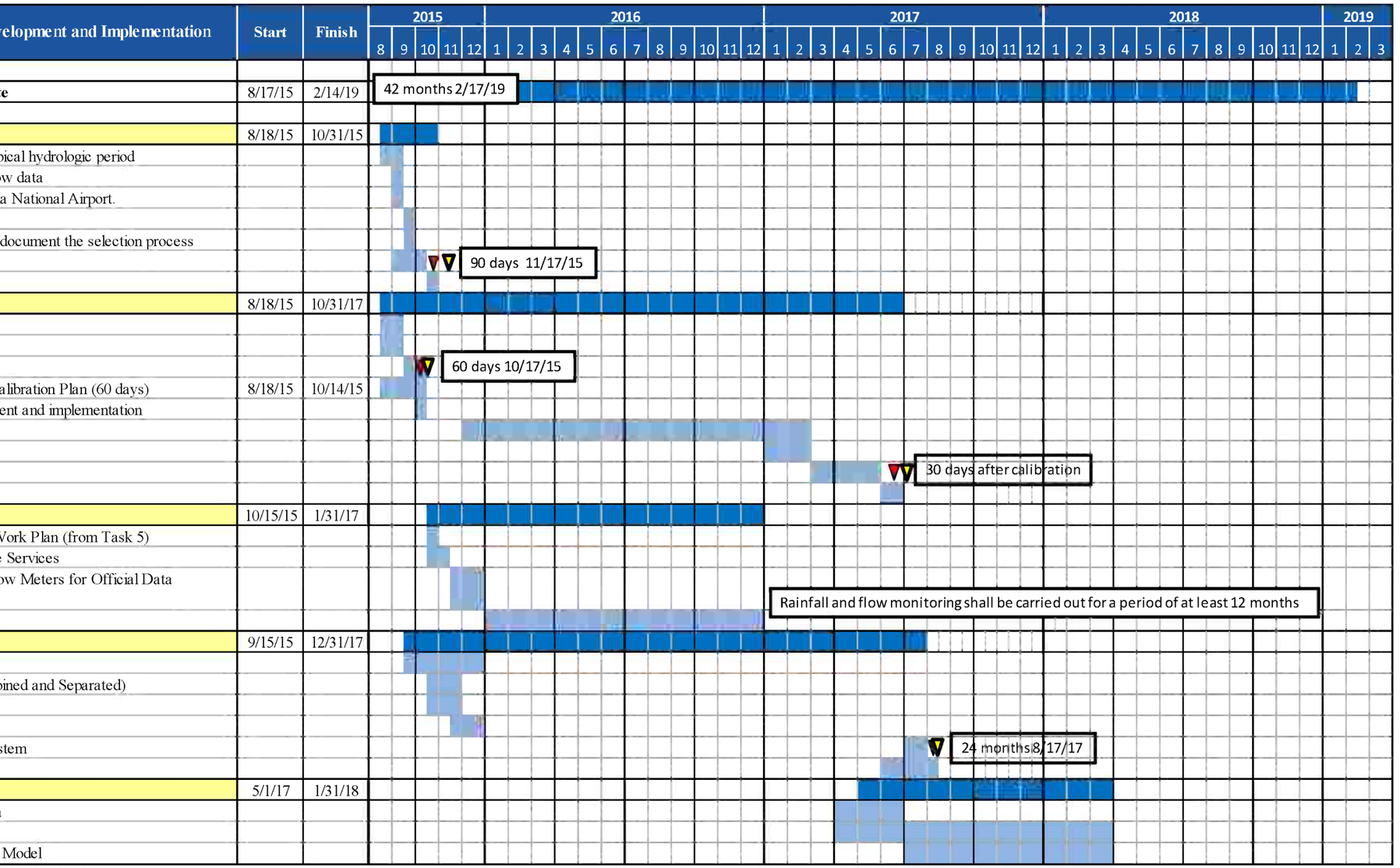


Section 6 Model Development and Implementation Schedule

The schedule for model development and implementation is shown in **Figure 6-1**. All LTCPU tasks related to the H&H model construction, application, and implementation are included in the schedule. The schedule is integrated into LTCP development consistent with other dates required pursuant to the Consent Decree.

Figure 6-1 Schedule for H&H Model Development and Implementation

	Tasks of DELCORA H&H Model Development and Implementation	Start	Finish
	Lodging date of Consent Decree (8/17/15)		
	DELCORA Long Term Control Plan Update	8/17/15	2/14/19
	TASK 3 - Typical Year Rainfall Record (90 days)	8/18/15	10/31/15
1	Develop criteria for determination of typical hydrologic period		
2	Review available historic rainfall and flow data		
3	Obtain rainfall data from the Philadelphia National Airport.		
4	Review with DELCORA		
5	Select the typical hydrologic period and document the selection process		
6	Draft Report		
7	Final Report		
	TASK 5 - Hydrologic & Hydraulic Model	8/18/15	10/31/17
1	Initial assessment of GIS Model		
2	Initial assessment of H&H Model		
3	Report summarizing Initial Assessment		
4	Develop an H&H Model Update and Calibration Plan (60 days)	8/18/15	10/14/15
5	Develop Schedule for Model Development and implementation		
6	H&H Model Update		
7	Flow Monitoring Data Analysis		
8	H&H Model Calibration		
9	H&H Model Report		
	TASK 6 - Rainfall and Flow Monitoring	10/15/15	1/31/17
1	Prepare Rainfall and Flow Monitoring Work Plan (from Task 5)		
2	Procure Flow Metering and Rain Gauge Services		
3	Install and Calibrate Rain Gauge and Flow Meters for Official Data Gathering		
4	Conduct Rainfall and Flow Monitoring		
	TASK 7 - Existing Service Area Characterization	9/15/15	12/31/17
1	GIS Mapping Review and Update		
2	Refine Service Area Delineation (Combined and Separated)		
3	Investigate Existing CSO Facilities		
4	Investigate Service Agreements		
5	Perform H&H Modeling of Existing System		
6	Documentation		
	Evaluation of CSO Alternatives (Part of Task 11)	5/1/17	1/31/18
1	Develop Future DWF and Service Area		
2	Develop CSO Alternatives		
3	Evaluate CSO Alternatives using H&H Model		



Consent Order Deadline Draft and Final submittals

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GREELEY AND HANSEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

MAR 01 2016

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Hydrologic and Hydraulic Model Update and Calibration Plan. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP).

EPA hereby approves the plan with the understanding that the term "two days" as stated in paragraph 5.1.2.1 (Dry Weather Overflow Analysis) shall mean 48 hours.

Thank you for your continued cooperation with this matter. Please do not hesitate to contact me at (215)814-2097 if you have any questions.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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APPENDIX E

Typical Hydrologic Period Report

- DELCORA Typical Hydrologic Period Report (Final) dated November 2015 (Updated April 2016)
- USEPA Approval of the Typical Hydrologic Period Report dated May 23, 2016

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Typical Hydrologic Period Report (Final)

November 2015
(Updated April 2016)

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Typical Hydrologic Period Report.

DELCORA MANAGEMENT		
Executive Director	*Signature*	11/5/15 *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	11/5/15 *Date*
(type in other as needed / delete row if unused)	*Signature*	*Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	11/5/15 *Date*
(type in other as needed / delete row if unused)	*Signature*	*Date*
	Signature	*Date*
	Signature	*Date*

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
1	4/26/16	Greeley and Hansen	• Pg. 1-3, Section 1-4: Deleted paragraph at end of section. • Pg. 2-7: Added Table 2-6 – Top 5 Ranked Hydrologic Periods (IET = 12 hr). Renumbered tables accordingly. • Page 2-10: Added new Section 2.6. • Page 2-10: Added Figures 2-4, 2-5 and 2-6 and renumbered figures accordingly.

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Section 1 Introduction

1.1 DELCORA's Consent Decree

DELCORA prepared and submitted their original Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the PADEP in 1999. This LTCP was subsequently approved by the PADEP, and DELCORA had started to implement the CSO control elements selected in the LTCP. In 2009, the United States Environmental Protection Agency (USEPA) informed DELCORA that the original LTCP was not in compliance with the requirements of the USEPA's CSO Policy. As such, DELCORA prepared and submitted a revised LTCP in April 2012. Subsequent to the receipt of the revised LTCP, DELCORA and the USEPA had corresponded various times including requests for additional information from the USEPA in accordance with Section 308 of the Clean Water Act. A Consent Decree was issued by the USEPA to DELCORA in June 2015. The Consent Decree requires a new LTCP to be prepared based on an agreed upon schedule, which will include interim deliverables and milestones that must be met.

According to the Consent Decree between the US EPA, PADEP, and DELCORA, within ninety (90) days after August 17, 2015 (the lodging date), DELCORA shall submit to Plaintiffs a report or technical memorandum describing DELCORA's statistical evaluation of long-term local rainfall patterns and the identification of an appropriate typical period for LTCP development purposes.

The statistical evaluation in this study utilizes local long-term rainfall record from the Philadelphia International Airport. It considers various appropriate rain year characteristics, including distributions of event rainfall totals, event durations, and peak and average rainfall intensities.

1.2 Typical Year for CSO LTCP Development

Precipitation generates urban storm water, combined sewer overflows (CSOs), and increased wet weather flows to the wastewater treatment plant. These will contribute bacteria and pollutants to the Delaware River and its tributaries. The effect of these contributors on the Delaware River mainly depends on the magnitude and duration of rainfall events and on the prevailing ambient river conditions controlling dilution and transport of the pollutants. This variability and complexity poses a significant challenge for assessing the performance of wet weather and CSO control alternatives.

In accordance with the USEPA CSO Control Policy (CSO Policy), dated April 19, 1994, the CSO control alternatives should be assessed on a "system-wide, annual average basis". This is accomplished by continuous simulation using a typical hydrologic period for the combined sewer system (CSS) and receiving water quality modeling applications. The CSO Policy supports continuous simulation modeling, i.e., using long-term rainfall records rather than records for individual storms. Long-term continuous rainfall records enable simulations to be based on a sequence of storms so that the additive effect of storms occurring close together can be examined. They also enable storms with a range of characteristics to be included.

Typically, a 3- to 5-year period is evaluated to balance between manageable model simulation time and representation of various rainfall/river conditions. In this study, a 3-year period is deemed most appropriate considering the modeling complexity. The representative three-year period is intended to

contain a relatively wet year, a dry year and an average year. Average year conditions are defined as the arithmetic average of the predictions for the selected period.

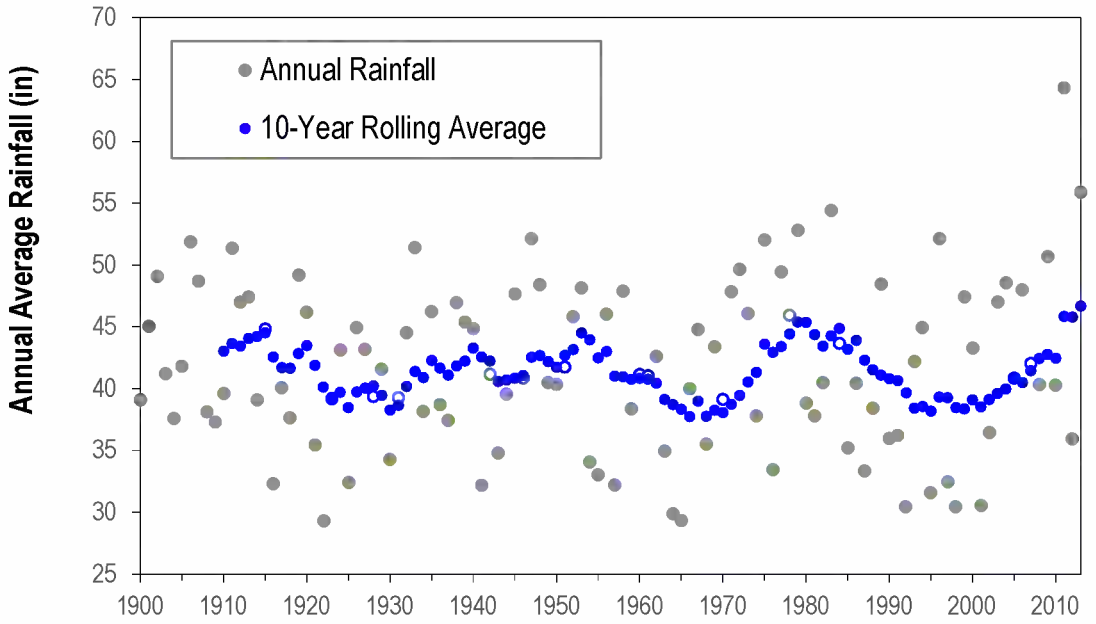
1.3 Climate Change Considerations

Average U.S. precipitation has increased since 1900, but there are regional differences, with some areas having larger increases, and others, decreases. Local climate change should be considered when selecting appropriate data records for the typical period analysis.

Rainfall data from the Philadelphia International Airport were obtained from the National Oceanic and Atmospheric Administration (NOAA). Hourly rainfall data is available from 1900 through 2013. This provides sufficient data to evaluate climate change in the area. **Figure 1-1** shows annual rainfall from 1900 to 2013. A 10-year rolling average trend line is also shown in the figure for characterizing long-term precipitation pattern. In the past 114 years, annual rainfall ranges from 29.3 to 64.33 inches, with the wettest year in 2011. The 10-year rolling average rainfall indicates that precipitation in the area runs through various dry and wet cycles, however with more extreme conditions (dry and wet) in recent years.

Considering the climate change, it is determined that the typical period for the LTCPU be selected based on statistical analysis of rainfall records in recent 30 years (i.e., 1984-2013).

Figure 1-1 Historical Annual Rainfall at Philadelphia International Airport



1.4 Methodology of Typical Year Selection

The typical hydrologic period is selected to provide representative and unbiased approximations of expected future conditions in terms of both averages and historical variability. Representativeness is

assessed using objective criteria for each of the ambient factors (i.e., river flow and rainfall). As indicated in the previous section, the selection of the typical hydrologic period is based on the historical records in the past 30 years from 1984 through 2013.

The following datasets are used for the analysis of the typical hydrologic period:

- Hourly precipitation data for the National Climate Data Center gauge at Philadelphia International Airport for 1984 - 2013.
- Daily Delaware River stream flow data from the U.S. Geological Survey gauge at Trenton, NJ (USGS 01463500) for 1984 - 2013. This is the closest USGS gauge that with daily river flow available.

Key criteria parameters used in the evaluation are listed in **Table 1-1**. Each parameter is given a weighting factor to describe the individual importance on the averageness of the analyzed time period. The parameters that are given the highest impact weighting include the following:

- The total annual rainfall depth, which drives the total runoff volume.
- The maximum peak intensity, which usually defines the biggest overflow event.
- The median Delaware River flow; the impact of sewer overflows on the water quality of the receiving water is dependent on the magnitude of the flows in river, and in the project area, intense local rainfall events are typically independent from watershed wide high flow events.

Table 1-1 Hydrologic Period Ranking Parameters

Key Parameter	Weighting Factor	Comments
Annual rainfall depth	25.0%	Important for evaluating annual overflow volume
Number of events > 0.1" rainfall depth	2.5%	Typically storms over 0.1" would start to cause surface runoff
Number of events > 0.25" rainfall depth	2.5%	Previous model indicates system overflows at storms over 0.25"
Number of events > 1.5" rainfall depth	7.5%	Storms to be controlled to meet potential presumption approach
Number of back-to-back events	5.0%	Important for evaluating the antecedent conditions
Maximum peak intensity	20.0%	Storms with high intensity causes overflows
Average rainfall duration	2.5%	Important for evaluating wet weather durations
Average rainfall intensity	5.0%	Important for evaluating overall rainfall intensity
Delaware River flow - 25th percentile	2.5%	Important for evaluating dilution power of the Delaware River flow for water quality
Delaware River flow - 50th percentile	25.0%	
Delaware River flow - 75th percentile	2.5%	

Section 2 Typical Year Selection for DELCORA

2.1 Annual Rainfall and River Flow Statistics

30-year hourly precipitation data (1984 - 2013) from the Philadelphia International Airport was analyzed to evaluate all individual rainfall events in the period. An inter-event time (IET) of 6 hours (i.e. minimum dry time of 6 hours between rainfall events was used to differentiate between individual events. Precipitation periods with a total rainfall volume of greater than 0.1 inch were counted as rainfall events. If the next rainfall event's starting time is within one day of the previous rainfall event's ending time, these two rainfall events are considered as back-to-back rainfall events. All rainfall events for the data period were analyzed for duration, inter-event duration, total rainfall amount, as well as maximum and average rainfall intensities.

A total of 1,934 rainfall events were counted for the period of 1984 - 2013. **Table 2-1** summarizes rainfall events on an annual basis for rainfall volume, max rainfall intensity, average intensity, average rainfall duration, quantities of rainfall events above 0.1 inch and 0.25 inch, and back-to-back rainfall event number. Statistical river flow information is also included in **Table 2-1**.

Table 2-1 Annual Rainfall and River Flow Statistics 1984-2013

Year	Rainfall								Delaware River Flow (cfs)		
	Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1984	43.7	1.14	0.096	9.6	70	50	5	14	4,675	8,615	15,675
1985	35.2	1.10	0.091	9.7	56	40	3	8	4,470	6,340	9,000
1986	40.4	1.06	0.079	11.0	62	44	5	12	5,190	9,190	16,500
1987	33.3	0.66	0.073	11.3	56	40	1	7	5,660	9,000	12,500
1988	38.4	1.69	0.083	10.3	57	37	7	9	4,473	6,605	10,775
1989	48.5	1.50	0.076	11.0	69	51	8	14	5,210	7,610	13,400
1990	36.0	0.48	0.070	10.2	64	44	1	8	7,110	10,800	17,600
1991	36.2	1.26	0.082	11.2	55	40	5	7	3,240	5,720	12,400
1992	30.4	1.31	0.057	11.0	64	31	2	9	5,460	7,610	10,900
1993	42.2	1.11	0.098	9.8	61	43	8	6	4,070	7,210	13,600
1994	44.9	1.50	0.088	11.0	67	50	4	8	5,680	8,460	15,000
1995	31.6	1.00	0.070	9.5	53	34	3	1	4,260	6,670	10,700
1996	52.1	1.03	0.087	9.7	75	57	8	12	6,893	14,000	24,625
1997	32.5	0.84	0.078	10.2	65	46	1	11	3,860	6,870	13,000
1998	30.4	0.54	0.065	11.2	58	39	2	12	3,070	8,550	19,100
1999	47.4	0.95	0.077	11.7	60	47	6	10	3,500	7,650	11,400
2000	43.3	2.43	0.111	10.3	61	48	5	6	5,243	8,510	16,575
2001	30.6	1.03	0.072	11.0	50	36	5	4	3,370	5,400	9,770
2002	36.4	0.69	0.082	12.5	53	39	4	4	3,630	7,610	13,600

Year	Rainfall								Delaware River Flow (cfs)		
	Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
2003	47.0	0.62	0.068	10.9	78	52	7	17	10,300	15,600	26,400
2004	48.6	1.17	0.077	10.8	67	48	6	8	8,158	12,500	18,125
2005	40.9	1.55	0.084	11.1	58	45	5	8	4,690	11,200	17,000
2006	48.0	1.23	0.089	10.2	64	52	8	13	8,180	12,200	19,000
2007	42.1	1.09	0.091	10.5	60	38	4	9	5,220	7,950	16,600
2008	40.3	1.29	0.083	11.1	59	38	7	6	4,910	9,825	20,200
2009	50.7	1.42	0.100	11.5	76	51	10	18	8,700	11,100	16,400
2010	40.3	1.24	0.094	12.4	52	39	5	8	4,680	9,610	14,100
2011	64.3	1.31	0.109	10.5	68	49	11	11	10,400	18,100	28,600
2012	35.9	1.46	0.098	7.9	62	44	4	10	5,255	8,235	12,700
2013	55.9	2.86	0.118	10.2	64	50	9	10	5,750	8,900	12,000
Average 1984-2013	**41.6**	**1.22**	**0.085**	**10.6**	**62**	**44**	**5.3**	**9.3**	**5,510**	**9,255**	**15,575**

2.2 Three-year Rainfall and River Flow Analysis

Three-year rainfall and river flow characteristics were developed based on an annual average of the three consecutive years. **Table 2-2** summarizes rainfall and river flow statistics in the 28 individual three-year periods.

Table 2-2 Three-year Rainfall and River Flow Statistics 1984-2013

Year	Rainfall								Delaware River Flow (cfs)		
	Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1984-1986	39.8	1.14	0.089	10.1	63	45	4	11	4,778	8,048	13,725
1985-1987	36.3	1.10	0.081	10.7	58	41	3	9	5,107	8,177	12,667
1986-1988	37.4	1.69	0.078	10.9	58	40	4	9	5,108	8,265	13,258
1987-1989	40.1	1.69	0.077	10.9	61	43	5	10	5,114	7,738	12,225
1988-1990	41.0	1.69	0.076	10.5	63	44	5	10	5,598	8,338	13,925
1989-1991	40.2	1.50	0.075	10.8	63	45	5	10	5,187	8,043	14,467
1990-1992	34.2	1.31	0.069	10.8	61	38	3	8	5,270	8,043	13,633
1991-1993	36.3	1.31	0.079	10.7	60	38	5	7	4,257	6,847	12,300
1992-1994	39.2	1.50	0.081	10.6	64	41	5	8	5,070	7,760	13,167
1993-1995	39.5	1.50	0.086	10.2	60	42	5	5	4,670	7,447	13,100
1994-1996	42.9	1.50	0.083	10.1	65	47	5	7	5,611	9,710	16,775
1995-1997	38.7	1.03	0.079	9.8	64	46	4	8	5,004	9,180	16,108
1996-1998	38.3	1.03	0.078	10.3	66	47	4	12	4,608	9,807	18,908

Year	Rainfall								Delaware River Flow (cfs)		
	Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1997-1999	36.8	0.95	0.074	11.0	61	44	3	11	3,477	7,690	14,500
1998-2000	40.4	2.43	0.085	11.1	60	45	4	9	3,938	8,237	15,692
1999-2001	40.4	2.43	0.087	11.0	57	44	5	7	4,038	7,187	12,582
2000-2002	36.8	2.43	0.090	11.2	55	41	5	5	4,081	7,173	13,315
2001-2003	38.0	1.03	0.073	11.4	60	42	5	8	5,767	9,537	16,590
2002-2004	44.0	1.17	0.075	11.3	66	46	6	10	7,363	11,903	19,375
2003-2005	45.5	1.55	0.075	10.9	68	48	6	11	7,716	13,100	20,508
2004-2006	45.8	1.55	0.083	10.7	63	48	6	10	7,009	11,967	18,042
2005-2007	43.6	1.55	0.088	10.6	61	45	6	10	6,030	10,450	17,533
2006-2008	43.4	1.29	0.088	10.6	61	43	6	9	6,103	9,992	18,600
2007-2009	44.3	1.42	0.092	11.1	65	42	7	11	6,277	9,625	17,733
2008-2010	43.7	1.42	0.093	11.6	62	43	7	11	6,097	10,178	16,900
2009-2011	51.7	1.42	0.102	11.4	65	46	9	12	7,927	12,937	19,700
2010-2012	46.8	1.46	0.101	10.2	61	44	7	10	6,778	11,982	18,467
2011-2013	52.1	2.86	0.109	9.6	65	48	8	10	7,135	11,745	17,767
Average 1984-2013	**41.3**	**1.18**	**0.084**	**10.7**	**62**	**44**	**5**	**9**	**5,540**	**9,325**	**15,770**

2.3 Ranking Analysis

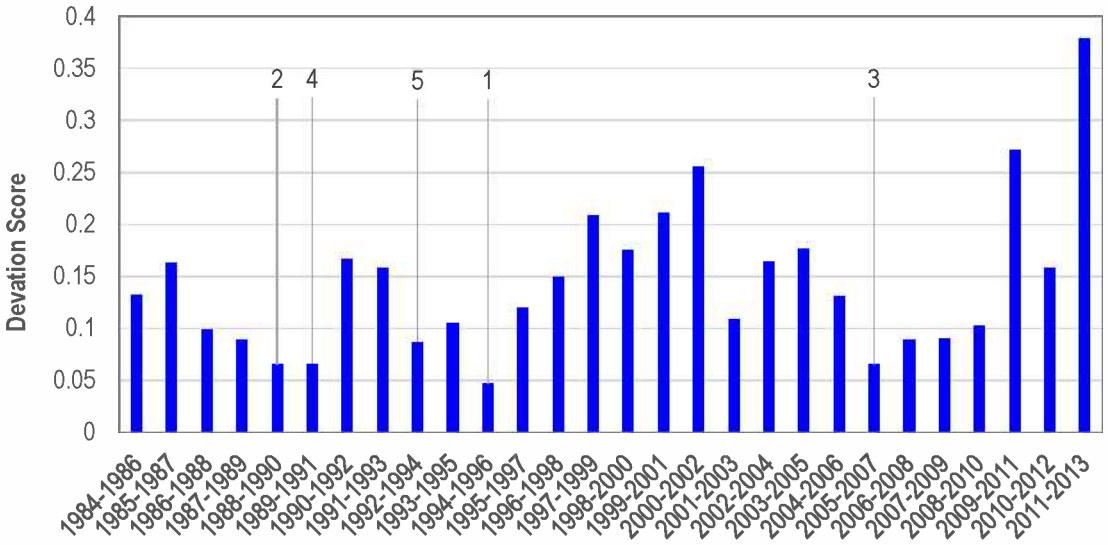
From **Table 2-2** the relative deviation for each parameter was calculated for individual 3-year period. With the weighting factors listed in **Table 1-1**, a deviation score was developed for each individual period. The 3-year periods were then ranked based on the deviation score. The lower the deviation score (**Figure 2-1** Y-axis), the higher the rank for the hydrologic period (i.e., the closer it is to the average condition). **Table 2-3** and **Figure 2-1** shows the ranking results of the 28 hydrologic periods, with a ranking of 1 being the highest and a ranking of 28 being the lowest ranked hydrologic period. Hydrologic period 1994-1996 is ranked No.1 because it has the lowest deviation score of 0.047.

Table 2-3 Typical Period Ranking Analysis

Year	Rainfall								Delaware River Flow			Deviation Score	Rank
	Annual Rainfall	Max Rainfall Intensity	Average Rainfall Intensity	Average Rainfall Duration	Events ≥0.10 in	Events ≥0.25 in	Events ≥1.5 in.	Back-to-Back Event	25th Pct	50th Pct	75th Pct		
Wt. Factor	**25%**	**20%**	**5%**	**2.5%**	**2.5%**	**2.5%**	**7.5%**	**5%**	**2.5%**	**25%**	**2.5%**		
1984-1986	4%	26%	6%	6%	1%	2%	18%	23%	14%	14%	13%	0.132	15
1985-1987	12%	28%	3%	0%	6%	6%	43%	2%	8%	12%	20%	0.163	19
1986-1988	10%	10%	7%	1%	6%	8%	18%	1%	8%	11%	16%	0.100	9

Year	Rainfall								Delaware River Flow			Deviation Score	Rank
	Annual Rainfall	Max Rainfall Intensity	Average Rainfall Intensity	Average Rainfall Duration	Events ≥0.10 in	Events ≥0.25 in	Events ≥1.5 in.	Back-to-Back Event	25th Pct	50th Pct	75th Pct		
Wt. Factor	25%	20%	5%	2.5%	2.5%	2.5%	7.5%	5%	2.5%	25%	2.5%		
1987-1989	3%	10%	8%	1%	2%	3%	1%	9%	8%	17%	22%	0.089	6
1988-1990	1%	10%	9%	2%	2%	0%	1%	12%	1%	11%	12%	0.065	2
1989-1991	3%	2%	10%	1%	1%	3%	11%	5%	6%	14%	8%	0.066	4
1990-1992	17%	15%	18%	1%	2%	13%	49%	13%	5%	14%	14%	0.167	21
1991-1993	12%	15%	6%	1%	3%	13%	5%	20%	23%	27%	22%	0.159	18
1992-1994	5%	2%	3%	1%	3%	6%	11%	17%	8%	17%	17%	0.087	5
1993-1995	4%	2%	3%	5%	3%	3%	5%	46%	16%	20%	17%	0.105	11
1994-1996	4%	2%	1%	6%	5%	7%	5%	24%	1%	4%	6%	0.047	1
1995-1997	6%	33%	5%	8%	4%	4%	24%	13%	10%	2%	2%	0.120	13
1996-1998	7%	33%	7%	4%	6%	8%	30%	27%	17%	5%	20%	0.150	16
1997-1999	11%	38%	12%	3%	2%	0%	43%	19%	37%	18%	8%	0.208	24
1998-2000	2%	58%	1%	3%	4%	2%	18%	1%	29%	12%	0%	0.176	22
1999-2001	2%	58%	4%	3%	8%	0%	1%	28%	27%	23%	20%	0.211	25
2000-2002	11%	58%	7%	5%	12%	6%	11%	49%	26%	23%	16%	0.255	26
2001-2003	8%	33%	13%	6%	3%	3%	1%	10%	4%	2%	5%	0.109	12
2002-2004	6%	24%	11%	5%	6%	6%	8%	5%	33%	28%	23%	0.165	20
2003-2005	10%	1%	10%	2%	9%	10%	14%	19%	39%	40%	30%	0.176	23
2004-2006	11%	1%	0%	0%	2%	10%	20%	5%	27%	28%	14%	0.131	14
2005-2007	6%	1%	5%	1%	2%	3%	8%	9%	9%	12%	11%	0.065	3
2006-2008	5%	16%	5%	1%	2%	3%	20%	1%	10%	7%	18%	0.089	7
2007-2009	7%	7%	10%	3%	5%	3%	33%	19%	13%	3%	12%	0.090	8
2008-2010	6%	7%	11%	8%	1%	3%	39%	16%	10%	9%	7%	0.102	10
2009-2011	25%	7%	21%	6%	5%	6%	65%	34%	43%	39%	25%	0.272	27
2010-2012	13%	5%	21%	5%	2%	0%	27%	5%	22%	28%	17%	0.159	17
2011-2013	26%	86%	30%	11%	4%	9%	52%	12%	29%	26%	13%	0.379	28

Figure 2-1 Ranking Score of 3-year Period, 1984-2013



2.4 Top 5 Ranked 3-year Hydrologic Periods

Based on the ranking analysis, the top 5 ranked hydrologic periods are:

- Rank 1: 1994-1996
- Rank 2: 1988-1990
- Rank 3: 2005-2007
- Rank 4: 1989-1991
- Rank 5: 1992-1994

Table 2-4 shows rainfall and river flow statistics for these top ranked hydrologic periods.

Table 2-4 Top 5 Ranked Hydrologic Periods

Rank	Year	Rainfall								Delaware River Flow (cfs)		
		Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1	1994-1996	42.9	1.50	0.08	10.1	65	47	5	7	5,611	9,710	16,775
2	1988-1990	41.0	1.69	0.08	10.5	63	44	5	10	5,598	8,338	13,925
3	2005-2007	43.6	1.55	0.09	10.6	61	45	6	10	6,030	10,450	17,533
4	1989-1991	40.2	1.50	0.08	10.8	63	45	5	10	5,187	8,043	14,467
5	1992-1994	39.2	1.50	0.08	10.6	64	41	5	8	5,070	7,760	13,167
Average 1984-2013		41.3	1.53	0.08	10.7	62	44	5	9	5,540	9,325	15,770

Figure 2-2(a) shows the max rainfall day for each month from 1988 through 2013. Max rainfall day in the month is determined by analyzing the daily rainfall amount and the day with the maximum rainfall amount is selected as the max rainfall day for the month. Max rainfall day in the month is probably the precipitation day that causes the maximum wet weather inflow to the collection system and CSO overflows in the month. **Figure 2-2(b)** shows the river flow and flow statistics for the max rainfall day in the month. The selected typical hydrologic period must ensure that large storm events do not occur under the extremely low river flow conditions. **Figure 2-2** indicates that all the top 5 ranked hydrologic periods meet this criteria.

Rainfall return frequency during 1988 through 2013 was analyzed to understand the distribution of the large rainfall events with return frequencies above 1-year. Rainfall return frequency is shown for each month in **Figure 2-2** (the number in the parentheses indicates the quantity of rain events at the return frequency). **Table 2-5** summarizes quantity of large rainfall events with return frequencies for the top 5 ranked hydrologic periods.

- All of the top 5 hydrologic periods have a 25-yr storm.
- Hydrologic period 1994-1996 (Rank 1) contains one 25-yr storm, one 10-yr storm and three 1-year storm. Hydrologic period 1988-1990 (Rank 2) contains one 25-yr storm, one 10-yr storm, three 2-year storm and one 1-year storm.
- Hydrologic period 1994-1996 (Rank 1) is more conservative because its annual average rainfall amount of 42.9" is slightly greater than the 30-yr average. It is considered a better option than hydrologic period 1988-1990 (Rank 2), which has a slightly less annual rainfall than the average.

Table 2-5 Rainfall Return Frequency Summary for the Top 5 Ranked Hydrologic Periods

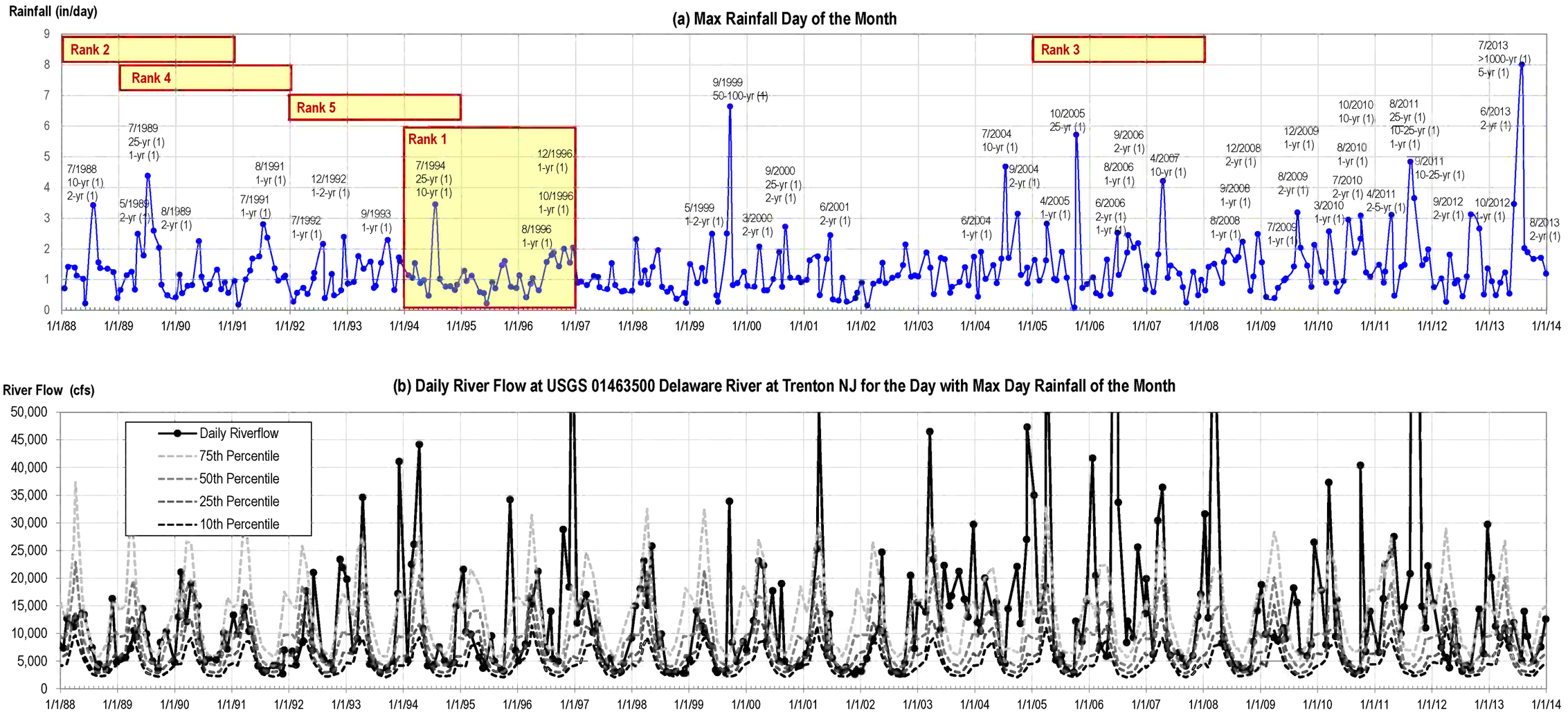
Rank	Year	Quantity of Rainfall Events with Return Frequency above				
		25-yr	10-yr	5-yr	2-yr	1-yr
1	1994-1996	1	1			3
2	1988-1990	1	1		3	1
3	2005-2007	1	1		2	4
4	1989-1991	1			2	3
5	1992-1994	1	1			3

The analysis was also conducted with an IET of 12 hours, and the top five ranked hydrologic periods were shown in **Table 2-6**. The top four hydrologic periods based on the IET of 12 hours are the same as the analysis based on the IET of 6 hours, which include the 3-year period 1994 - 1996 remaining as Rank 1.

Table 2-6 Top 5 Ranked Hydrologic Periods (IET = 12 hr)

Rank	Year	Rainfall								Delaware River Flow (cfs)		
		Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1	1994-1996	42.9	1.50	0.08	12.5	62	47	6	4	5,611	9,710	16,775
2	1988-1990	41.0	1.69	0.07	13.9	59	43	6	5	5,598	8,338	13,925
3	2005-2007	43.6	1.55	0.08	14.3	55	43	6	5	6,030	10,450	17,533
4	1989-1991	40.2	1.50	0.06	14.9	57	43	5	4	5,187	8,043	14,467
5	2007-2009	44.3	1.42	0.08	14.6	60	42	8	6	6,277	9,625	17,733
Average 1984-2013		41.3	1.53	0.07	14.1	58	43	6	5	5,540	9,325	15,770

Figure 2-2 Max Day Rainfall in the Month and Delaware River Daily Flows 1988-2013



2.5 Recommendation

It is recommended the 3-year period 1994-1996 (Rank 1) be selected as the typical hydrologic period for the CSO LTCPU. This period contains a wide range of storms and antecedent conditions. The hydrologic period of 1994-1996 is also evaluated for longer historical rainfall records up to 100 years. It is ranked No. 1 for the 50-years record and No.2 for the 100-year records (**Table 2-7**).

Table 2-7 Rank of Hydrologic Period 1994-1996 from Various Rainfall Data Set

	30-year Rainfall Records, 1984-2013	50-year Rainfall Records, 1964-2013	100-year Rainfall Records, 1914-2013
Rank of 1994-1996	1	1	2 (1925-1927 as Rank 1)

2.6 Additional Information on Statistical Analysis of Rainfall and River Flow Data

Figure 2-3 shows annual rainfall and average annual rainfall for years 1983-2013. The hydrologic period 1994-1996 contains a relatively wet year (1996 with 52.1 inches), a dry year (1995 with 31.6 inches) and a year close to average conditions (1994 with 44.9 inches).

Figure 2-4 shows annual average Delaware River flow and average flow for years 1983-2013. The hydrologic period 1994-1996 contains a relatively high flow year (1996 with 19,000 cfs), a low flow year (1995 with 9,000 cfs) and a year close to average conditions (1994 with 13,500 cfs).

Figure 2-3 Annual Rainfall 1983 - 2013

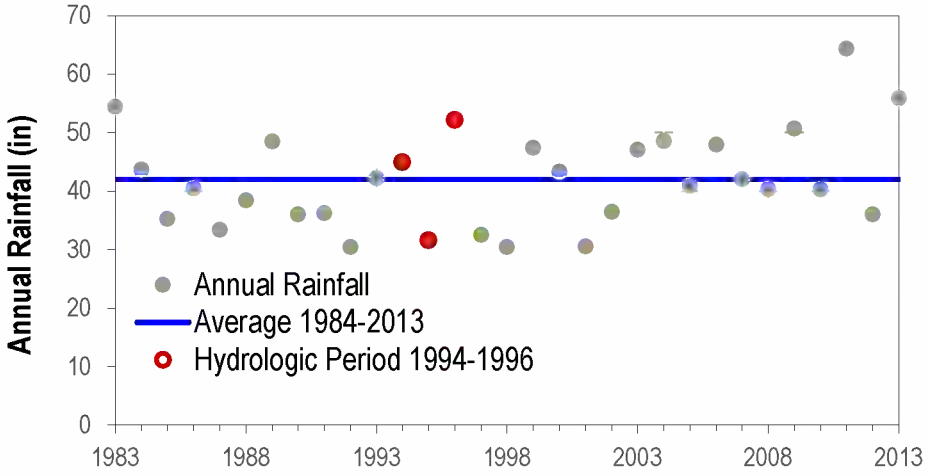
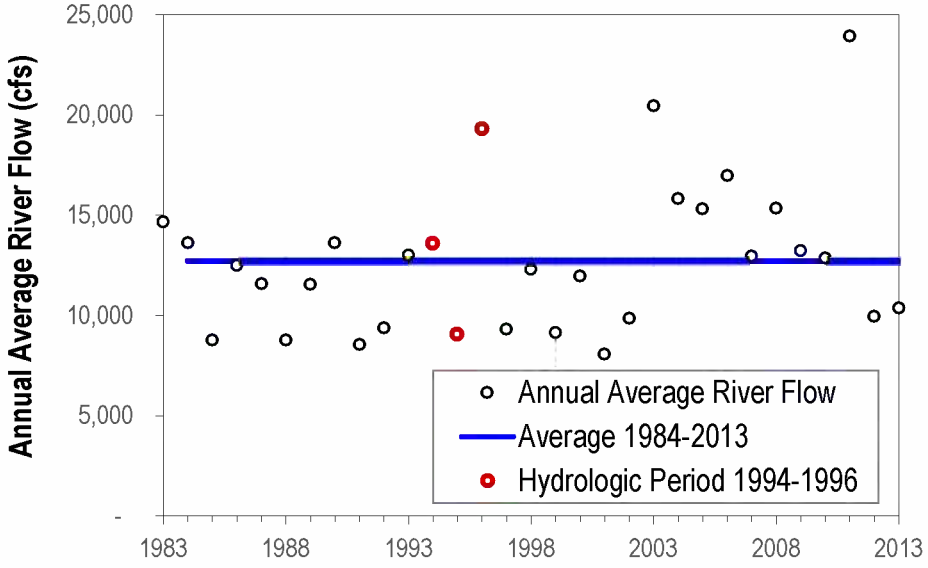


Figure 2-4 Annual Average Delaware River Flow 1983 - 2013



Delaware River flow distribution was developed for each calendar day using 100 years of records from 1913 to 2013, as shown in **Figure 2-5**. The River flow varies through the year with high flow season around March-April, and low flow season around June-August. **Figure 2-6** shows the Delaware River flow distribution during rainfall events at and above 1-year return frequency. Each dot on the plot represents an individual day during the storm events. It is observed that the river flows have a wide range of distribution during rainfall events below 2-yr return frequency. During larger storm events (greater than 5-year storms), the river flows tend to be relatively higher, as indicated by more dots with higher distribution percentiles on the plot. For example, during most of the 10-year storm events, the river flows are above the 35th percentile. In rare cases, large storm events occurred during a relatively low flow condition (e.g., the lowest dot for the 10-year storm), which is not a typical condition.

Figure 2-5 Delaware River Daily Flow Distribution

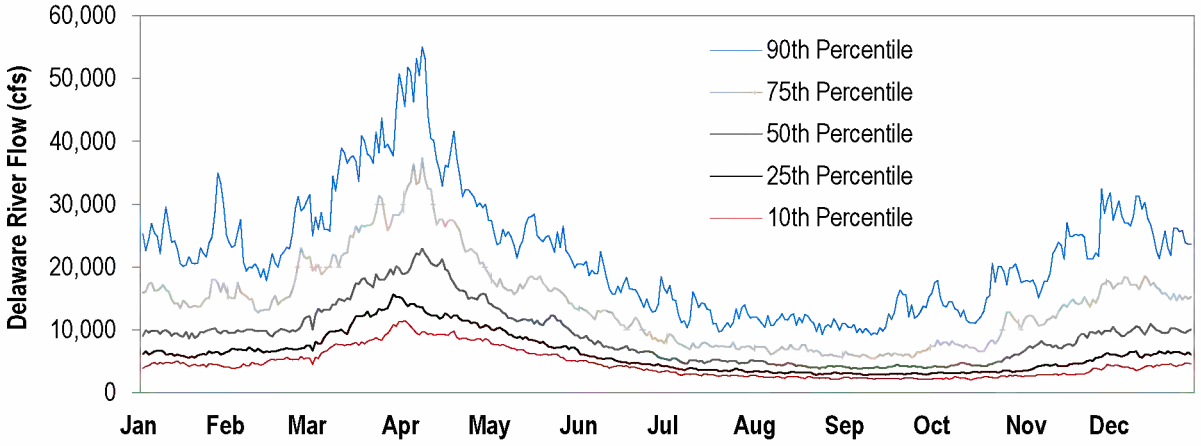


Figure 2-6 River Flow Distribution during Rainfall Events Greater Than 1-year Return Frequency

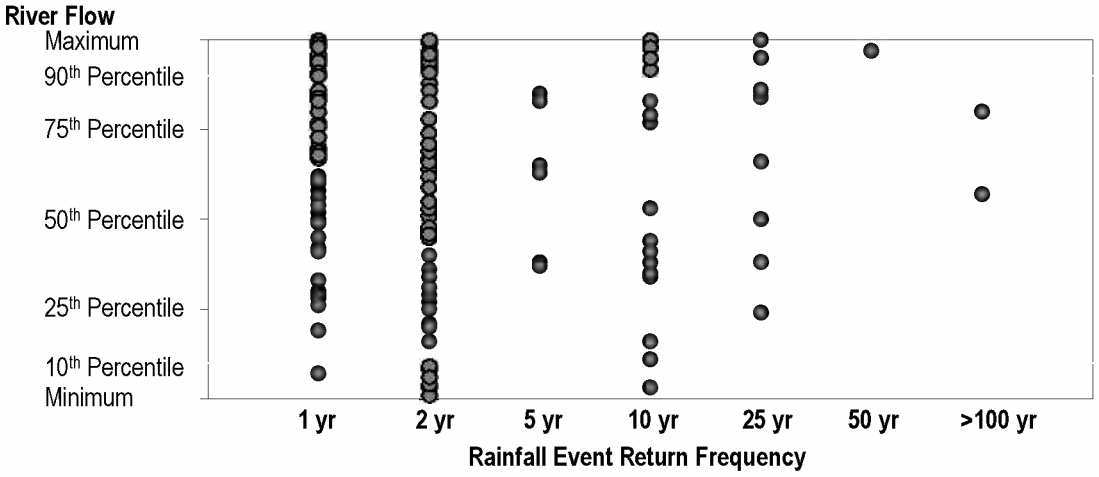


Figure 2-7 shows the daily rainfall profile and daily Delaware River flow hydrograph for the hydrologic period 1994-1996. This period includes two large storm events in July 1994 (a 10-year storm in July 14, 1994 and a 25-year storm in July 18, 1994). During these large storm events, the River flows were around 40th to 50th percentile (**Figure 2-8**). This is consistent with the typical trend shown in **Figure 2-6**. **Figure 2-9** shows Chester Creek and Ridley Creek flows in July 1994, it is obvious that creek flows are highly influenced by local precipitation and the big storms in July 1994 resulted in high creek flows.

Characteristics of the top 10 storms (by rainfall depth) in each year of the hydrologic period 1994-1996 are shown in **Table 2-8**, **Table 2-9**, and **Table 2-10**.

Figure 2-7 Daily Rainfall and River Flow Conditions 1994-1996

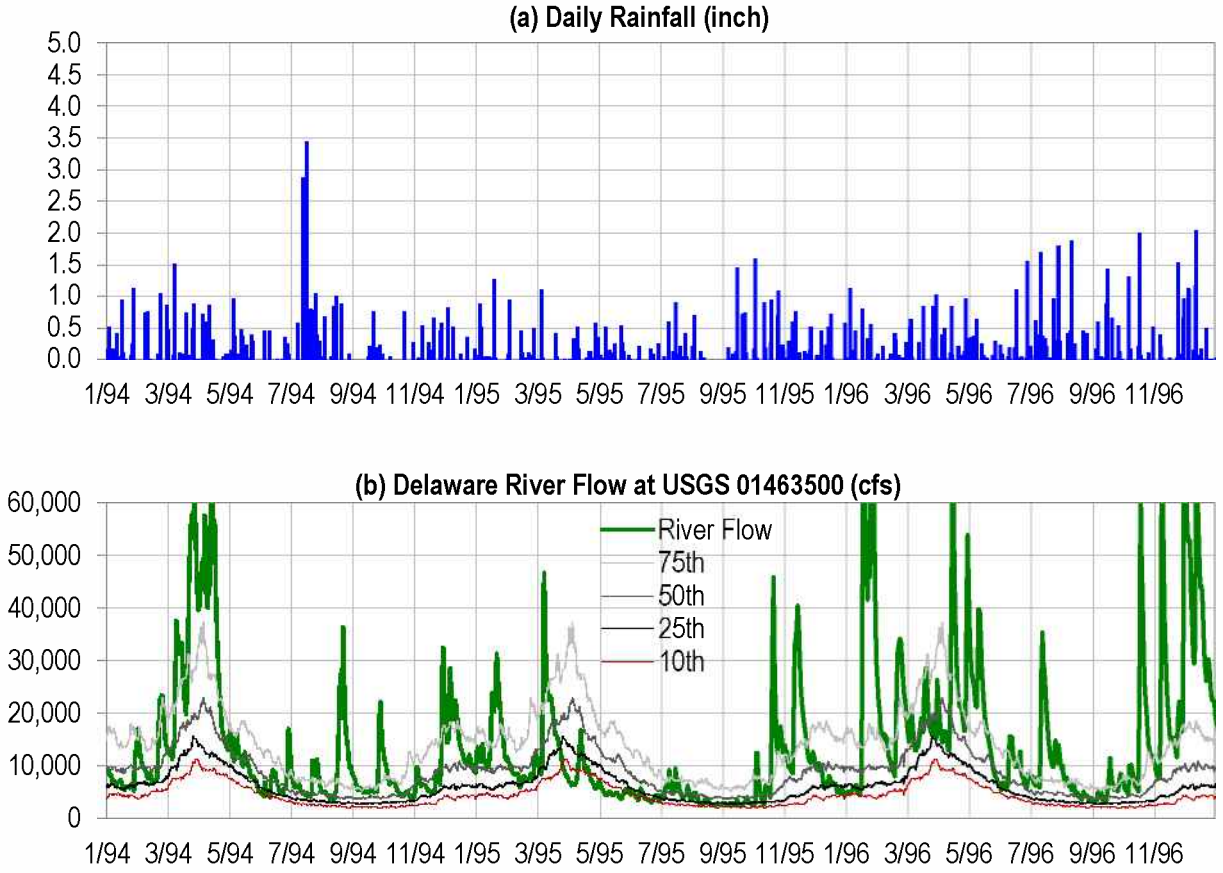


Figure 2-8 Rainfall and River Flow in July, 1994

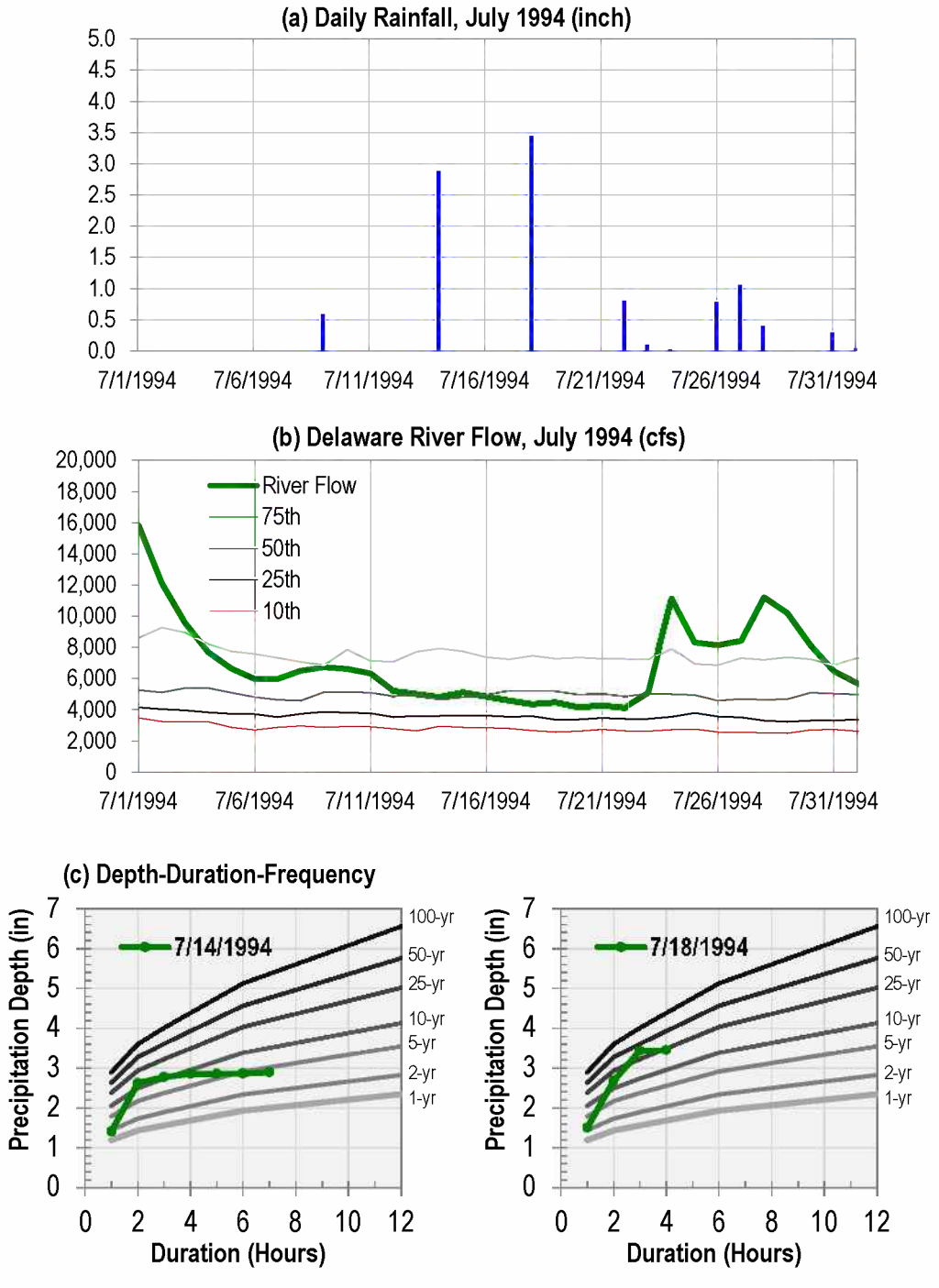


Figure 2-9 Rainfall and Creek Flow in July, 1994

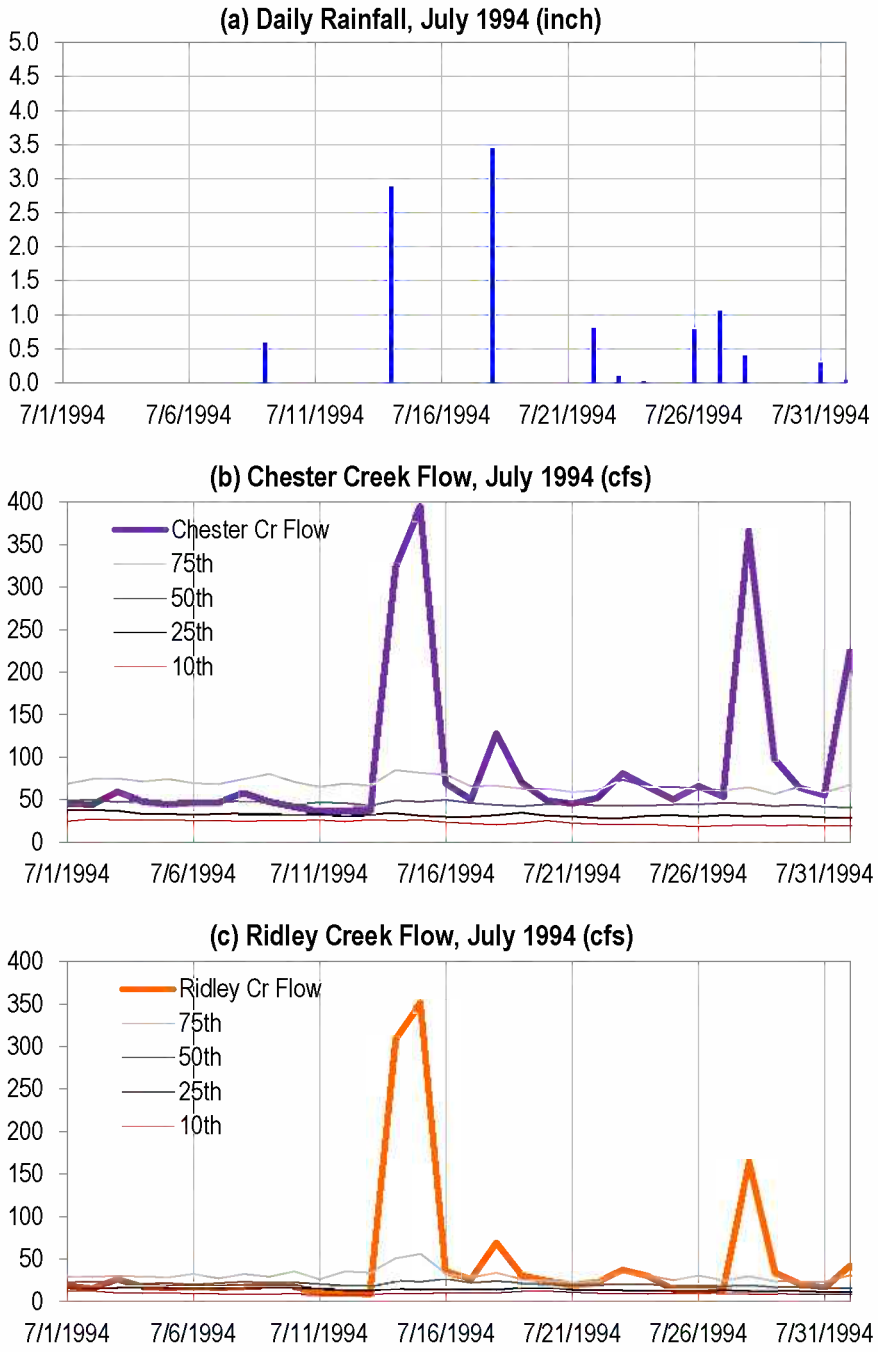


Table 2-8 Ten Largest Storms and Return Frequencies in 1994

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	7/18/1994 7:00	3.45	4	1.5	25-yr
2	7/14/1994 15:00	2.89	7	1.41	10-yr
3	3/9/1994 11:00	2.00	27	0.37	< 1 year
4	8/21/1994 19:00	1.76	18	0.49	< 1 year
5	3/28/1994 0:00	1.41	37	0.14	< 1 year
6	5/7/1994 15:00	1.37	15	0.25	< 1 year
7	3/2/1994 9:00	1.32	22	0.14	< 1 year
8	1/27/1994 19:00	1.15	20	0.2	< 1 year
9	7/27/1994 17:00	1.11	8	0.49	< 1 year
10	1/17/1994 10:00	1.07	18	0.18	< 1 year

Table 2-9 Ten Largest Storms and Return Frequencies in 1995

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	10/4/1995 18:00	1.82	33	0.54	< 1 year
2	10/27/1995 20:00	1.81	13	0.5	< 1 year
3	9/16/1995 22:00	1.6	13	0.24	< 1 year
4	1/6/1995 18:00	1.43	11	0.27	< 1 year
5	1/20/1995 0:00	1.25	10	1	< 1 year
6	10/20/1995 21:00	1.21	16	0.52	< 1 year
7	3/8/1995 17:00	1.16	8	0.29	< 1 year
8	10/14/1995 7:00	1.12	21	0.25	< 1 year
9	2/3/1995 22:00	1.04	15	0.2	< 1 year
10	7/17/1995 22:00	1.00	4	0.48	< 1 year

Table 2-10 Ten Largest Storms and Return Frequencies in 1996

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	12/13/1996 13:00	3.03	33	0.27	1-yr
2	8/12/1996 19:00	2.34	13	0.52	1-yr
3	9/16/1996 14:00	2.26	16	0.38	< 1 year
4	10/18/1996 16:00	2.22	19	0.54	1-yr
5	7/12/1996 15:00	2.11	22	0.4	< 1 year
6	12/1/1996 7:00	1.62	23	0.56	< 1 year
7	6/29/1996 22:00	1.61	17	0.26	< 1 year
8	11/25/1996 23:00	1.58	10	0.38	< 1 year
9	7/31/1996 20:00	1.48	4	1.03	< 1 year
10	10/8/1996 10:00	1.32	11	0.24	< 1 year

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GREELEY AND HANSEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

MAY 23 2016

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Michael J. DiSantis, Director
Operations & Maintenance
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Disantis:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Typical Hydrologic Period Report (Updated April 2016). EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA hereby approves the subject plan.

Thank you for your continued cooperation with this matter. Please do not hesitate to contact me at (215) 814-2097 if you have any questions.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DiSantis, DELCORA
S. O'Neil, PaDEP SERO
J. Fields, PaDEP SERO

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APPENDIX F

Sewer System Hydrologic and Hydraulic Model Report

- DELCORA Sewer System Hydrologic and Hydraulic Model Report dated June 2017
- Updated Appendix C Updated March 1, 2018 to address USEPA and PADEP Comments Received January 2, 2018
- USEPA Approval of the Sewer System Hydrologic and Hydraulic Model Report dated April 17, 2018

Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Sewer System Hydrologic and Hydraulic Model Report

June 2017

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Sewer System Hydrologic and Hydraulic Model Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	6/27/17 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	6/27/17 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	6/27/17 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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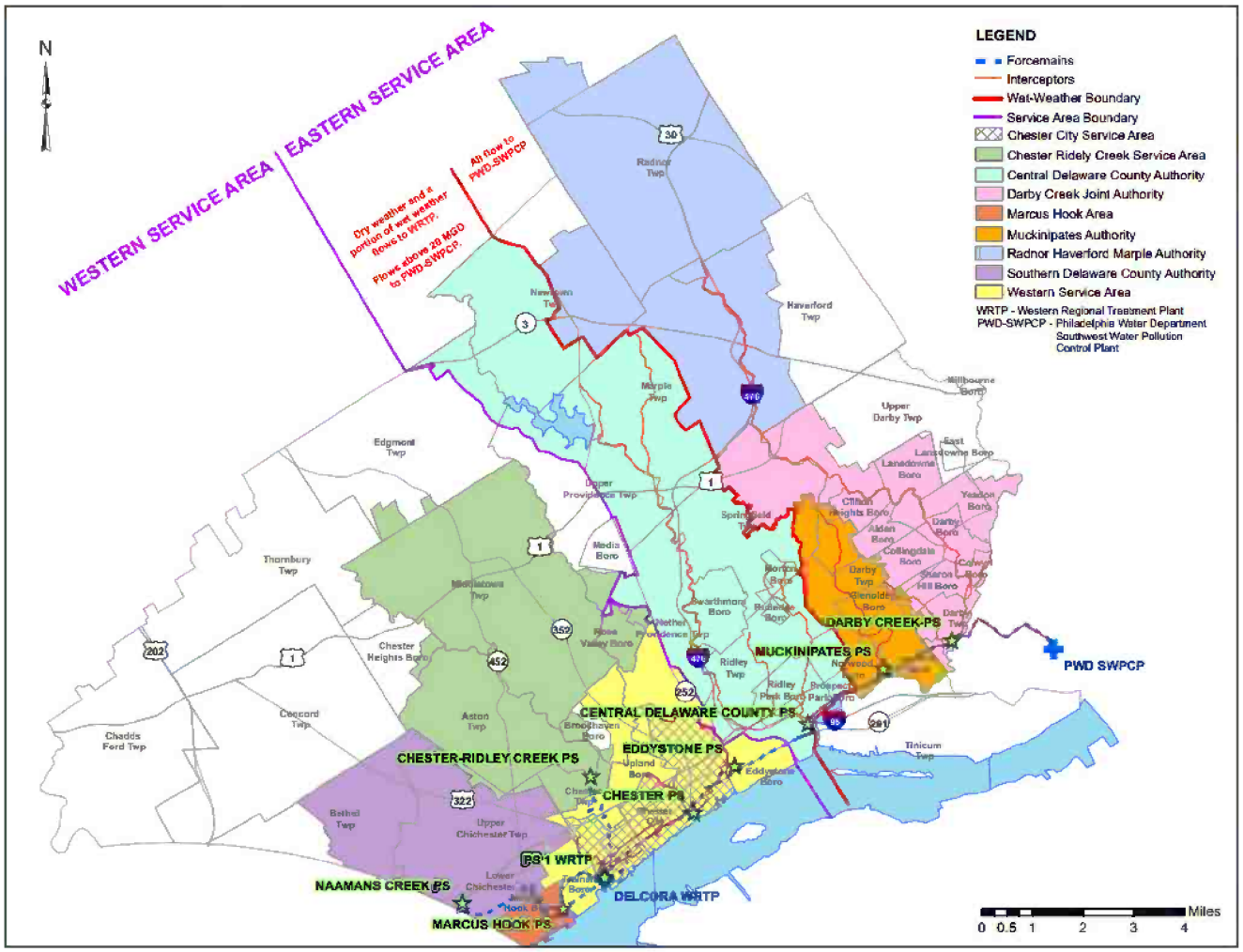
Section 1 Introduction

1.1 DELCORA's Service Area

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the safe collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The interconnectivity coupled with the legal agreements that DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates. The total service area served by DELCORA is approximately 82,977 acres, as shown on Figure 1-2: DELCORA'S Service Area



, which illustrates that DELCORA serves a significant and widespread portion of Delaware County. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The combined sewer area simulated in the model, also shown in Figure 1-2, is located within the Chester City. It comprises approximately 49% of the Chester City's serviced area.

DELCORA has characterized its service areas as "Eastern" and "Western." Historically, the Eastern service area discharged to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWPCP) while the Western Service Area discharged to DELCORA's Western Regional Treatment Plant (WRTP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area now discharges to the WRTP while only those CDPS flows above 20 MGD are to be directed to the PWD-SWPCP.

Eastern Service Area

The DELCORA Eastern Service Area is composed of four subareas that are served by conveyance authorities: Radnor Haverford Marple (RHM) Authority, Darby Creek Joint Authority (DCJA), Muckinipates Authority (MA), and Central Delaware County Authority (CDCA) and are delineated in Figure 1-2. Each of these authorities has a legal agreement with their member municipalities to dispose of their wastewater. In turn, DELCORA has legal agreements with each of the authorities, except RHM, to receive, treat, and dispose of the collected wastewater. RHM discharges to the DCJA. DELCORA owns and operates three large pump stations that serve DELCORA's Eastern service area; they are the Central Delaware Pump Station, the Muckinipates Pump Station, and the Darby Creek Pump Station. These pump stations were originally designed to pump the wastewater from DELCORA's Eastern Service Area to PWD-SWPCP for treatment.

The Central Delaware Pump Station (serving CDCA) is rated for 40 MGD. It was constructed in the 1970s to discharge all flow through a force main that is routed northeast toward the Muckinipates Pump Station. The operation of the pump station had been modified in 2002 to allow for flow from the CDPS to be discharged to the WRTP. Currently the wastewater flows above 20 MGD are conveyed to PWD-SWPCP. The next pump station is the 24-MGD Muckinipates Pump Station (serving MA). Here, the force main increases to 48 inches in diameter and continues approximately 1.65 miles northeast to the Darby Creek Pump Station. Upon reaching the 60-MGD Darby Creek Pump Station (serving DCJA and RHM), the force main increases in diameter to 66 inches and continues approximately 2.5 miles for ultimate discharge at PWD-SWPCP.

Under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall 001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow (CSO) outfalls (002-026, 032, 033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

There are a total of 26 combined sewer overflow (CSO) outfalls listed with 25 discharge points (Outfalls 009 and 010 both discharge at Outfall 009) in DELCORA's existing NPDES Permit.

1.2 DELCORA's Consent Decree

DELCORA prepared and submitted their original Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the PADEP in 1999. This LTCP was subsequently approved by the PADEP, and DELCORA had started to implement the CSO control elements selected in the LTCP. In 2009, the United States Environmental Protection Agency (USEPA) informed DELCORA that the original LTCP was not in compliance with the requirements of the USEPA's CSO Policy. As such, DELCORA prepared and submitted a revised LTCP in April 2012. Subsequent to the receipt of the revised LTCP, DELCORA and the USEPA had corresponded various times including requests for additional information from the USEPA in accordance with Section 308 of the Clean Water Act. A Consent Decree was issued by the USEPA to DELCORA in June 2015. A Consent Decree was ultimately executed between DELCORA, the Pennsylvania Department of Environmental Protection (PADEP) and USEPA, was lodged on August 17, 2015 and was approved by the Federal District Court on November 10, 2015. The final Consent Decree requires that a new LTCP be prepared based on a 42-month schedule from the date of lodging (August 17, 2015), which includes interim deliverables and milestones that must be met.

DELCORA's original Hydrologic and Hydraulic Model (H&H Model) was updated to meet the requirements in Section V.A.14.a-f of the Consent Decree. These requirements along with a description of submissions made to comply with these requirements appear in Table 1-1.

Figure 1-1: DELCORA's Conveyance System

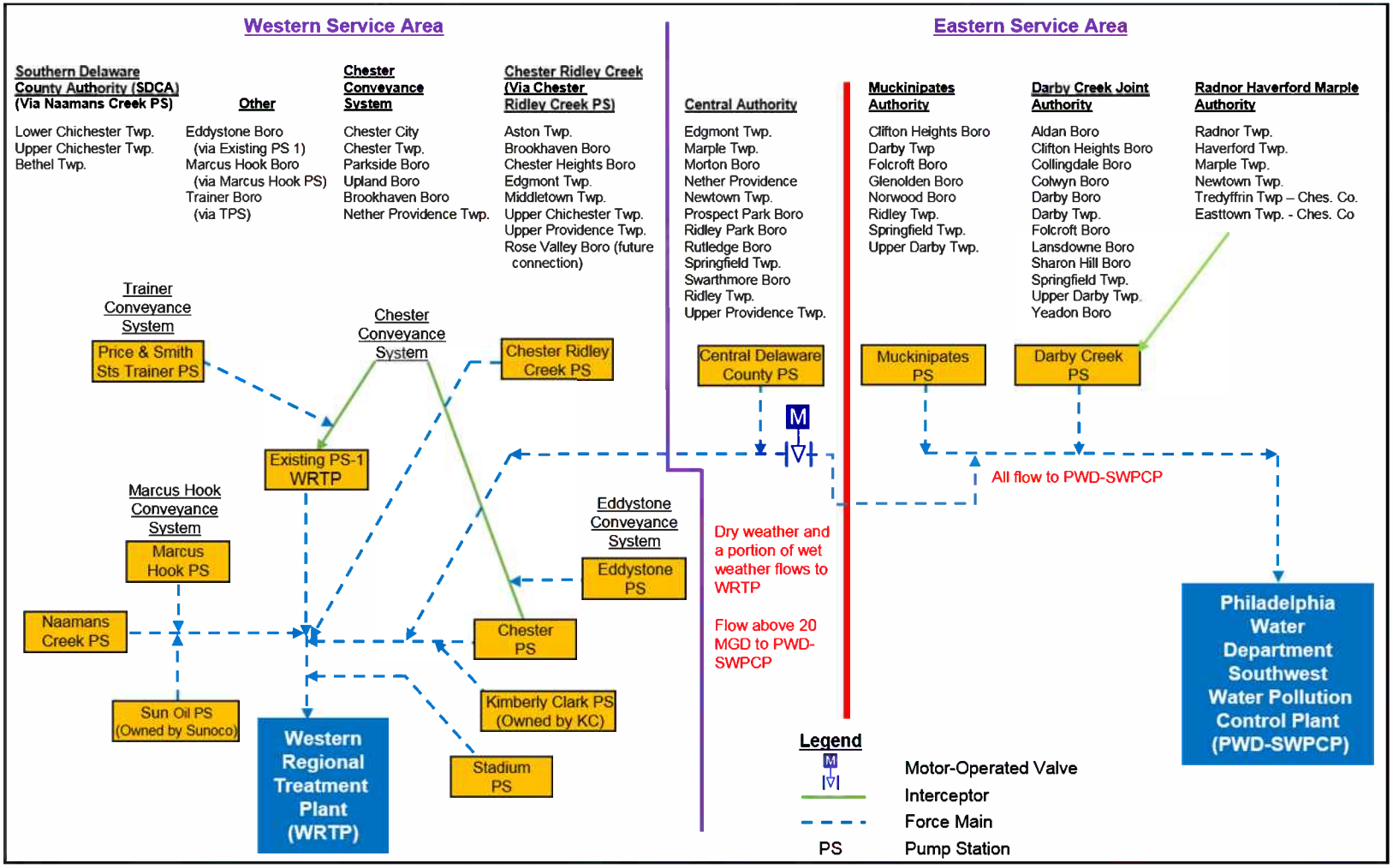


Figure 1-2: DELCORA'S Service Area

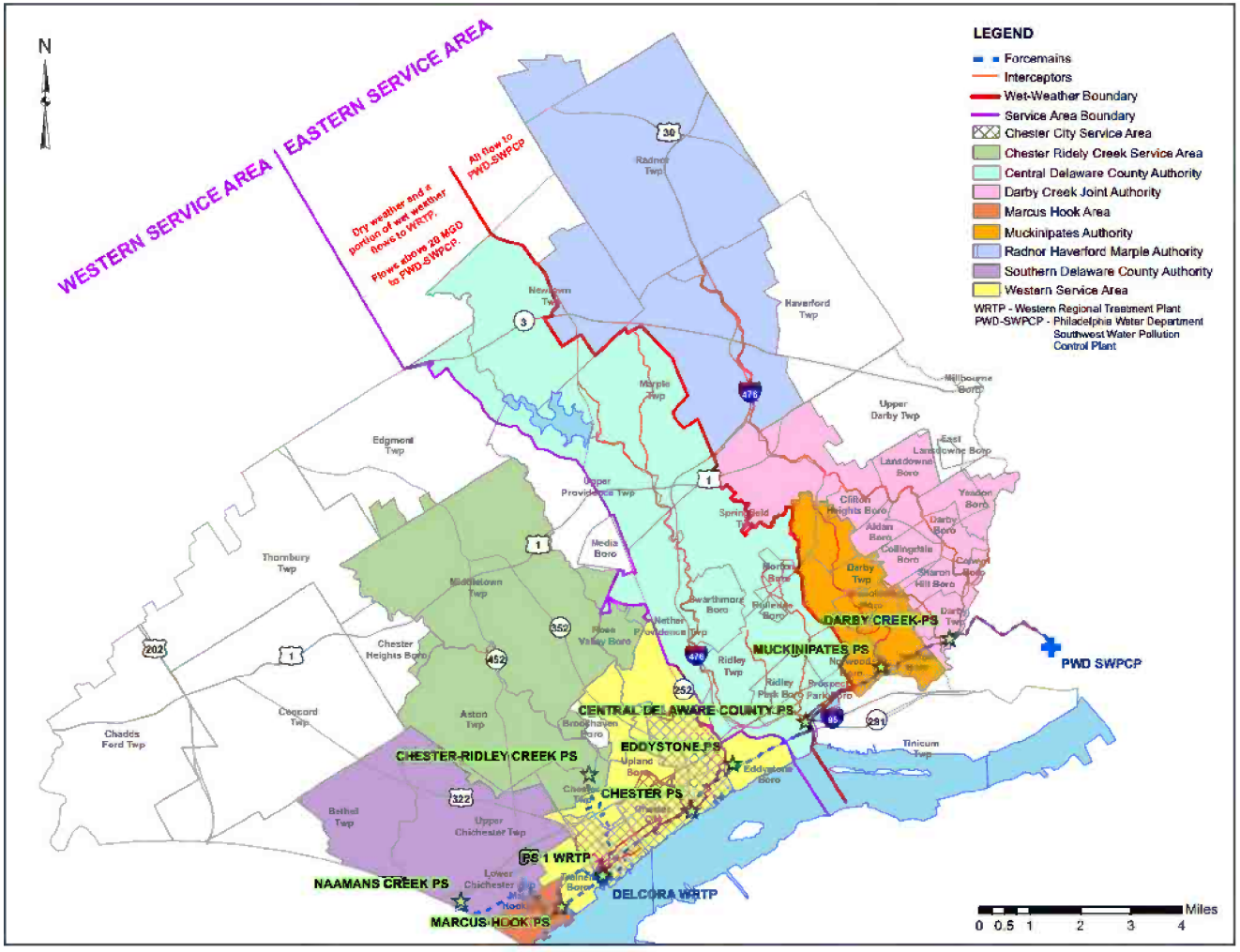


Table 1-1: Summary of Consent Decree Section V.A.14

Consent Decree Requirement	Submission Addressing Consent Decree Requirement
§V.A.14.a *a. Not later than sixty (60) Days after the Date of Lodging of this Consent Decree, DELCORA shall submit a detailed plan to update, calibrate, and validate the H&H Model to Plaintiffs for review and approval pursuant to Section VI (Review and Approval of Submittals). The plan shall address:* *(i) Model Update Methodology.* *(ii) Hydrologic and Hydraulic Model Refinement.* *(iii) Flow Data Assessment, and additional Rainfall and Flow Monitoring to be Carried Out.* *(iv) Dry Weather Flow Calibration, including quantitative and qualitative calibration criteria.* *(v) Wet Weather Flow Calibration, including quantitative and qualitative calibration criteria.* *(vi) Model Validation; and* *(vii) Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to this Consent Decree.",*	Addressed through submission of the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015) submitted on October 15, 2015 USEPA approved the plan on March 1, 2016. Schedule revised on July 28, 2016. Revised schedule can be found in Appendix A.
§V.A.14.b *b. The updated H&H Model shall specifically include hydrologic representation of all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area")."*	

Consent Decree Requirement	Submission Addressing Consent Decree Requirement
§V.A.14.c *c. The H&H Model shall accurately represent the response of the Model Area to wet weather events, including the flows that result from wet weather events to and from DELCORA's CSOs and to the WRTP. To accomplish this, the model shall explicitly include all interceptors, diversion structures, CSOs, pump stations and major trunk sewers within the Collection System, as well as such pipes and appurtenances within the areas outside the Collection System that are needed to ensure adequate H&H Model accuracy. The H&H Model shall also include all sewers required for model continuity and/or that hydraulically impact or are downstream of known chronic unpermitted releases. DELCORA shall investigate and collect current system attribute information as necessary to update the H&H Model.",*	Revisions to H&H model characterization of the system described in Section 3 of this report. Calibration and verification of model described in Section 4 of this report.
§V.A.14.d *d. Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve (12) months, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*	Rainfall and flow monitoring approach described in Section 2 of this report Rainfall and flow monitoring data described in prior quarterly reports (see below) Minimum effective density of 1 gauge/virtual radar based gauge per square km was obtained as described in Section 2 of this report.
§V.A.14.e *e. For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data.*	Addressed through submission of the *Rainfall and Flow Monitoring Quarterly reports.* 1st Quarter: August 08, 2016 2nd Quarter: November 01, 2016 3rd Quarter: February 01, 2017 4th Quarter: May 01, 2017

Consent Decree Requirement	Submission Addressing Consent Decree Requirement
§V.A.14.f *Within 30 Days after the H&H Model is revised, calibrated, and validated in accordance with the schedule set forth in the plan, DELCORA shall submit a Sewer System H&H Model Report to Plaintiffs for review and approval in accordance with the requirements of Section VI (Review and Approval of Submittals). The Sewer System H&H Model Report shall specifically address each item set forth in Subparagraphs 14(a)(i)-(vii) hereof."*	Addressed through submission of the *Sewer System H&H Model Report*.

In order to comply with Sections V.A.14.d.and e of the Consent Decree, the 12-month rainfall and flow monitoring period was completed on March 31, 2017 and quarterly rainfall and flow monitoring memoranda were submitted.

The outstanding requirements described in Sections V.A.14b, c and f will be addressed in this Sewer System H&H Model Report (hereinafter referred to as Report). This Report will evaluate the Model Area comprising those areas hydraulically connected to the WRTP. Section V.A.14.b of the Consent Decree describes the Model Area as follows:

> *"b. The updated H&H Model shall specifically include hydrologic representation of all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area")."*

As shown in the schematic of DELCORA's conveyance system (see Figure 1-1), the conveyance system is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to, and thus is hydraulically connected to, DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows to the PWD-SWPCP and cannot pump flow to the WRTP. Therefore, municipalities connected to these pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area. In summary, the Model Area includes the municipalities in the Western Service Area plus those municipalities that are connected to the Central Delaware Pump Station, as described in Table 1-2.

Table 1-2: Model Area

Municipality ID No.	Municipality	Service Area
1	Aston Township	Western
2	Bethel Township	Western
3	Brookhaven Borough	Western
4	Chester City	Western
5	Chester Township	Western
6	Eddystone Borough	Western
7	Edgmont Township	Eastern
8	Lower Chichester Township	Western
9	Marcus Hook Borough	Western
10	Marple	Eastern
11	Middletown Township	Western
12	Morton	Eastern
13	Nether Providence*	Eastern and Western
14	Newtown Township	Eastern
15	Parkside Borough	Western
16	Prospect Park	Eastern
17	Ridley Park Borough	Eastern
18	Ridley Township	Eastern
19	Rose Valley Borough	Western
20	Rutledge	Eastern
21	Springfield	Eastern
22	Swarthmore	Eastern
23	Trainer Borough	Western
24	Upland Borough	Western
25	Upper Chichester Township	Western
26	Upper Providence Township	Eastern and Western

As outlined in the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015) and in conformance with Section V.A.14.c, the original H&H model was evaluated and updated as necessary to ensure inclusion of necessary components of the collection and conveyance system.

In addition, this Report includes results of the gauge-adjusted rainfall analysis (GARR) to demonstrate compliance with the requirement of Sections V.A.14.d that "…*Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area.*"

1.3 Contents in This Report

This report was prepared based on the requirements listed in the Consent Decree. The purpose of this document is to describe the development, calibration and validation of the updated sewer collection system H&H model. The 2012 H&H model was expanded to the Model Area and updated as needed to reflect current hydrologic and hydraulic conditions of DELCORA's collection system. After updating, the revised model was calibrated and validated with the additional rainfall and flow monitoring data so it can then be used to assist the Delaware County Regional Water Authority (DELCORA) throughout its combined sewer overflow (CSO) long-term control plan (LTCP) update process. Table 1-3 lists individual sections of this Report and their contents.

Table 1-3: DELCORA Sewer System H&H Model Report

Section	Description
Section 1 Introduction	Section 1 introduces DELCORA's system, Consent Decree requirements and the purpose of this report.
Section 2 Rainfall and Flow Monitoring	Section 2 provides an overview of the rain gauge and flow monitoring program and data analysis process for model input.
Section 3 DELCORA H&H Model Update	Section 3 summarizes the review of the original H&H model, describes general methodology used in the model update, and details the model updates made to the service area delineation, combined and separated area delineation, model network extension, regulator, and model inputs.
Section 4 DELCORA H&H Model Calibration and Validation	Section 4 provides a description of calibration and validation, lists criteria for dry weather and wet weather calibration, and illustrates calibration and validation method and results.
Section 5 Conclusion	Section 5 provides a short summary of the H&H Model Update, including model calibration results.

Section 2 Rainfall and Flow Monitoring

As per the Consent Decree, DELCORA was required to perform a Rainfall and Flow Monitoring program for at least 12 months and submit quarterly reports to document the findings of the program. This program started on March 18, 2016 and was completed on April 4, 2017. The rainfall and flow monitoring data were collected on a monthly basis. This section will discuss the network of rainfall and flow monitoring instrumentation, outline the monitoring program, and describe how the data collected for the Rainfall and Flow Monitoring Program was analyzed for use in the H&H Model calibration and validation.

2.1 Rainfall Monitoring and Analysis

A total of six (6) rain gauges were used for the monitoring program. As shown in Figure 2-1, the gauges are stationed at the following locations:

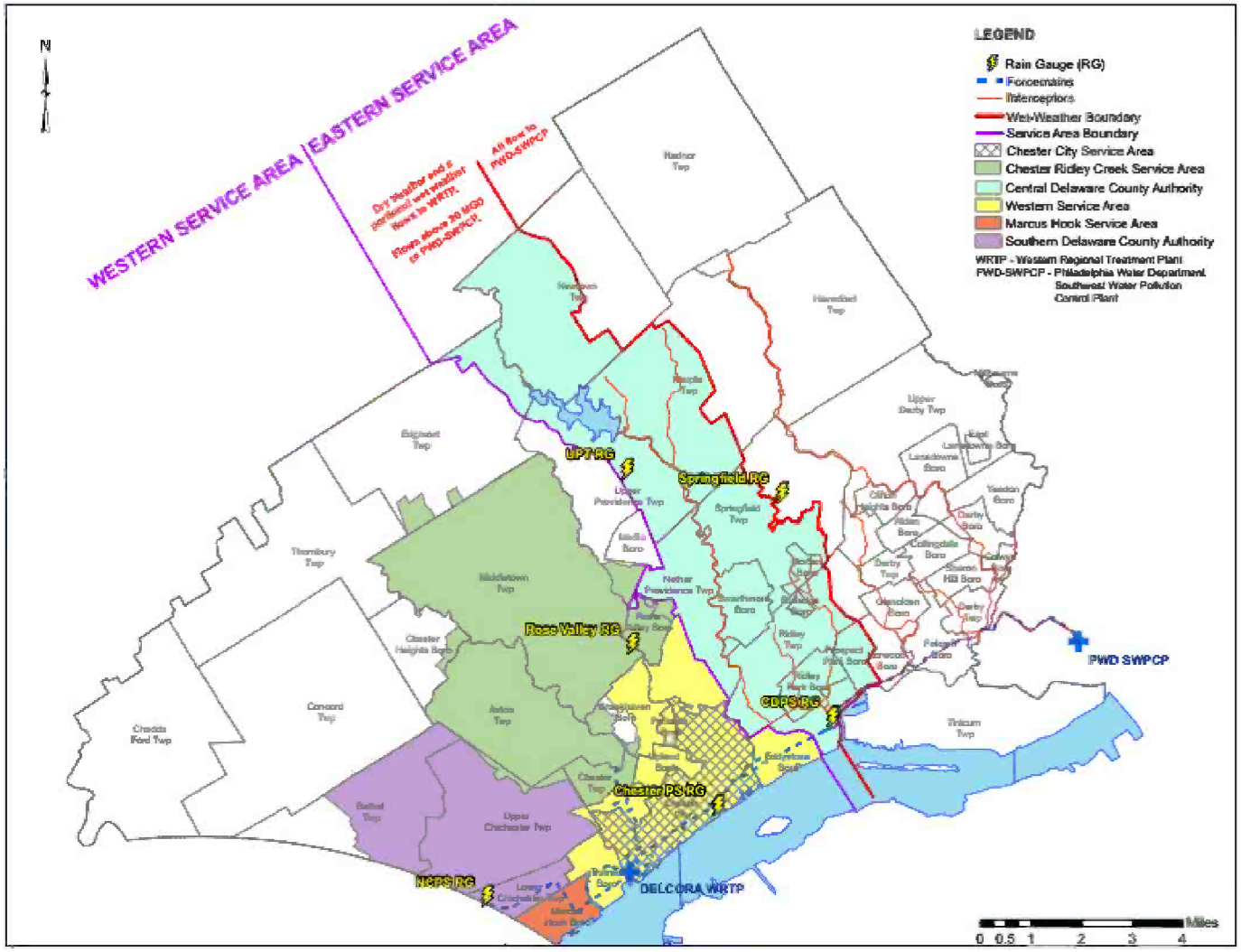
- Rose Valley
- Chester Pump Station (CPS)
- Naaman's Creek Pump Station (NCPS)
- Springfield
- Upper Providence Township (UPT)
- Central Delaware County Pump Station (CDPS)

Five out of six of the gauges provided data at 5 minute intervals. One rain gauge provided data on 15-minute intervals. According to the Consent Decree, rainfall data to be used for calibration and validation of the model *"…shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per kilometer"*. In order to achieve this density, Gauge-Adjusted Radar Rainfall (GARR) was employed. The rain gauges used to complete the flow monitoring program and choose the wet weather events used in calibration and validation were also used in the GARR analysis which provided effective spatial coverage of the entire Model Area. The gauge rainfall data from the six rain gauges installed throughout the DELCORA service area was analyzed and used to:

- Document rainfall and flow monitoring locations,
- Overview flow monitoring data quality,
- Analyze rainfall data to identify dry weather and wet weather conditions and to characterize individual rainfall event for precipitation depth, duration, maximum intensity, and return frequency,
- Analyze flow data to determine dry weather flow and diurnal pattern, wet weather flow and peak factor, and system response to wet weather events, and
- Determine the wet weather events for H&H Model calibration and validation.

An inter-event time of 48 hours was used to identify individual rainfall events. The inter-event time specifies the minimum duration in which precipitation does not occur. Based on this criterion, a dry weather time period and the number of total rainfall events were identified. The rainfall events during the

Figure 2-1: Rain Gauge Locations



flow monitoring periods had a wide variation in terms of total depth, intensity, duration, and antecedent conditions to provide a large dataset for balanced model calibration and validation.

The rainfall events were characterized by event start time, event end time, rainfall depth, duration, maximum intensity, and return frequency. As an initial screening criterion, rainfall events with a minimum of 0.9 inches of rainfall were identified. Further screening based on requiring at least two dry days prior to the event resulted in an initial list of ten (10) candidate events for calibration and validation (see Table 2-1).

Table 2-1: Top 10 Rainfall Events

Event	Event Start	Event End	Chester-PS Rainfall (in)	Duration (hr)	Max Intensity (in/hr)
E1	5/29/16 19:00	5/30/16 5:00	1.82	11.00	0.78
E2	9/28/16 12:00	9/30/16 10:00	2.36	47.00	0.37
E3	11/29/16 7:00	11/29/16 20:00	1.08	14.00	0.21
E4	3/30/17 21:00	4/1/17 3:00	1.83	31.00	0.25
E5	5/21/16 11:00	5/22/16 21:00	1.71	35.00	0.33
E6	7/28/16 15:00	7/29/16 9:00	1.26	19.00	0.74
E7	9/19/16 8:00	9/19/16 16:00	0.96	9.00	0.42
E8	3/13/16 18:00	3/14/16 14:00	1.08	21.00	0.25
E9	5/6/16 4:00	5/7/16 11:00	1.18	32.00	0.24
E10	10/8/16 14:00	10/9/16 11:00	1.00	22.00	0.15

2.2 Flow Monitoring

DELCORA owns and operates a flow monitoring network across the DELCORA Service Area. The monitoring network includes various types of flow meters located throughout DELCORA's Eastern Service Area and Western Service Area, at the WRTP, in each of the Pump Stations, and at the tie-in points where other municipal collection systems tie-into the collection system. Seven existing flow meters in the separated area (outside the CSO area), eight existing flow meters at pump stations and one existing flow meter at WRTP were used for the calibration and validation of the H&H Model. In addition, temporary flow meters were installed at 38 new locations to characterize surface runoff from the combined area and CSO discharges. The locations of flow meters installed specifically for the flow monitoring program and the H&H Model calibration and validation can be categorized into the following five categories:

1. Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
2. Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
3. Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.

4. Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
5. Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

Table 2-2 lists the flow meter locations and location categories of the meters. Figures 2-2 and 2-3 show the locations of the flow meters that were used for H&H Model calibration and validation. After initial installation of the new temporary flow meters, difficulties were encountered at Manhole MH3029. The site was severely surcharged during field investigation. Meanwhile it was found that at Manhole MH3002 (four manholes upstream of MH3029, approximately 800 feet upstream) another existing flow meter (Ridley Creek MH-28) was already installed for DELCORA. Instead of installing a new temporary flow meter around the site, the existing meter Ridley Creek MH-28 was used for the flow monitoring program. Data was gathered from a total of 55 flow meters, 38 of which were newly installed as part of the flow monitoring program.

The network of flowmeters can be grouped to define metersheds where flow from a given area discharges through a common flowmeter. Subcatchments associated with each metershed are shown in Table 2-3 along with the associated metershed acreage. Rainfall and flow data gathered for each metershed will be used to calibrate the associated subcatchments in the H&H Model.

2.3 Dry Weather Flow (DWF) Analysis

A "dry weather" condition was defined as a period with no precipitation that begins 48 hours after the last wet weather event and lasts until the beginning of the next precipitation event. Dry weather flow periods based on this definition are illustrated in the hydrograph shown in Figure 2-4.

Average dry weather flow was calculated by averaging the monitored flows from the dry weather periods identified in the rainfall data analysis. The overall and monthly DWFs for all monitoring sites were analyzed and used as inputs in the H&H Model.

Table 2-2: Flow Monitoring Locations

Flow Meter	Approximate Location	Category
In-02	Influent pipe to CSO 02 Regulator	On the influent pipe to regulator
In-03	Influent pipe to CSO 03 Regulator	On the influent pipe to regulator
In-05	Influent pipe to CSO 05 Regulator	On the influent pipe to regulator
In-08	Influent pipe to CSO 08 Regulator	On the influent pipe to regulator
In-09	Influent pipe to CSO 09 Regulator	On the influent pipe to regulator
In-10	Influent pipe to CSO 10 Regulator	On the influent pipe to regulator
In-11	Influent pipe to CSO 11 Regulator	On the influent pipe to regulator
In-13	Influent pipe to CSO 13 Regulator	On the influent pipe to regulator
In-14	Influent pipe to CSO 14 Regulator	On the influent pipe to regulator
In-16	Influent pipe to CSO 16 Regulator	On the influent pipe to regulator
In-17	Influent pipe to CSO 17 Regulator	On the influent pipe to regulator
In-18	Influent pipe to CSO 18 Regulator	On the influent pipe to regulator
In-19-1	Influent pipe to CSO 19 Regulator (from East)	On the influent pipe to regulator
In-19-2	Influent pipe to CSO 19 Regulator (from West)	On the influent pipe to regulator
In-25	Influent pipe to CSO 25 Regulator	On the influent pipe to regulator
In-26	Influent pipe to CSO 26 Regulator	On the influent pipe to regulator
INT- 2nd St	2nd Street Interceptor	On the interceptor pipe
INT-DRI	Delaware River Interceptor	On the interceptor pipe
INT-Ridley 2	Ridley Creek Interceptor	On the interceptor pipe
INT-Ridley 3	Ridley Creek Interceptor	On the interceptor pipe
INT-West End	West End Interceptor	On the interceptor pipe
Side-1	Side line on Penn St. to 2nd St. Interceptor	On the side-line from the combined area
Side-2	Side line on Highland Ave. to West End Interceptor	On the side-line from the combined area
Sep-1	Upstream of the CSO 02 Drainage	On the separated area
Sep-2	Upstream of the CSO 05 Drainage	On the separated area
Sep-3	Upstream from Upland Borough	On the separated area
Sep-4 (Existing MH-28 after first quarterly report)	Upstream from Eastern Chester	On the separated area
CSO-02	Outfall pipe from CSO 02 Regulator	On the outfall pipe
CSO-03	Outfall pipe from CSO 03 Regulator	On the outfall pipe
CSO-05	Outfall pipe from CSO 05 Regulator	On the outfall pipe

Flow Meter	Approximate Location	Category
CSO-08	Outfall pipe from CSO 08 Regulator	On the outfall pipe
CSO-14	Outfall pipe from CSO 14 Regulator	On the outfall pipe
CSO-19	Outfall pipe from CSO 19 Regulator	On the outfall pipe
Eff-02	Effluent pipe for CSO-02 Regulator	On the effluent pipe
Eff-03	Effluent pipe for CSO-03 Regulator	On the effluent pipe
Eff-05	Effluent pipe for CSO-05 Regulator	On the effluent pipe
Eff-08	Effluent pipe for CSO-08 Regulator	On the effluent pipe
Eff-14	Effluent pipe for CSO-14 Regulator	On the effluent pipe
Eff-19	Effluent pipe for CSO-19 Regulator	On the effluent pipe
BR MH-1 (Existing)	Upstream from Brookhaven MH-1	On the separated area
BR MH-3 (Existing)	Downstream from Brookhaven MH-3	On the separated area
BR MH-5 (Existing)	Downstream from Brookhaven MH-5	On the separated area
BR MH-6 (Existing)	Downstream from Brookhaven MH-6	On the separated area
RC MH-26 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
RC MH-30 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
RC MH-32 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
WRTP (Existing)	At WRTP	At WRTP

Figure 2-2: DELCORA Flow Meters

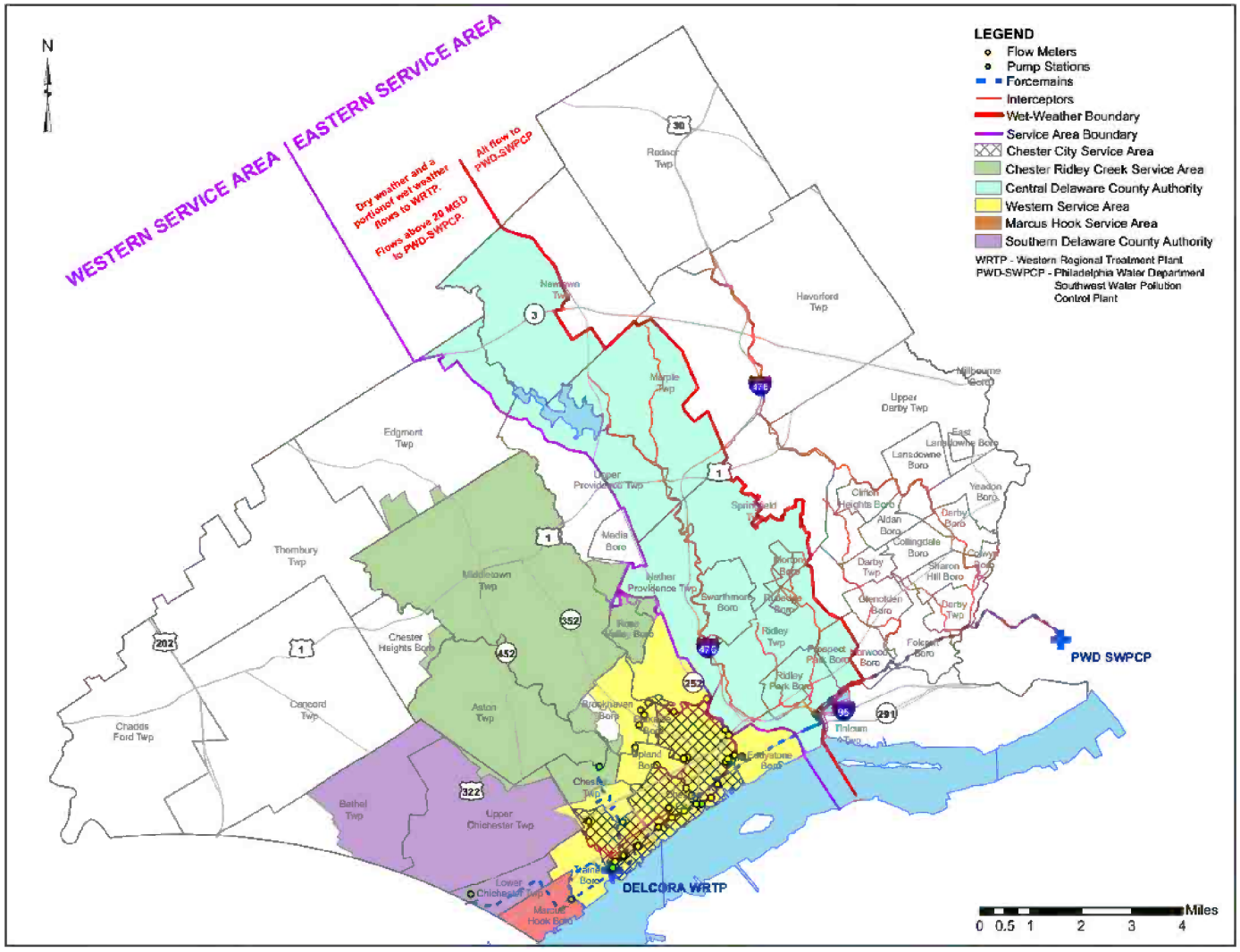


Figure 2-3: Enlarged Map of Flow Meters

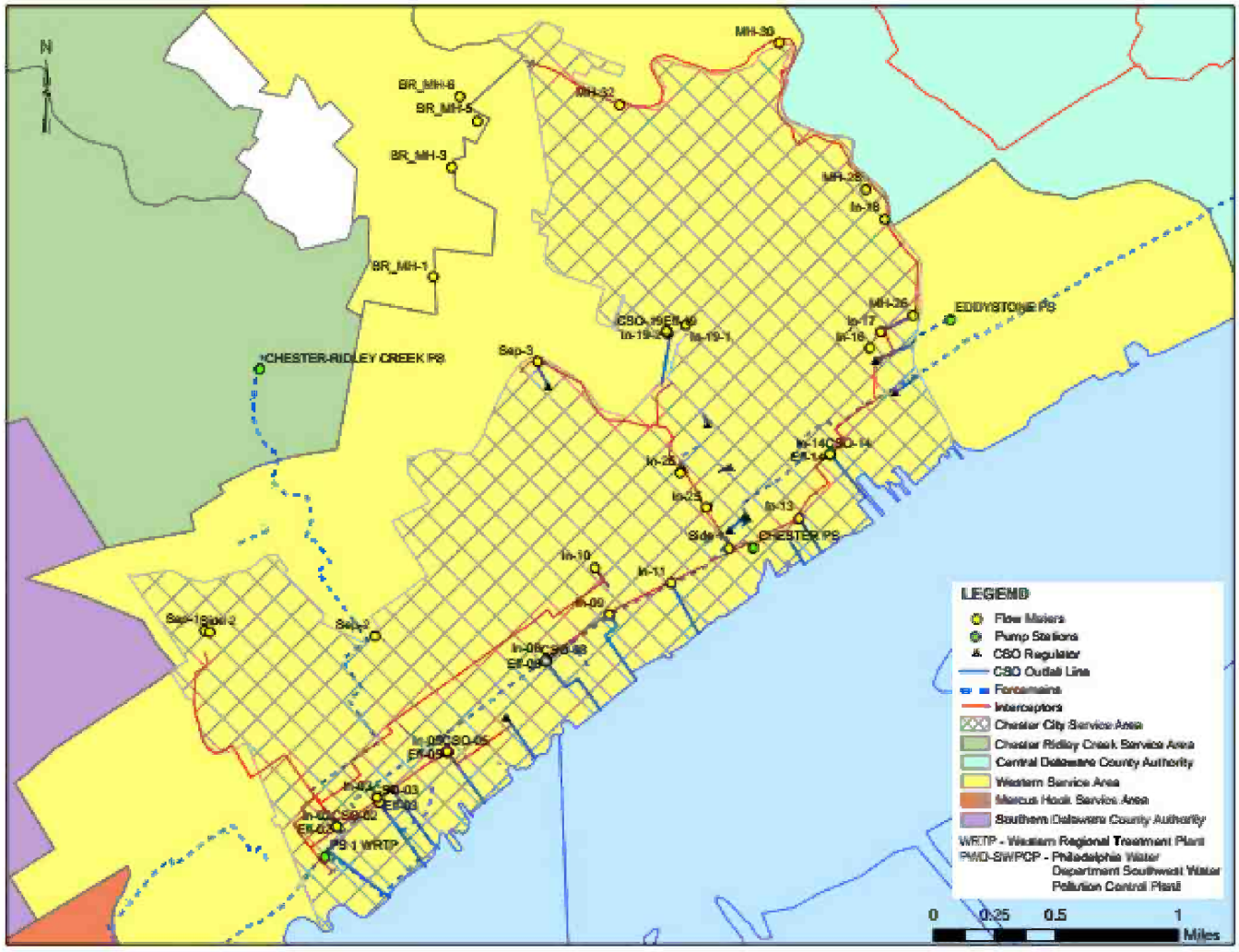


Table 2-3: Metersheds in the H&H Model

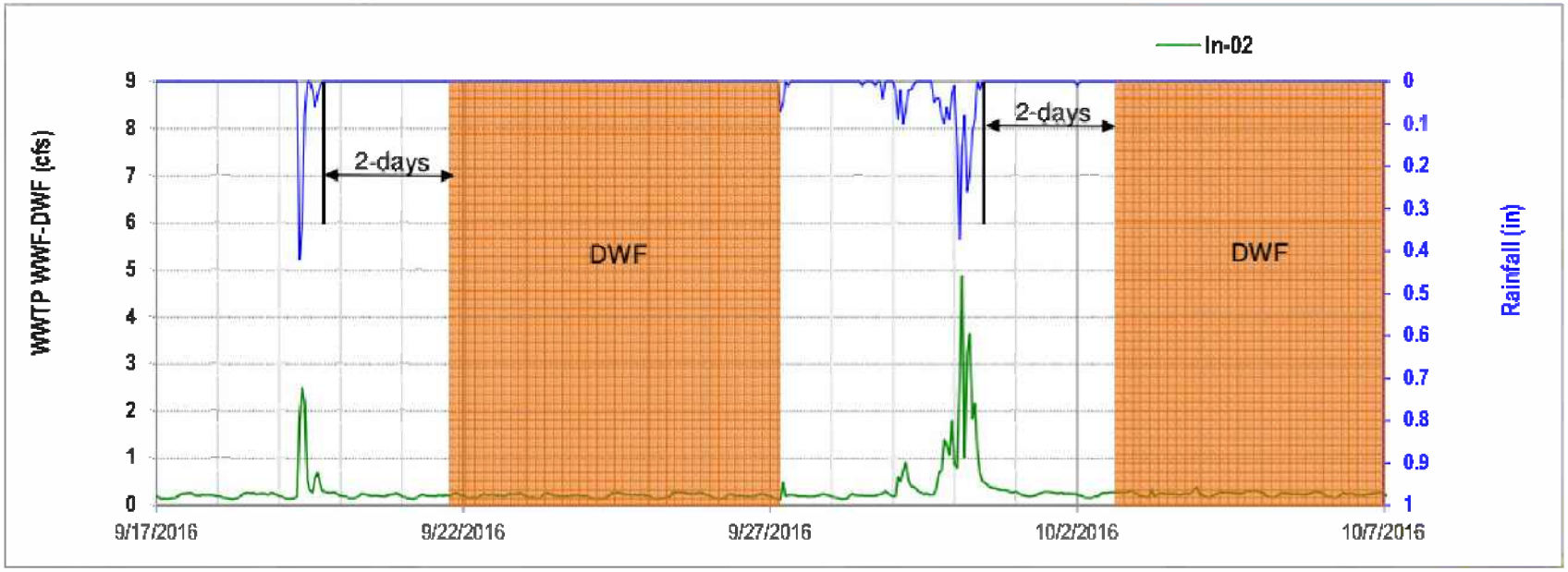
Metershed ID	Subcatchment ID	Metershed Area (ac)
BR_MH-1	BR_TWP_2	48.52
BR_MH-3	BR_TWP_3	236.08
BR_MH-5	BR_TWP_4	21.13
BR_MH-6	BR_TWP_5	43.55
In-02	02A	107.36
	02B	
	SC1	
In-03	03B	87.37
	03C	
	03D	
In-05	05C	160.31
	05D	
	CH_TWP_2	
In-08	08A	236.44
	08B	
	CH_CTY_12	
In-09	09A	27.02
In-10	10A	59.93
In-11	11A	43.54
In-13	13A	50.43
	13C	
In-14	14A	52.99
	14B	
	14C	
In-16	16A	2.18
In-16,In-17	16/17A	77.41
	16/17B	
In-17	17A	11.83
In-18	18A	29.71
	18B	

Metershed ID	Subcatchment ID	Metershed Area (ac)
In-19-1	18C	320.84
	CH_CTY_08	
	19B	
	19D	
	PA_BORO_1	
In-19-2	19E	94.48
	19G	
In-25	25A	11.84
In-26	26A	37.1
INT-2nd St	24A	6.24
INT-DRI	04A	57.01
	04B	
	07A	
	07B	
INT-Ridley 2	15A	9.72
	31A	
	RC1	
INT-Ridley 3	21A	51.8
	22A	
	23A	
	12A	
INT-West End	DR1A	25.69
	DR1C	
	CH_CTY_10	
MH-26	CH_CTY_07	46.62
MH-28 (Sep-4)	CH_CTY_04	135.72
MH-30	CH_CTY_06	1023.46
	NP_TWP_2	
MH-32	PA_BORO_2	523.12
	33A	
	BR_TWP_6	
	CH_CTY_05	

Metershed ID	Subcatchment ID	Metershed Area (ac)
Central PS (PS-1)	CH_CTY_02	502.62
	CH_CTY_03	
Eddystone PS (PS-10)	EDD_BORO_1	652.4
Marcus Hook PS (PS-11)	LC_TWP_1	1393.13
	MH_BORO_1	
Naamans Creek PS (PS-15)	BE_TWP_1	6503.31
	UC_TWP_1	
Chester Ridley Creek PS (PS-24*)	EDG_TWP_2	14369.97
	MI_TWP_1	
	NP_TWP_3	
	RV_BORO_1	
	UPR_TWP_2	
	AS_TWP_1	
	BR_TWP_7	
	CH_BORO_1	
	CH_TWP_4	
	UC_TWP_3	
Existing PS-1 (PS-3)	TR_BORO_1	987
	DR1B	
	CH_CTY_01	
Central Delaware PS Total and Central Delaware PS to WRTP (PS-7)	EDG_TWP_1	18644.24
	MA_TWP_1	
	MO_BORO_1	
	NE_TWP_1	
	NP_TWP_1	
	PR_BORO_1	
	RI_TWP_1	
	RP_BORO_1	
	RU_BORO_1	
	SP_TWP_1	
	SW_BORO_1	
	UPR_TWP_1	

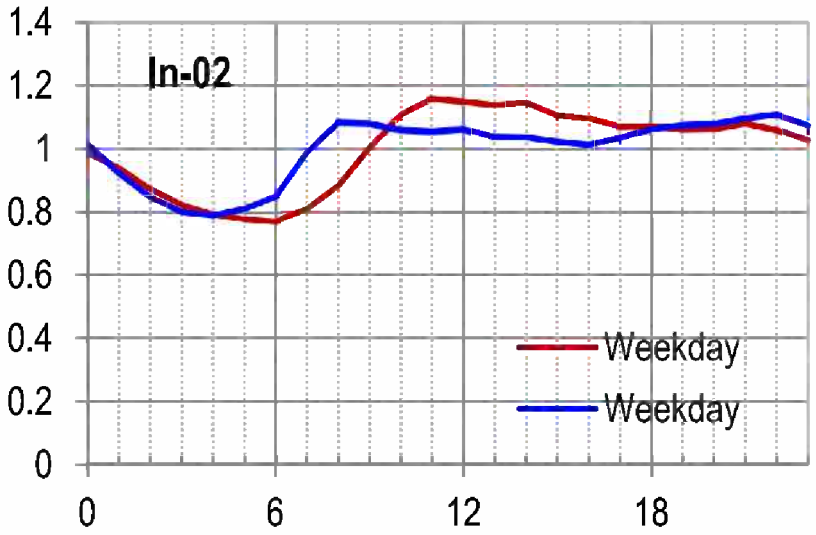
Metershed ID	Subcatchment ID	Metershed Area (ac)
Sep-1	CH_TWP_3	293.29
	UC_TWP_2	
Sep-2	CH_CTY_09	74.57
	CH_TWP_1	
Sep-3	BR_TWP_1	471.58
	CH_CTY_13	
	PA_BORO_3	
	UPL_BORO_1	
Side-1	20A	56.87
	CCE1	
	CCW1	
	CCW2	
	PS1	
	PS3	
	CH_CTY_11	
Side-2	BS3	31.75
	BS2	

Figure 2-4: Hydrograph to Show Dry Weather Flow



The dry weather flows vary throughout the day, with the highest flows normally occurring around noon and the lowest rates between midnight and early morning. Flow data from the dry weather periods were used to develop a flow diurnal pattern for each flow meter site. Diurnal patterns were analyzed for both weekdays and weekends. In the plot shown on Figure 2-5, the weekend DWF peak and valley have a 3-hour lag compared to the weekday pattern.

Figure 2-5: Weekday and Weekend Dry Weather Flow Diurnal Pattern (Example Plot)

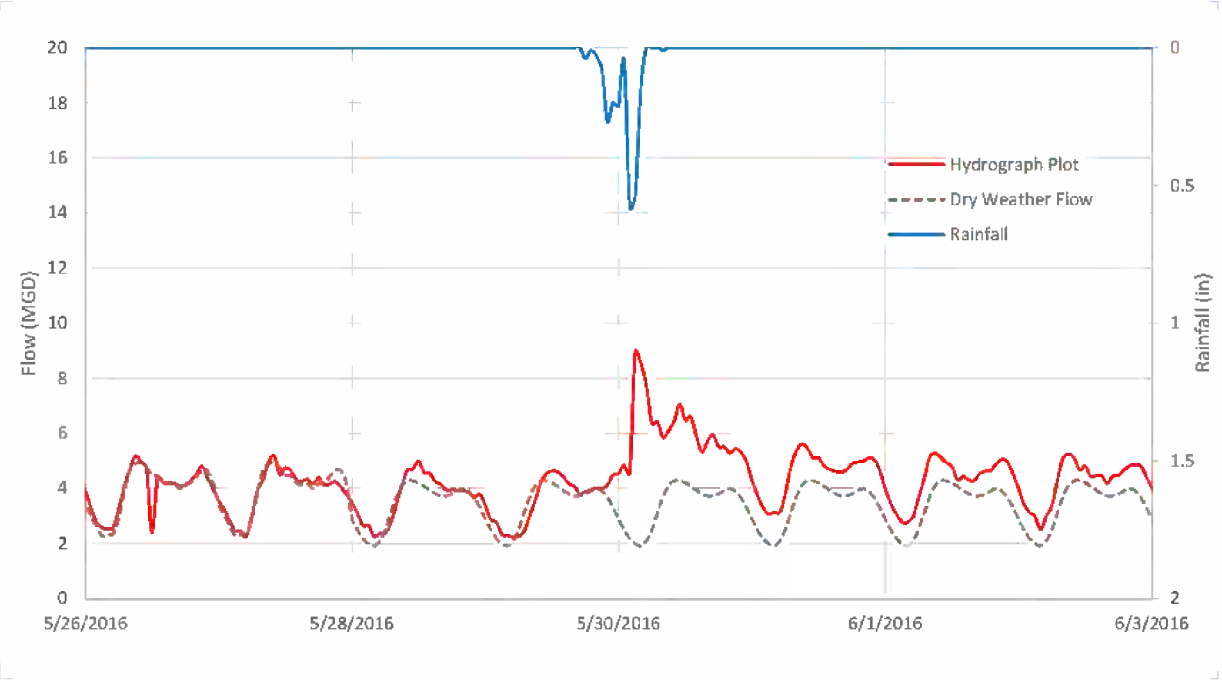


2.4 Wet Weather Flow Analysis

Wet weather flows are the combination of dry weather flows and additional flows that enter the system during wet weather conditions. The additional flows are from combined area surface runoff and RDII. Inflow normally occurs when rainfall enters the system through direct connections such as roof leaders, yard drains, catch basins, sump pumps, manhole covers and frame seals or indirect connections with storm sewers. Inflow is usually recognized graphically by large magnitude, short duration spikes immediately following a rain event. Infiltration occurs during wet weather conditions when water enters a sewer system from the ground through means which include, but not limited to, deteriorated pipes, pipe joints, connections, or manholes. It is significantly influenced by the size and duration of the rainfall event. Infiltration is often recognized graphically by a gradual increase in flow after a wet weather event. The increased flow typically sustains for a short period after rainfall has stopped and then gradually drops off.

The peaking factor represents the ratio of the peak wet weather flow to the average dry weather flow. Usually, an hourly peaking factor is used to represent the wet weather peaking factor. Peaking factors were analyzed for each flow monitoring site. The peaking factors in the separated area can be used to determine the extent of the RDII within a particular basin. Figure 2-6 is a flow hydrograph plot showing an hourly peaking factor of approximately 4.5 for the monitoring site. This high peaking factor indicates that a significant amount of RDII enters the collection system. The immediate flow increase shortly after the rainfall indicates significant inflow into the collection pipes, and the long tail back to the base flow indicates infiltration occurrence at the site as well.

Figure 2-6: Hydrographs of Flow Meters in Separated Area (Example Plot)



2.5 Wet Weather Event Selection for Model Calibration and Validation Flow Analysis

Based on the rainfall and flow monitoring data analysis, the rainfall events shown in Table 2-4 were selected for model calibration and validation. The events were selected to cover variations in terms of rainfall depth, intensity, duration and antecedent conditions. .

Table 2-4: Calibration and Validation Rainfall Events

Event	Start	End
E1	5/29/16 19:00	5/30/16 5:00
E2	9/28/16 12:00	9/30/16 10:00
E3	11/29/16 7:00	11/29/16 20:00
E5	5/21/16 11:00	5/22/16 21:00
E6	7/28/16 15:00	7/29/16 9:00

Section 3 DELCORA H&H Model Update

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was updated and expanded over the years to account for changes in the CSO system, but it was not re-calibrated during the development of the 2012 LTCP (Weston, 2012). The project team reviewed the 2012 model in order to:

- Assess adequacy of the original model for use in DELCORA's LTCPU,
- Identify gaps with the original model in meeting the requirements in the Consent Decree,
- Identify updates required to reflect current hydrologic and hydraulic conditions of DELCORA's collection system, and
- Determine refinements needed for the model update.

Results from the review of the 2012 H&H Model were presented in the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015). The purpose of this section of the Report is to describe the model update methodology and summarize the revisions incorporated into the updated model.

3.1 Model Update Methodology

3.1.1 Hydrologic Representation

Instead of including only the combined area for the subcatchments as in the original model, the updated model has subcatchments for both combined and separated service areas. All the areas that contribute dry weather flow and/or wet weather flow to DELCORA's CSOs and/or the WRTP were included in the service area for the model. Wet weather flows generated from surface runoff in the combined area and RDII in the separated areas were simulated in the updated model.

3.1.2 Hydraulic Representation

The 2012 H&H model included only the combined sewer system (CSS) area of DELCORA's collection system, which is located within the boundaries of the City of Chester. The CSS area is shown in Figure 3-1. The combined CSS area according to the original model is shown in in Figure 3-2. Per the requirements of the Consent Decree, the H&H model was updated to include the Model Area. Pipe networks in the updated model were extended to the updated service areas for both the combined and separated areas. All hydraulic structures that control flows in the collection system, including pump stations, regulator orifices and weirs, and their operating rules, were simulated in the updated model.

3.2 Model Refinement

A number of hydraulic modeling software packages are available, including EPA SWMM5, InfoSWMM, InfoWorks, Mike Urban and PCSWMM. For this H&H Model update, EPA SWMM, Version 5.0, Build 5.0.022 and Innovyze InfoSWMM Version 14.5 Update 4 were selected as the modeling software. EPA

SWMM5 is a fully dynamic model and has been used extensively throughout the United States and abroad to assess CSO, flooding and water quality issues. It can be applied to simulate single events or long periods of time in a continuous mode. InfoSWMM uses the current EPA SWMM 5 engine as its computational solution and is fully integrated with ArcGIS which provides greater flexibility of importing model network from existing GIS database and preparing initial model inputs from existing datasheets. InfoSWMM was used during the model development and the calibration phase.

The model update is based on information obtained from a variety of sources including DELCORA's input, GIS, record drawings and field survey. Other documents pertaining to standard/actual operating procedures for CSO regulators, pump stations and the WRTP were also used to set up real time controls in the model. The model network consists of all major interceptors and force mains and extends to all active overflow points. The datum for the model is NGVD 29.

3.2.1 Delineation of Model Area and Combined Area

DELCORA's latest GIS database, survey and record drawings were used to perform the desktop CSS delineation to verify the boundaries. The total acreage of the model area is approximately 50,000 acres and the updated combined sewer area is approximately 1,460 acres as of May 2017.

Metersheds were delineated for the purpose of dry weather flow allocation and model calibration. A metershed means the geographical area served by a system of sanitary drains, storm drains, private interceptor, main sewers, and public sewers that drain to a common monitoring point (flow meter location). Metershed delineation was performed based on the location of flow meter, sewer connectivity, and city contours. A listing of metersheds, their acreage and their associated subcatchments can be found in Table 2-3.

Sewersheds (subcatchment) are delineated based on the drainage network, area characteristics, and flow monitor locations. Each sewershed has a dry weather and a wet weather flow input to the model network. The model network comprises 111 sewersheds (subcatchments), including 54 combined and 57 separated subcatchments.

3.2.1.1 Delineation of Model Area

The updated H&H model will evaluate the Model Area comprising those areas hydraulically connected to the WRTP. As shown in the schematic of DELCORA's conveyance system (see Figure 1-1), the conveyance system is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to, and thus is hydraulically connected to, DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows to the PWD-SWPCP rather than to the WRTP. Therefore, municipalities connected to these pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area.

Eastern Service Area

Within the Eastern Service Area, only the municipalities in the Central Delaware County Authority contribute flows to the WRTP and are, therefore, only these municipalities are included in the Model Area. These municipalities include Marple Township, Morton Borough, Nether Providence Township, Newtown Township, Prospect Park Borough, Ridley Park Borough, Rutledge Borough, Springfield Township, Swarthmore Borough, Ridley Township, and Upper Providence Township. In October 2012, DELCORA signed an agreement with Edgmont Township to provide sewer service to the eastern portion of the Township. The sanitary sewage of the Township will be collected and transported using the Crum Creek Sewer District System through the CDCA collection and conveyance facilities to the DELCORA System for treatment and ultimate disposal and discharge.

Western Service Area

DELCORA's Western Service Area (shown in Figure 3-1) contributes flow to their WRTP and is therefore considered part of the Model Area. DELCORA owns and operates the collection system in the following communities in the Western Service Area.

- Chester City
- Chester Township (parts of)[1]
- Marcus Hook Borough
- Parkside Borough
- Rose Valley Borough[1]
- Upland Borough
- Trainer Borough

DELCORA does not own or operate the collection system in the following communities in the Western Service Area, however, these communities will be included as part of the service areas in the updated H&H model because they contribute flows to the WRTP.

- Brookhaven Borough
- Lower Chichester Township
- Nether Providence Township
- Eddystone Borough

Model Area Summary

In summary, the Model Area includes the municipalities in the Western Service Area plus those municipalities in the Eastern Service Area that are connected to the Central Delaware Pump Station, as described in Table 3-1. The Model Area is illustrated in Figure 3-1. A schematic of the facilities and conveyance network are shown in Figure 1-1.

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[1] - DELCORA owns only a portion of Chester Township's collection system, but all flow comes to WRTP as some goes through the CRC PS service area.
- Rose Valley Borough collection system discharges to its own treatment plant (this portion will be discharged to the CRC PS service area in future) and the remaining portion is discharged to the Western Service Area to the WRTP.

Figure 3-1: DELCORA's Western Regional Treatment Plant (WRTP) Model Area

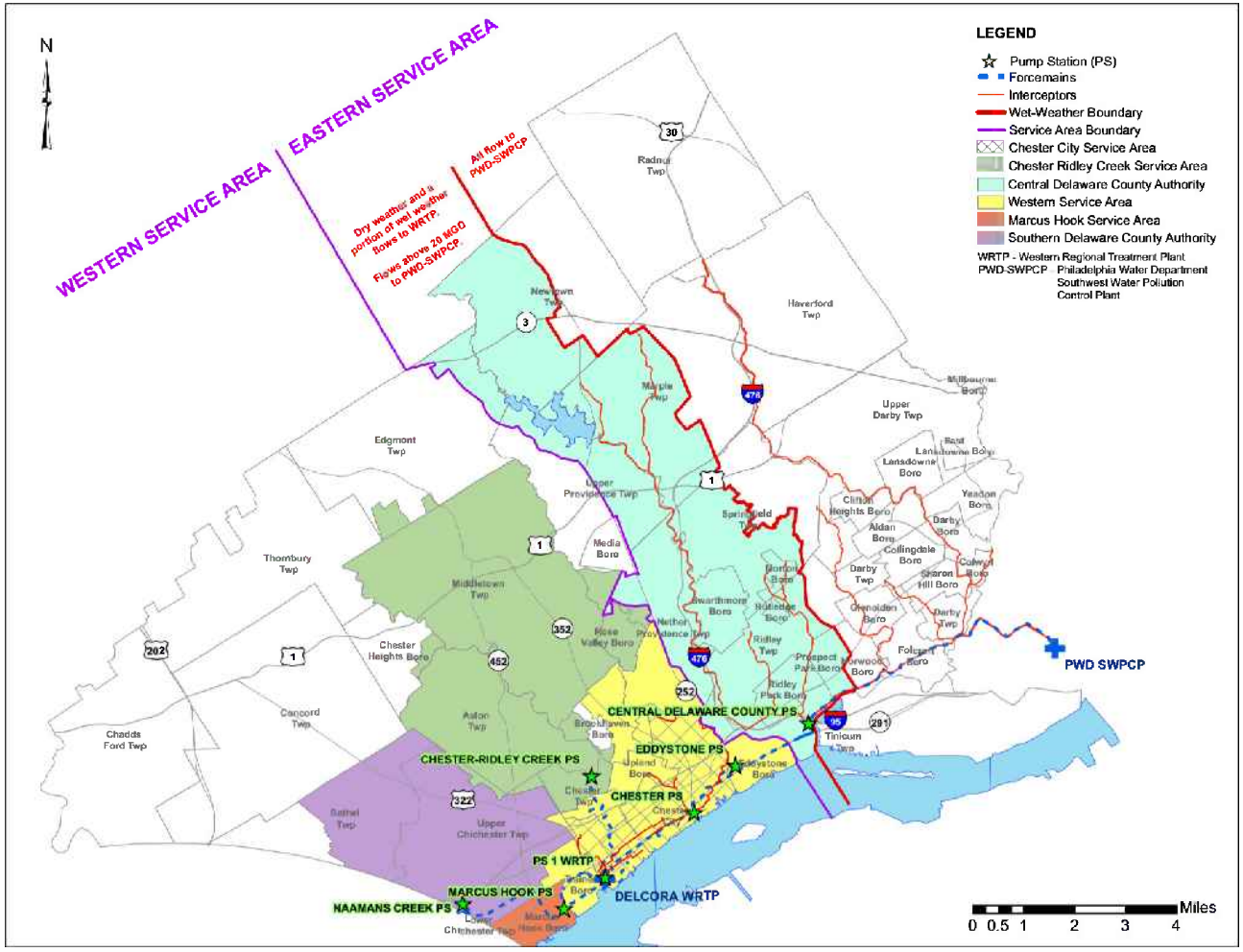


Table 3-1: Model Area

Municipality	Service Area
Aston Township	Western (CRCSA)
Bethel Township*	Western (SDCA)
Brookhaven Borough*	Western
Chester City	Western
Chester Township	Western (CRCSA)
Eddystone Borough	Western
Edgmont Township*	Eastern (CDCA)
Lower Chichester Township	Western (SDCA)
Marcus Hook Borough	Western (MHSA)
Marple Township*	Eastern (CDCA)
Middletown Township	Western (CRCSA)
Morton Borough	Eastern (CDCA)
Nether Providence Township	Eastern (CDCA) and Western
Newtown Township*	Eastern (CDCA)
Parkside Borough	Western
Prospect Park Borough	Eastern (CDCA)
Ridley Park Borough	Eastern (CDCA)
Ridley Township*	Eastern (CDCA)
Rose Valley Borough	Western
Rutledge Borough	Eastern
Springfield Township*	Eastern (CDCA)
Swarthmore Borough	Eastern (CDCA)
Trainer Borough	Western
Upland Borough	Western
Upper Chichester Township	Western (SDCA)
Upper Providence Township*	Eastern (CDCA) and Western
*Indicates that only a portion of the municipality contributes flow to WRTP CDCA: Central Delaware County Authority CRCSA: Chester Ridley Creek Service Area MHSA: Marcus Hook Service Area SDCA: Southern Delaware County Authority	

3.2.1.2 Delineation of Combined Sewer System Area

The entire combined sewer system (CSS) area of DELCORA's collection system is located in the City of Chester and consists of a drainage area of approximately 1,460 acres. It comprises approximately half of Chester City's serviced area. To support this service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five[2] (25) combined sewer outfall regulators controlling storm

[2] DELCORA's NPDES permit includes 26 regulators. After the NPDES permit was issued, CSO regulator 033 was disconnected from the CSS.

overflows. The location of the CSS area is shown in Figure 3-1. An enlarged view of the CSS area according to the 2012 H&H model is shown in Figure 3-2.

The CSS area delineation was updated with separation projects completed in recent years. The latest GIS database, survey, and record drawings were used to perform the desktop combined sewer area check. Some areas have separated systems with trunk sewers that subsequently connect to the CSS. For this situation, these particular separate sewer system areas were included within the delineation of the CSS. The revised CSS delineation is illustrated in Figure 3-3.

3.2.2 Model Network Extension

The collection system network in the original model has been updated with the following.

- Extended sewers to the updated delineation of the combined and separated areas
- Included all pump stations that control flows in the DELCORA collection system, and
- Reflect actual configuration of the CSO regulators.

3.2.2.1 Sewer Lines and Manholes

3.2.2.2 Regulators

Since the approval of the first LTCP in 1999, DELCORA has under-taken a program to replace and/or rehabilitate CSO regulators and tide gates in the City of Chester CSO system. In some cases, regulators have been eliminated. The updated model includes twenty-five[2] (25) CSO regulators, which were modeled as weirs and orifices. The configuration of CSO regulators was obtained from both record drawings and field surveys.

As indicated in Table 3-2, the majority of the City's CSO regulators are Brown & Brown type regulators. The operation of the CSO regulators has been changed from being controlled by the level in the trunk sewer entering the CSO regulator chamber to being controlled by the level in the interceptor. This change is being implemented as part of the CSO regulator replacement program. This ensures that the flow sent to the WRTP for treatment is maximized.

During dry-weather operations, the sewage flow levels entering the CSO regulator chamber are below the top of the diversion weir and will pass through the CSO regulator gate. Once through the CSO regulator gate, the flow typically passes through an orifice plate and then will be sent to the WRTP via the interceptors. During wet-weather events, the level in the combined sewer (Type A regulator) or in the interceptor (Type B regulator) will begin to rise thus raising the float assembly and beginning to close the CSO regulator gate. For cases where the regulator float and gate have been removed, dry weather flow and some portion of the wet weather flow will pass through the opening previously covered by the now removed gate. Flow through this opening will be modeled as an orifice. When weather flow exceeds the

Table 3-2: CSO Regulator Information

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	CSO Regulator Type
002	Front & Booth	Delaware River	Brown & Brown
003	Front & Highland	Delaware River	Brown & Brown
004	Front & Hayes	Delaware River	McNulty
005	Front & Townsend	Delaware River	Brown & Brown
007	Delaware & Reaney	Delaware River	Brown & Brown
008	2nd & Tilghman	Delaware River	Brown & Brown
009	2nd & Lloyd	Delaware River	Brown & Brown
010*	5th & Pusey	Delaware River	Brown & Brown
011	2nd & Parker	Delaware River	Brown & Brown
012	2nd & Edgmont	Delaware River	Brown & Brown
013	2nd & Welsh	Delaware River	Brown & Brown
014	3rd & Upland	Delaware River	Brown & Brown
015	4th & Melrose	Ridley Creek	Brown & Brown
016	8th & McDowell	Ridley Creek	Brown & Brown
017	9th & Campbell	Ridley Creek	Brown & Brown
018	Sun Dr. & Hancock	Ridley Creek	Brown & Brown
019	14th & Crozer Hospital	Chester Creek	Brown & Brown
020	Kerlin & Finland	Chester Creek	Brown & Brown
021	9th & Sproul	Chester Creek	Brown & Brown
022	6th & Sproul	Chester Creek	Brown & Brown
023	3rd & Edgmont	Chester Creek	Brown & Brown
024	3rd & Dock	Chester Creek	Brown & Brown
025	5th & Penn	Chester Creek	Brown & Brown
026	7th & Penn	Chester Creek	Brown & Brown
032	2nd & Avenue of the States	Delaware River	No CSO Regulator
033	Elkington Blvd. and Ridley Creek	Ridley Creek	No CSO Regulator

Notes:
- CSO Regulator 010 discharges at Outfall 009.
- CSO Regulators 006 ad 007 have been disconnected from CSS and removed from NPDES permit
- CSO Regulator 033 has been disconnected from the CSS but had not been removed from NPDES permit at the date of this Report

Figure 3-2: CSS Area Delineation in the Original Model

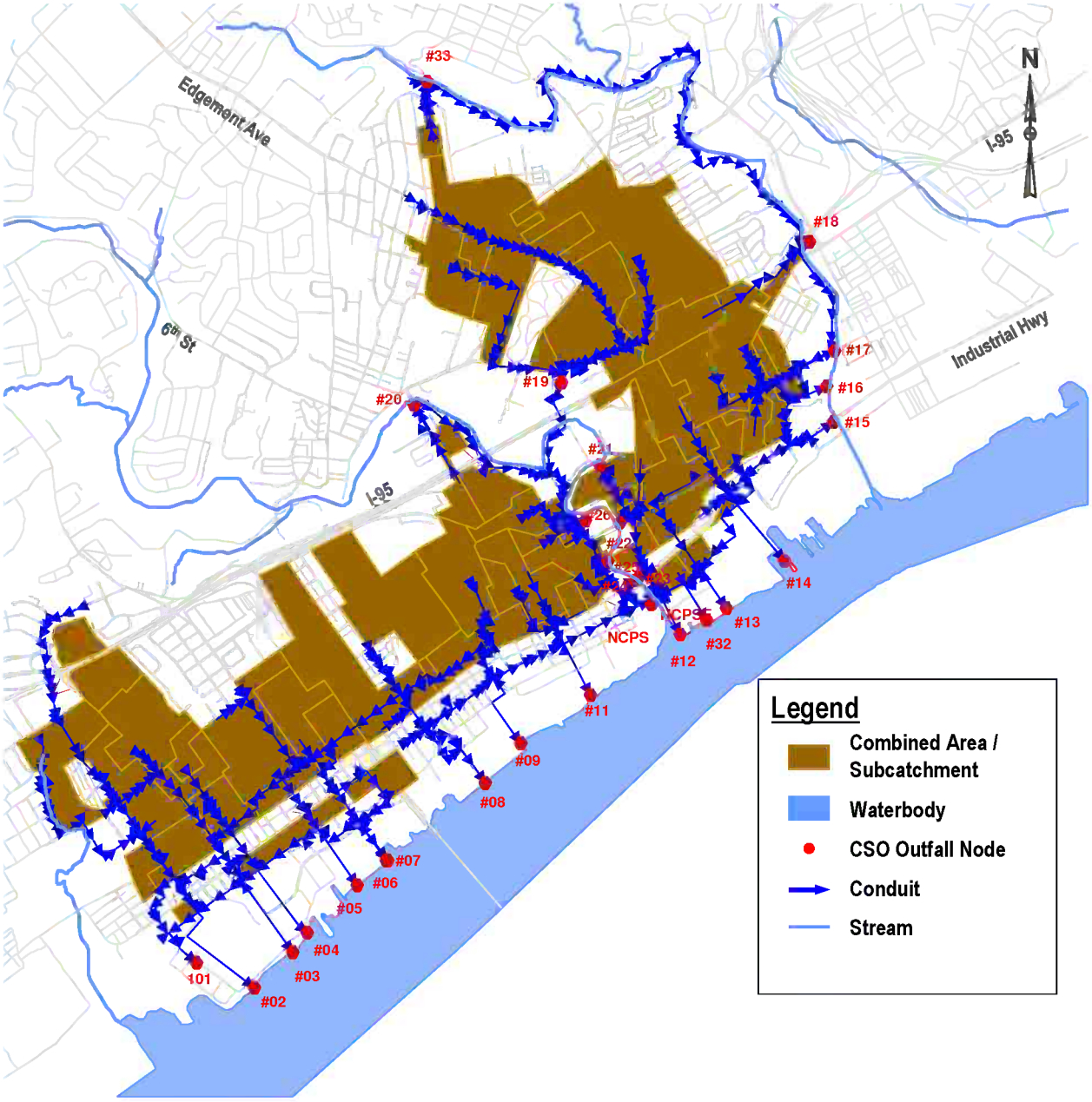
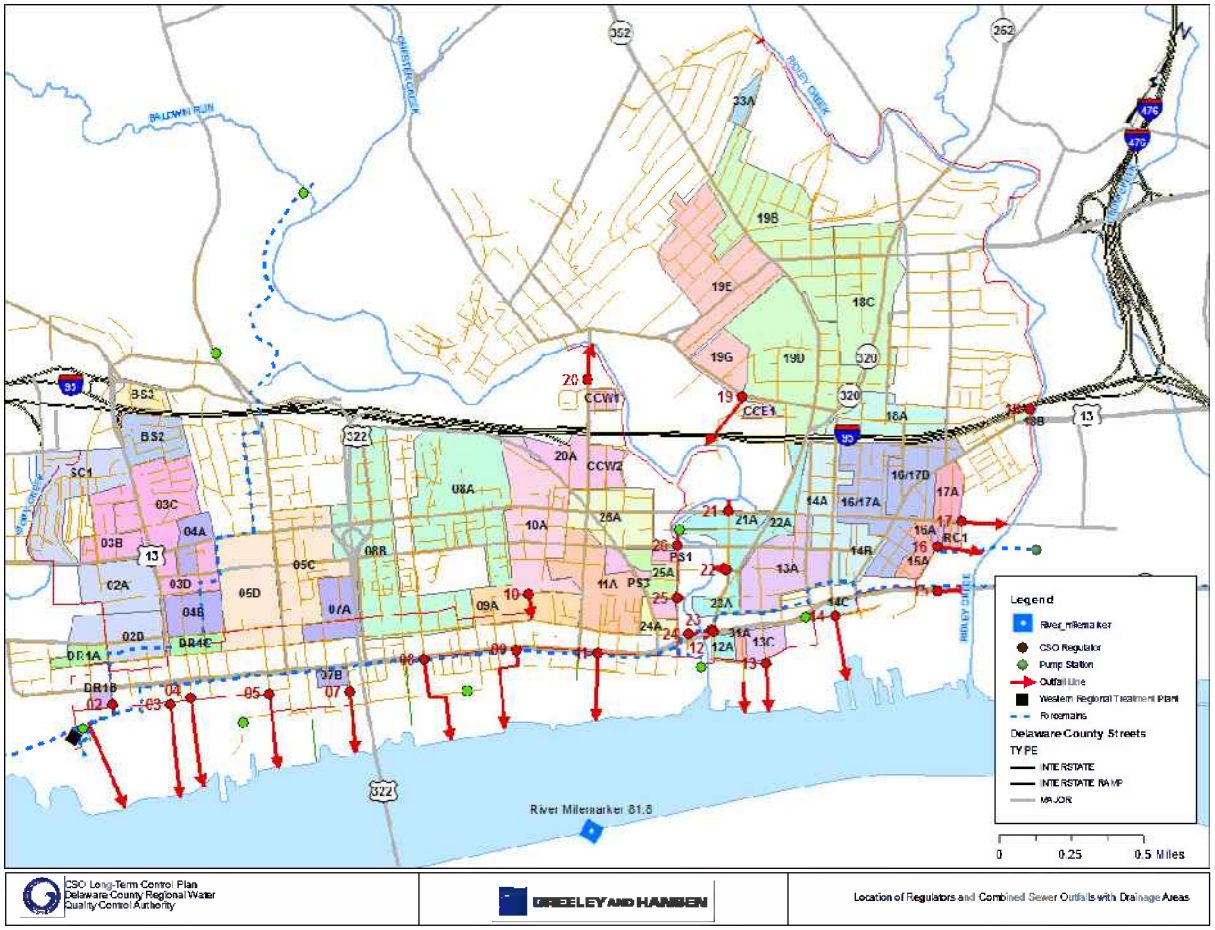


Figure 3-3: CSS Area Delineation in the Revised Model



capacity of the orifice, the level in the sewer will continue to rise until it is high enough for a portion of the flow to pass over the weir be discharge through the associated outfall.

Regulator gates, diversion weirs, and operating rules are simulated in the updated model.

3.2.3 Pump Stations

Major pump stations in the Western Service Area and the Central Delaware Pump Station in the Eastern Service Area were added to the updated model, as well as force mains connecting the pump stations to the interceptor/WRTP. The list of the pump stations includes (Figure 3-4):

- Chester PS
- Existing PS-1 WRTP
- Marcus Hook PS
- Naamans Creek PS

- Eddystone PS
- Central Delaware PS
- Chester Ridley Creek PS

The following pump stations were excluded from the H&H Model:

- Price & Smith Street Trainer PS
- Sun Oil PS (Owned by Sunoco)
- Kimberly Clark PS (Owned by KC)
- Stadium PS

Flow from the Price & Smith Street Trainer PS discharges to the downstream existing PS-1 Pump Station (EPS-1) where it is re-pumped. The updated H&H model assumes that all flow from subcatchments associated with the Price and Smith Street Trainer PS can be treated as an input to EPS-1.

Flow from the Stadium PS is sanitary sewage with no wet weather flow. The Stadium PS discharges flow only during events held at the stadium. Due to the limited flow, its sporadic nature and the lack of wet weather flow, the Stadium PS is expected to have negligible effect on the wet weather capacity of the CSS. Therefore, the Stadium PS was not included in the H&H Model.

DELCORA owns or operates a number of lift stations that contribute to the Western Service Area and whose flows are handled by the above list of pumps stations. It was determined that the behavior of these lift stations would not require modeling and that inflow can be assumed to equal outflow to the downstream conduit.

3.2.4 Model Input

3.2.4.1 Subcatchments

The following subcatchment information is required by the model:

- Area
- Percent of directly connected impervious area (effective impervious area)
- Width
- Slope
- Manning's roughness coefficient (n) for both pervious and impervious areas
- Depression storage for both pervious and impervious areas (initial abstraction)
- Soil and soil infiltration parameters
- Rainfall dependent inflow and infiltration (RDII) parameters
- Base flow

Area

Area of the combined sewer subcatchment is the geographical area of the subcatchment. It was estimated from the GIS by geometry calculation of the area of the subcatchment. Subcatchment areas for the updated H&H model are depicted in Figure 3-3.

Percent of Directly Connected Impervious Area

Directly connected impervious area means the impervious area that is effectively connected to the sewer collection system. As a result, runoff from these areas is completely captured by the collection system. Runoff from the rest of the impervious area is deemed not to be captured by the system due to various potential reasons including, but not limited to, drains to pervious areas/creeks/streams, limited number and capacity of stormwater inlets, and bypassing. For model construction, the percent imperviousness was calculated using the high resolution land cover raster published by the Chesapeake Conservancy (Chesapeake Conservancy, 2017) as well as the land use shapefile published in 2015 by the Delaware Valley Regional Planning Commission as the initial inputs. Then, the impervious percentage values were adjusted during the model calibration process (see Section 4) to best simulate the observed hydrologic response over the selection of precipitation events.

The initial percent imperviousness for the combined area was calculated based on the impervious coverage shape file and the subcatchment shape file. The subcatchment delineations were overlaid on the land cover designation and the percent impervious within each subcatchment was evaluated with the results presented in Table 3-3.

For the separated area, the initial percent imperviousness will be set at 0% because the impervious area in the separated area is not contributing runoff to the CSS, therefore it is not effectively connected. *Subcatchment parameters mentioned hereafter will be set at default values for the separated subcatchments.*

Width

The width of a subcatchment relates to sheet flow path and affects time of concentration and the shape of the runoff hydrograph. The initial estimate of the width was made by dividing the subcatchment area by the representative overland flow length. Width is one of the calibration parameters for runoff.

Slope

The slope of a subcatchment should reflect the average slope along the pathway of overland flow to inlet locations. For the combined sewer subcatchments, slopes from the 2012 H&H model were retained for use in the updated model.

Figure 3-4: Pump Stations Included in the Updated Model

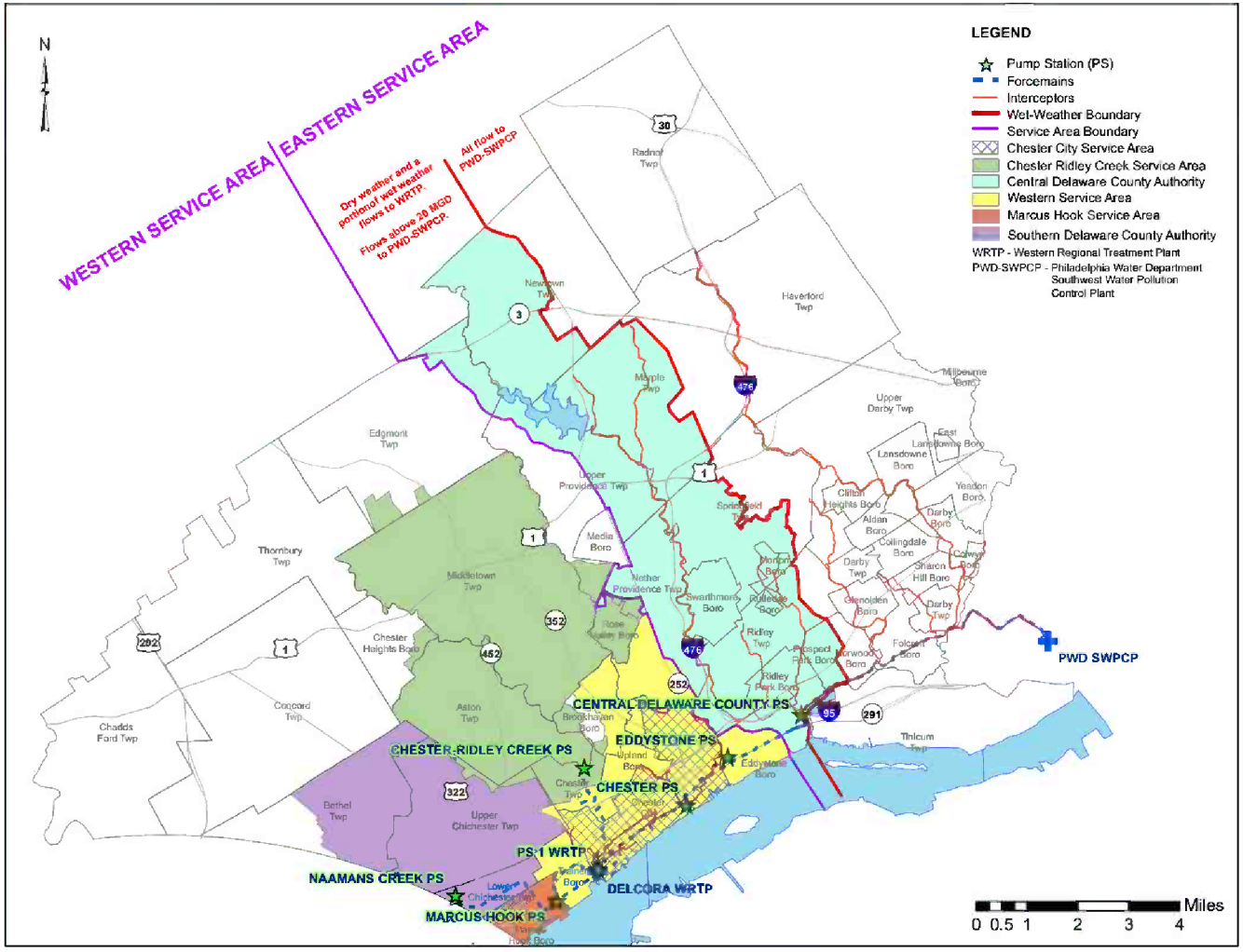


Table 3-3: Percent Imperviousness Applied to Subcatchments

Subcatchment ID	Percent Imperviousness
02A	74%
02B	60%
03B	69%
03C	55%
03D	72%
04A	80%
04B	66%
05C	72%
05D	44%
07A	70%
07B	72%
08A	52%
08B	60%
09A	65%
10A	60%
11A	70%
12A	91%
13A	89%
13C	88%
14A	61%
14B	52%
14C	79%
15A	63%
16/17A	55%
16/17B	65%
16A	76%
17A	79%
18A	58%
18B	70%
18C	64%
19B	57%
19D	49%
19E	58%
19G	34%
20A	64%
21A	85%
22A	85%
23A	93%
24A	60%
25A	76%
26A	77%
31A	91%
BS2	51%
BS3	50%
CCW1	69%
CCW2	58%

Subcatchment ID	Percent Imperviousness
DR1A	69%
DR1B	51%
DR1C	68%
PS1	52%
PS3	64%
RC1	64%
SC1	44%
CCE1	1%

Manning's roughness coefficient (n)

Manning's roughness coefficient (n) was estimated for both pervious and impervious overland flow. The initial values were set to 0.013 for impervious surfaces and 0.15 for pervious surfaces. A typical range of Manning's n suggested by the SWMM is 0.011-0.024 for impervious area and 0.06-0.80 for pervious area. Roughness is an empirical value and may be treated as a calibration parameter if necessary.

Depression Storage

Depression storage is the rainfall abstraction volume that must be filled prior to the occurrence of runoff. It represents the loss (initial abstraction) caused by surface ponding, surface wetting, etc. The initial values of depression storage were set to 0.05 for impervious surfaces and 0.15 for pervious surfaces. Typical depression storage values are 0.05-0.10 for impervious surfaces and 0.10-0.30 for pervious surfaces. Depression storage is an empirical value and may be treated as a calibration parameter, especially to adjust runoff volumes.

In the model, the subcatchment was divided into three subareas: pervious area with depression storage, impervious area with depression storage, and impervious area without depression storage. The initial percent of the impervious area without depression storage was set to 0.10.

Soil and Soil Infiltration Parameters

Soil information was obtained to estimate infiltration in the pervious areas of the CSS. The rate of infiltration is a function of soil properties and antecedent soil conditions. Three infiltration methods are available in the software: Horton method, Green-Ampt method, or National Resources Conservation Service (NRCS) Curve Number method. The Horton method has been extensively used for similar type of modeling work and it was used in this modeling effort to estimate infiltration. The required soil parameters for Horton method include:

- Maximum Infiltration rate (in/hr)
- Minimum Infiltration Rate (in/hr)
- Decay Constant (/hr)
- Drying time (d)
- Maximum Infiltration Volume Possible (inch)

To determine the Horton infiltration parameters, a soil map was first obtained from the NRCS (USDA, 2017). The soil types were then correlated to standard hydrologic soil groups.[3] A map of the hydrologic soil groups found in the CSS is presented in Figure 3-5. Hydrologic soil groups found in DELCORA's CSS are groups A, B, C, B/D and C/D. Horton's infiltration parameters for these soil groups were estimated based on typical values from literature and are shown in Table 3-4.

Table 3-4: Horton Infiltration Parameters

Horton Infiltration Parameter	Soil A	Soil B	Soil C	Soil B/D	Soil C/D
Max Infiltration Rate (in/hr)	5	3	2	2	1.5
Min Infiltration Rate (in/hr)	1.18	0.43	0.2	0.22	0.06
Decay Constant (1/hr)	4	4	4	4	4
Drying Time (d)	2	3	8	8	10.5
Max Volume (in)	14	13.2	12.5	9.8	7.0

3.2.4.2 Manhole

Sewer manholes were simulated as junction nodes in the model. The following information is required:

- Node ID
- Invert
- Maximum Depth (approximated as the difference from manhole rim and manhole invert)
- Surcharge Depth

Manhole ID was inherited from the name of the manhole in the sewer GIS. The naming convention is "MH_XXXX". Manhole input information was updated based on the latest available GIS information.

Manhole input parameters, including invert and rim were found or estimated from record drawings, design drawings, and the sewer manhole shape file. For water tight manholes or manholes with bolted down covers, a surcharge depth of 50-ft will be applied.

[3] Soil types can be categorized into standard hydrologic soil groups A, B, C and D, with group A having the lowest runoff potential and group D having the highest runoff potential. Dual rated groups are group D in their natural state, but can behave according to the first letter if the area is drained. Additional information regarding hydrologic soil group descriptions can be found in the Appendix.

3.2.4.3 Sewer Mains

Sewer mains are the conveyance element and were simulated as conduits in the model. The following input information was needed:

- Conduit ID
- Shape
- Number of barrels
- Upstream and downstream nodes
- Upstream and downstream offset
- Dimension (length, diameter/depth)
- Manning's roughness coefficient
- Minor loss coefficient (entry loss, exit loss, average loss)
- Flap gate installed or not (set at no flap gate for most of the sewer mains)

Conduit ID was inherited from the 2012 H&H Model.

Most of the pipe input parameters, including upstream and downstream nodes, dimension, shape, number of barrels, and flap gate information, were found or estimated from record drawings, design drawings and sewer gravity main GIS shapefiles. For pipes that do not begin or end at the invert of the upstream or downstream node, an offset value was provided to describe the difference from the invert of the pipe to the invert of the upstream or downstream node.

Manning's roughness coefficient is related to the pipe material. The initial input of the Manning's n for different materials is summarized in Table 3-5. The Manning's n may be changed during calibration to account for minor loss or additional sediment depositions in the pipe.

The initial minor loss for pipe will be set at zero for most pipes. For those pipes with sharp turns, a higher minor loss was applied.

If sewer main information was not available, sewer length was estimated in GIS geometry measurement; sewer size were assumed based on upstream and downstream sewers; sewer upstream and downstream offsets were estimated based on sewer connectivity assuming constant slope.

Figure 3-5: Hydrologic Soil Groups for CSS Area

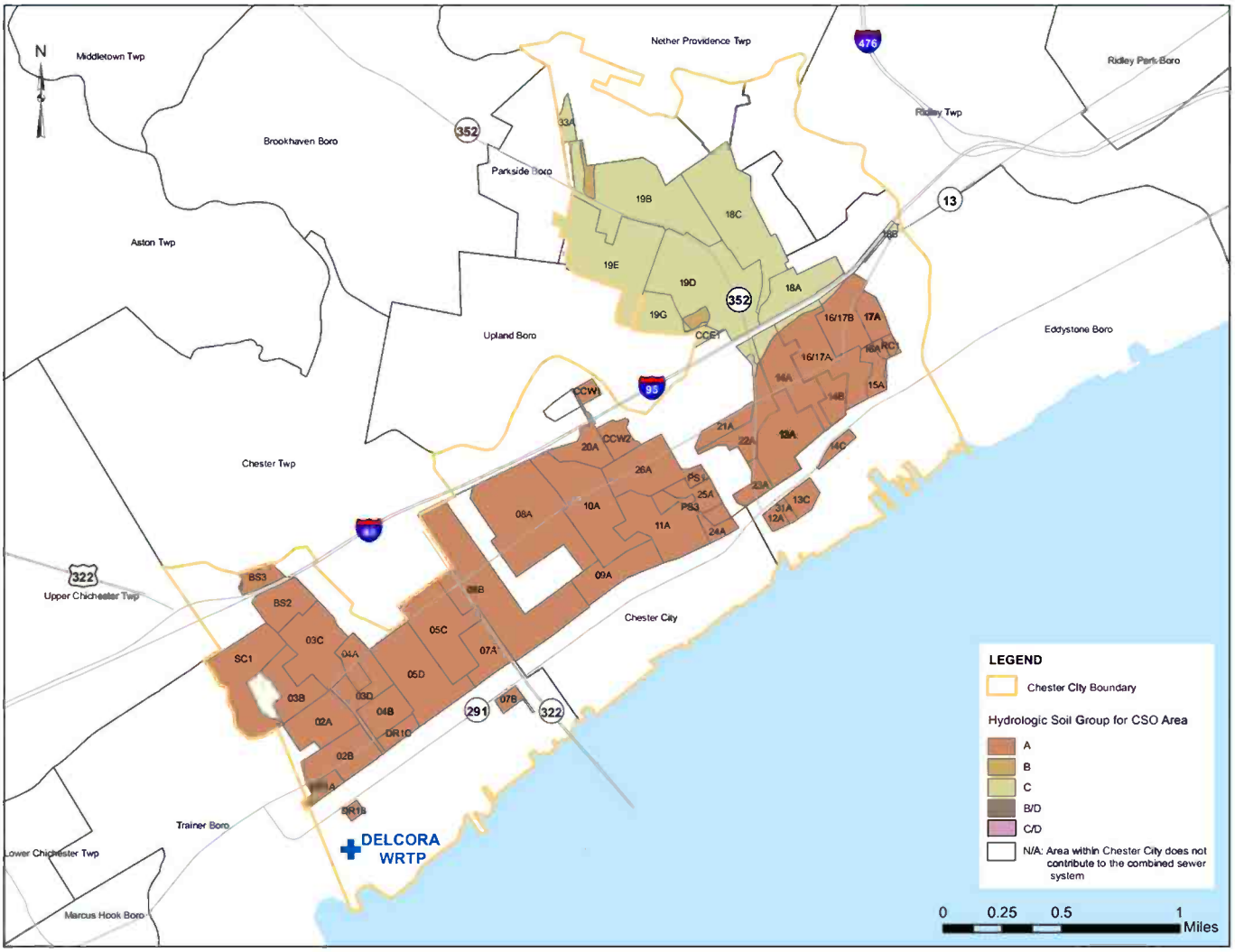


Table 3-5: Manning's Roughness Coefficient for Sewer Mains

Pipe Material	Manning's N
Polyvinyl Chloride (PVC)	0.011
Reinforced Concrete Pipe (RCP)	0.013
Ductile Iron (DI)	0.013
Cast Iron (CI)	0.013
Corrugated Metal Pipe (CMP)	0.020
Masonry	0.025
Unknown	0.013

3.2.4.4 CSO Outfalls

CSO outfalls will be simulated as outfall nodes in the model. The following information is required:

- Outfall ID
- Type (free, normal, fixed stage, tidal stage, time series, stage-flow, flap gate)
- Invert
- Boundary conditions

Outfalls are the discharge points in the model. The outfalls can either be free outfalls without any boundary conditions or the outfalls can have a boundary condition that the head needs to overcome for outflow to occur. The outfalls in the DELCORA's collection system are mostly in the tidal river reach. Therefore, appropriate tidal stages from NOAA data were used to set boundary conditions. Outfalls can have a flap gate at the end to prevent backflow.

Outfall ID will be named according to the CSO regulator overflow points. For example, the outfall for CSO regulator 002 will be named "NREG-002". The inverts of outfalls will be estimated based on record drawings and design drawings, and will be confirmed/adjusted from the field survey, if necessary.

A summary of the outfall data used in the model is contained in Table 3-6. One regulator (Regulator 010) does not have its own outfall, but rather discharges through the same outfall (Outfall 009) as Regulator 009. Also, Regulator 033 has been disconnected from the CSS and, therefore, its outfall is not included in the updated H&H model. As a result, there are a total of 24 CSO outfalls in the updated H&H model.

Table 3-6: CSO Outfall Characteristics Summary

Outfall No.	CSO Receiving Water	Invert at Regulator	Invert at Receiving Stream
002	Delaware River	7.00	-3.5
003	Delaware River	7.98	-3.5
004	Delaware River	8.80	-3.5
005	Delaware River	4.74	-4.5
007	Delaware River	0.81	0.21
008	Delaware River	2.79	0.01
009	Delaware River	2.61	-4
010*	Delaware River	22.5	*
011	Delaware River	7.09	-4
012	Delaware River	1.46	-2
013	Delaware River	1.86	-4
014	Delaware River	-1.09	-4
015	Ridley Creek	0.52	-3
016	Ridley Creek	0.11	-5
017	Ridley Creek	0.09	0.09
018	Ridley Creek	6.28	-5.0
019	Chester Creek	18.00	12.28
020	Chester Creek	8.78	-4
021	Chester Creek	5.78	-1.5
022	Chester Creek	11.5	-3.5
023	Chester Creek	1.33	-3.0
024	Chester Creek	1.21	-4.0
025	Chester Creek	-1.08	-4.0
026	Chester Creek	9.00	-4.0
032	Delaware River	1.00	-4.0
033	Ridley Creek	N/A	N/A

Notes:
*CSO regulator 010 discharges at Outfall 009.
N/A: Not Applicable

3.2.4.5 Flow Diversion Structure

As described in Section 3.2.2.2, most of the flow diversion structures are similar to Brown and Brown type regulators. The key components required for modeling these structures include float-operated gates, orifice plates and diversion weirs. Schematic representations of the flow diversion structures are shown in Figure 3-6.

Regulator Gates

Regulator gates will be simulated as orifices in the updated model. The following information is required to model a regulator gate in the model:

- Regulator Gate ID
- Upstream and downstream nodes
- Type
- Shape (two shapes: circle, rectangular)
- Dimension (Height, Width)
- Discharge Coefficient

Regulator gate ID is named according to the CSO regulator points. For example, the regulator gate for CSO regulator 003 is named "REG_003_Gate." All regulator gates are modeled as side-type orifices and have been assigned a discharge coefficient of 0.65. All regulator gates are modeled as rectangular except for REG_004_Gate which is modeled as a circular orifice. The updated model includes real time control rules for opening and closing of the gates based on levels in the float chamber and regulator limit settings. A summary of regulator gate characteristics is shown in Table 3-7.

Orifices

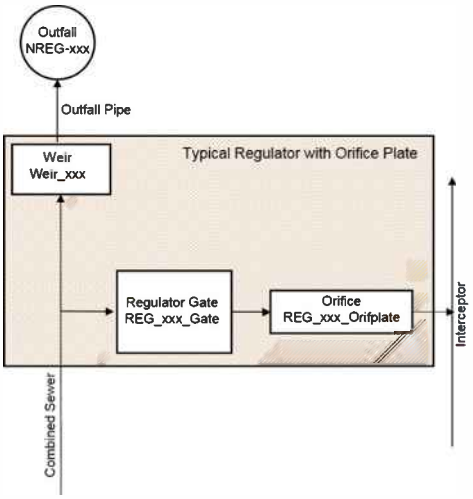
The following information is required to model an orifice in the model:

- Orifice ID
- Upstream and downstream nodes
- Type (two types: side, bottom)
- Shape (two shapes: circle, rectangular)
- Dimension (Height, Width, Crest Height)
- Discharge Coefficient

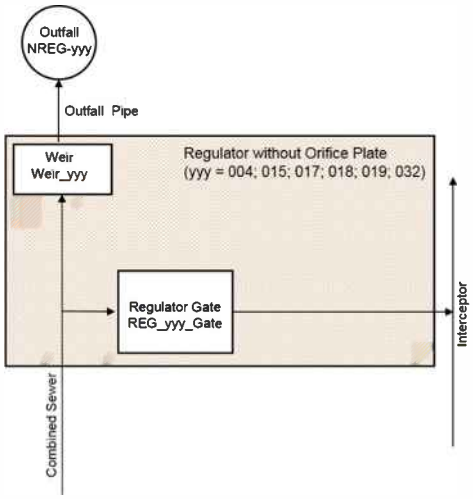
Orifice ID will be named according to the CSO overflow points. For example, the orifice for CSO 03 will be named "REG_03_Orifplate". All orifices in the collection system are side orifice type, rectangular in shape and were assigned a discharge coefficient of 0.65. The dimensions are based on record drawings.

A summary of the orifice data used in the model is contained in Table 3-8. The update H&H model has 20 orifices. All orifices are side type and are rectangular in shape. Regulators 004, 015, 017 018 and 032 do not have an orifice plate. Regulators 006, 027 and 033 are no longer connected to the CSS and therefore do not have any orifices, weirs or outfalls included in the H&H model.

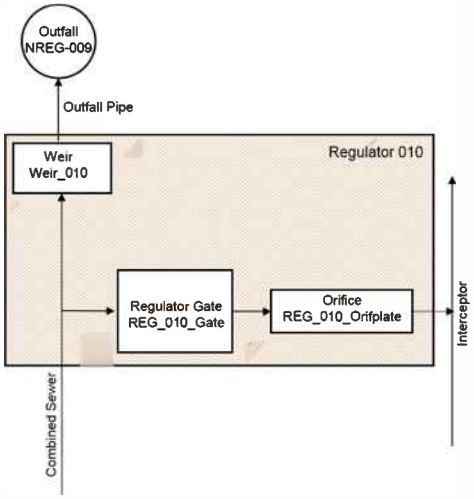
Figure 3-6: Flow Diversion Structure Schematic



(A) Schematic of Regulator with Orifice Plate



(B) Schematic of Regulators without Orifice Plate



(C) Schematic of Regulator 010

Table 3-7: Regulator Gates Characteristics

Regulator Gate ID No.	Dimensions		Invert EL (ft.)
	Height	Width	
002	5.0 in.	7.5 in.	6.29
003	7.5 in.	7.75 in	7.18
004	8.0 in. dia.	N/A	7.89
005	12.0 in.	12.0 in.	3.99
007	5.0 in.	6.00 in.	0.50
008	7.5 in.	12.375 in.	2.63
009	5.0 in.	7.5 in.	2.45
010*	7.5 in.	15.375 in.	21.50
011	5.0 in.	9.25 in.	6.99
012	2.50	9.25 in.	0.50
013	7.5 in.	7.75 in.	0.84
014	12.0 in.	15.00 in.	-2.50
015	5.0 in.	6.00 in.	0.46
016	7.5 in.	12.375 in.	-0.55
017	5.0 in.	6.00 in.	0.09
018	5.0 in.	6.00 in.	6.06
019	7.5 in.	15.38 in.	16.89
020	7.5 in.	7.75 in.	8.06
021	7.5 in.	7.75 in.	4.56
022	5.00 in.	6.00 in.	10.47
023	7.5 in.	7.75 in.	0.50
024	5.0 in.	9.25 in.	0.50
025	5.0 in.	6.00 in	-2.25
026	7.5 in.	12.375 in.	7.91
032	*	*	-0.20
033	N/A	N/A	N/A

*Gate removed; no data for gate opening dimensions. Regulator modeled as pipe with same diameter as upstream sewer

Table 3-8: Orifice Characteristics

Orifice ID No.	Orifice Type	Dimensions		Invert EL (ft.)
		Height	Width	
002	Side	4 5/8 in.	6 in.	5.78
003	Side	6 ¼ in.	7 in.	6.68
004	None	N/A No Orifice Plate		N/A
005	Side	7 ½ in.	12 in.	3.49
007	Side	3 ½ in.	5 in.	0
008	Side	6 7/8 in.	18 in.	2.13
009	Side	3 ½ in.	8 in.	1.95
010*	Side	10.563 in.	15 in.	21.09
011	Side	5 7/8 in.	8 in.	6.49
012	Side	4 5/8 in.	14 in.	0.00
013	Side	4 ½ in.	16 in.	0.34
014	Side	7 ½ in.	16 in	-3
015	None	N/A No Orifice Plate		N/A
016	Side	9 1/8 in.	30 in.	-1.05
017	None	N/A No Orifice Plate		N/A
018	None	N/A No Orifice Plate		N/A
019	None	N/A No Orifice Plate		N/A
020	Side	12.15 in.	8 in.	7.41
021	Side	11.33 in.	15 in.	4.47
022	Side	2.9 in.	8 in.	9.97
023	Side	5.75 in.	14 in.	0.00
024	Side	7.5 in.	16 in.	-2.75
025	Side	4.61 in.	5 in.	7.41
026	Side	7.69 in.	30 in.	
032	None	N/A No Orifice Plate		N/A
033	N/A	N/A No longer connected to CSS		N/A

Weirs

Diversion weirs will be simulated as weirs in the model. The following information is required to model a weir in the model:

- Weir ID
- Upstream and downstream nodes
- Type (four potential weir types: transverse, sideflow, V-notch, trapezoidal)
- Dimension (Height, Weir Length, Weir Crest Height)
- Coefficient of Discharge
- Number of End Contractions

Weir ID will be named according to the CSO overflow points. For example, the weir for CSO 03 will be named "Weir_03". Weir information will be obtained from record drawings and will be field verified, if necessary. All weirs were found to be of the transverse type with no end contractions. All weirs are assigned a discharge coefficient of 3.33.

A summary of the weir data used in the model is contained in Table 3-9.

3.2.4.6 Pump Stations

The wet wells in the pump stations were simulated as storage nodes, and pumps were simulated as ideal pumps in the model. Dimensions of the storage nodes were based on record drawings. For pumps, the following information is required:

- Pump ID
- Startup Depth
- Shutoff Depth

Pump startup depth and shutoff depth will be set up in the model according to the typical pump operation.

Table 3-9: Weir Characteristics

Weir ID No.	Dimensions		
	Height	Length	Crest Height
002	2.50 ft.	2.24 ft.	1.21 in.
003	2.50 ft.	2.24 ft.	1.30 in.
004	2.74 ft.	1.69 ft.	1.17 in.
005	3.50 ft.	2.65 ft.	1.25 in.
007	3.50 ft.	2.65 ft.	0.81 in.
008	4.98 ft.	3.54 ft.	1.23 in.
009	3.25 ft.	3.12 ft.	0.94 in.
010*	2.50 ft.	2.24 ft.	1.50 in.
011	2.44 ft.	3.9 ft.	1.76 in.
012	1.58 ft.	1.73 ft.	1.46 in.
013	3.40 ft.	2.65 ft.	1.62 in.
014	2.75 ft.	2.52 ft.	2.33 in.
015	2.79 ft.	1.53 ft.	0.27 in.
016	3.58 ft.	4.51 ft.	2.08 in.
017	2.17 ft.	2.63 ft.	0.96 in.
018	4.33 ft.	2.58 ft.	0.25 in.
019	3.17 ft.	2.05 ft.	1.44 in.
020	2.50 ft.	2.24 ft.	1.44 in.
021	0.63 ft.	1.48 ft.	1.72 in.
022	2.53 ft.	2.24 ft.	1.53 in.
023	1.50 ft.	2.24 ft.	1.25 in.
024	3.00 ft.	2.45 ft.	1.13 in
025	2.50 ft.	2.24 ft.	1.67 in.
026	0.95 ft.	2.43 ft.	2.64 in.
032	2.75 ft.	1.66 ft.	1.54 in.
033	N/A	N/A	N/A

*Height (H) measured from weir crest to pipe crown; Crest Height (H) measured from invert of upstream node to weir crest

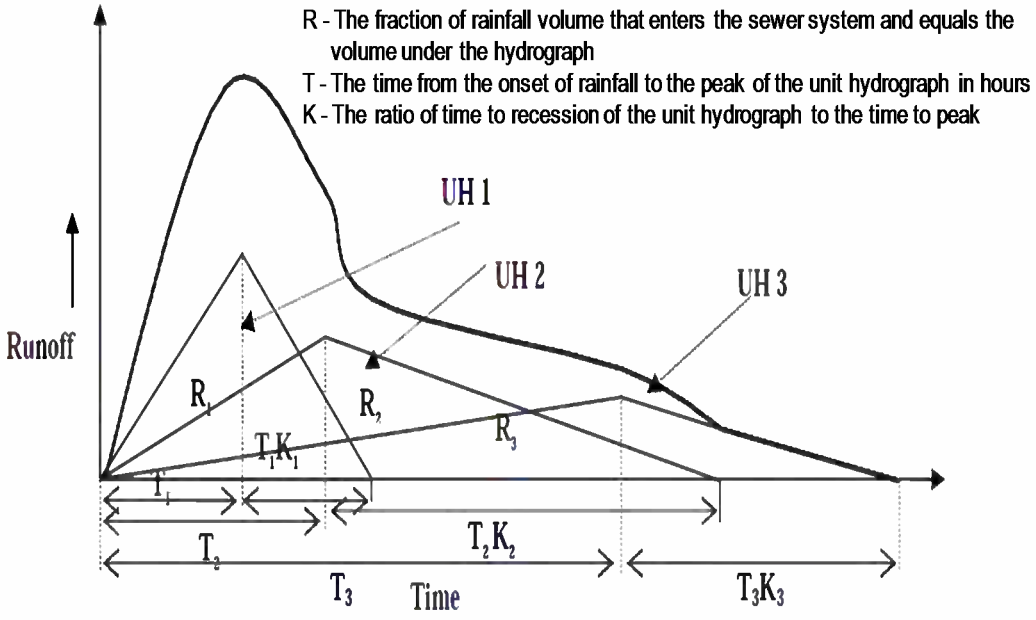
3.2.4.7 Modeling of Separated Areas - Rainfall Derived Infiltration and Inflow (RDII)

The model will use the RTK unit hydrograph (UH) to estimate RDII into the separated area sewer systems. As shown in Figure 3-7 (Muleta & Boulos, 2008), a RTK UH set contains up to three hydrographs: one for a short-term response (UH1), one for an intermediate-term response (UH2), and one for a long-term response (UH3). UH1 represents the most rapidly responding inflow component and has a short T value, UH2 includes both inflow and infiltration and has a longer T value, and UH3 includes infiltration that may continue long after the storm event has ended and has the longest T value. The unit hydrograph is defined by the following three parameters:

- R: the fraction of rainfall volume that enters the sewer system and equals to the volume under the hydrograph,
- T: the time from the onset of rainfall event to the peak of the unit hydrograph in hours, and
- K: the ratio of time to recession of the unit hydrograph to the time to peak.

The same set of RDII parameters will be applied in the same metershed because of the availability of the flow hydrograph for model calibration. The initial values of RTK will be estimated using the RDII Analyst tool in the InfoSWMM. The RTK values are calibration parameters to be refined during model calibration.

Figure 3-7: RTK Unit Hydrographs



Source: M.K. Muleta and P.F. Boulos, Analysis and Calibration of RDII and Design of Sewer Collection Systems, ASCE Conference Proceedings 316, 642 (2008)

3.3 Summary

The 2012 H&H model was updated as described above. A summary of the key revisions is presented in Table 3-10. The detailed layout of the updated model is shown in Figure 3-8 and Figure 3-9.

Table 3-10: Summary of Revised H&H Model

Review Item	2012 Model Review Observation	Comments	Updated Model
Model Software	- EPA SWMM 5.0		Innovyze InfoSWMM version 14.5
Vertical Datum	- NAVD 88	- To be verified	- NGVD29
General Sub Models	- EPASWMM for the runoff model - Horton Equation for the infiltration model - Hydrodynamic wave for the flow routing model	- All these choices are commonly seen in collection system modeling practices	
Rain Gauge	- One (1) rain gage, located at the Western Regional Treatment Plant (WRTP)	- One rain gauge is not sufficient for the entire service area in the model	- Seven (7) rain gauges, as shown in Section 2 - Additional GARR analysis performed
Service Area	- 67 subcatchments, all for combined area - One set of Horton infiltration parameters are applied to most of the subcatchments (66 out of 67 subcatchments) - The infiltration parameters applied in the model is equivalent to infiltration parameters for soil type C/D	- All service area including separated area that contribute flow to the DELCORA collection system should be included in the model - Combined area delineation will be checked to include any changes along the years - Soil type need to be checked to verify Horton infiltration parameters in all subcatchments	- 111 subcatchments, 54 for combined area and 57 for separated areas - Combined area was modified to include newly separated areas. - Horton infiltration parameters applied to 54 out of 111 subcatchments - Horton infiltration parameters varied based on identified soil types -

Review Item	2012 Model Review Observation	Comments	Updated Model
Sewer Manhole	- 736 storage nodes. - All sewer manholes are simulated as storage units in the model. - The majority of the storage units (732 out of the 736) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - All storage units are set-up with a ponding area of 9,999 sf. to allow excess water to collect atop of the nodes and be re-introduced into the system as conditions permit.	- Sewer manholes will be simulated as common junction node - This will help with SSO evaluation in the collection system	- 860 common junction nodes. - The majority of the common junction nodes (836 out of the 860) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - There are 35 imaginary junctions created to receive flow from the subcatchments gravity network not included in the model network
CSO Outfall	- 29 outfall nodes - All CSO outfalls are free outfall	- All outfalls are located in the Delaware River in the tidal reach, a tidal stage instead of free outfall should be assigned to the outfalls - Outfall ID 101 has dry weather input of 1.76 cfs, it represents WRTP in the model	- 24 CSO outfall nodes - Tidal data is assigned to 24 outfalls using time series - Wherever tide gates are installed, a real time control is applied

Review Item	2012 Model Review Observation	Comments	Updated Model
Sewer Mains	- 735 conduit links. - Negative slopes at Nodes 73803 and 70709 not matching the GIS. - Pipe connectivity is not consistent with the GIS in Subcatchment EA1, 25A. - Pipe size and connectivity is not consistent with the GIS around Node: 5201242, 5201234. - Pipe size is not consistent with the GIS around Node: 52018-52015. - Pipe size is not consistent with the GIS around Node: 531-527, 522-517, 516-513, 510020301-5100202, 403-NCPS, 40801-40801A, 32405-32404, and 1110402-11103. - Pipe size and slope are not consistent with the GIS around Node: 422-4140. - NREG06 outfall pipe direction is opposite.	- All the negative slopes and inconsistencies need to be checked with the most updated GIS and record drawings during the model update	- 817 conduit links. - 45 imaginary conduit links created to receive flows from subcatchment gravity network not included in the model

Review Item	2012 Model Review Observation	Comments	Updated Model
CSO Regulators	- 34 orifice links. - All CSO regulators are simulated using orifices to intercept dry weather flows and partial wet weather flows to the collection system, and with elevated conduits to convey extra flows to the CSO outfalls. - Approximately 75% of the orifices (25 out of 34) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - None of the regulator diverting weir structures is simulated in the model.	- Diverting weir structures need to be added in the model - The slopes of all overflow pipes connected to the CSO outfalls need to verified - All orifice opening dimensions verified will be verified - All the RTC rules regulating orifice opening will be verified with actual operation	- 44 orifice links. - CSO regulators are simulated using orifices and float-operated gates to intercept dry weather flows and partial wet weather flows to the collection system, and with conduits set a verified inverts to convey extra flows to the CSO outfalls. Exceptions occur at several regulators where orifices have been removed and at one regulator where the float and gate have been removed. - Approximately 57% of the orifices (25 out of 45) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - Regulator diverting weir structures added to the model. - All orifice opening dimensions were verified using record drawings excepting Orifice 024 which was field verified.
Pump Station	- No pump station is included in the model	- All pump stations that contribute flow to the DELCORA collection system should be added to the model, with related force mains	- Pump stations added to model. - Related force mains added to model

Review Item	2012 Model Review Observation	Comments	Updated Model
Dry Weather Flow	- 94 dry weather flow (DWF) inputs - Total DWF is 7.01 MGD - No diurnal curve - DWF does not include all the separated service areas that contribute to the DELCORA system -	- DWF should be updated to include all the service areas that contribute to the DELCORA system - Weekday and weekend diurnal curve should be included in the model to effectively simulate dry weather diurnal pattern	- 111 dry weather flow (DWF) inputs - Total DWF is 24.6 MGD - DWF analysis was performed on all flow meters in separated and combined areas as well as pump stations - Weekday and weekend diurnal curves were generated as well as overall, weekday, weekend and monthly DWF factors.
RDII	- No rainfall-derived infiltration/inflow (RDII) element was found in the model	- RDII should be included in the model to estimate reasonable wet weather inflow from RDII	- RDII was included in the model to estimate reasonable wet weather inflow from RDII

Figure 3-8: Updated H&H Model Layout

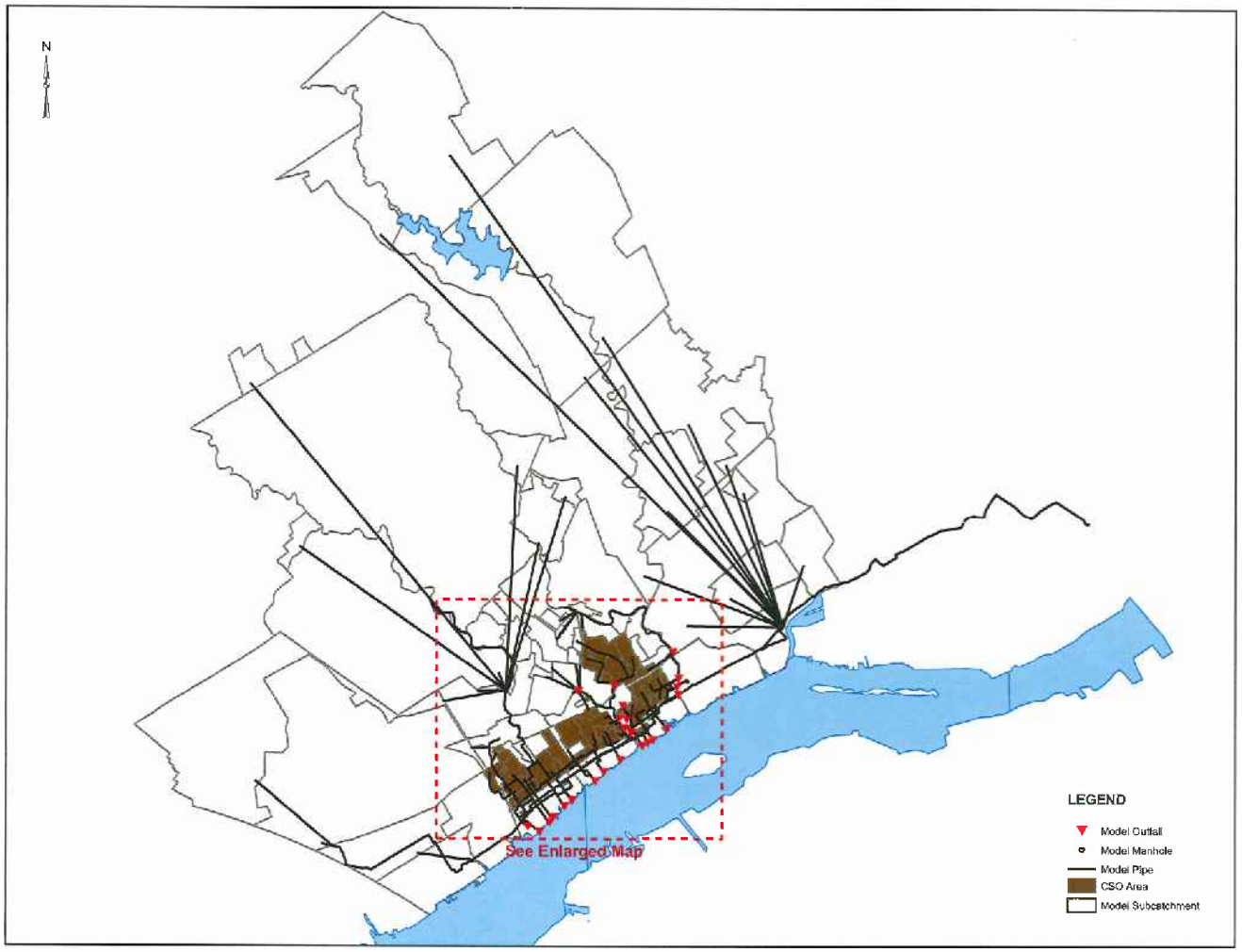
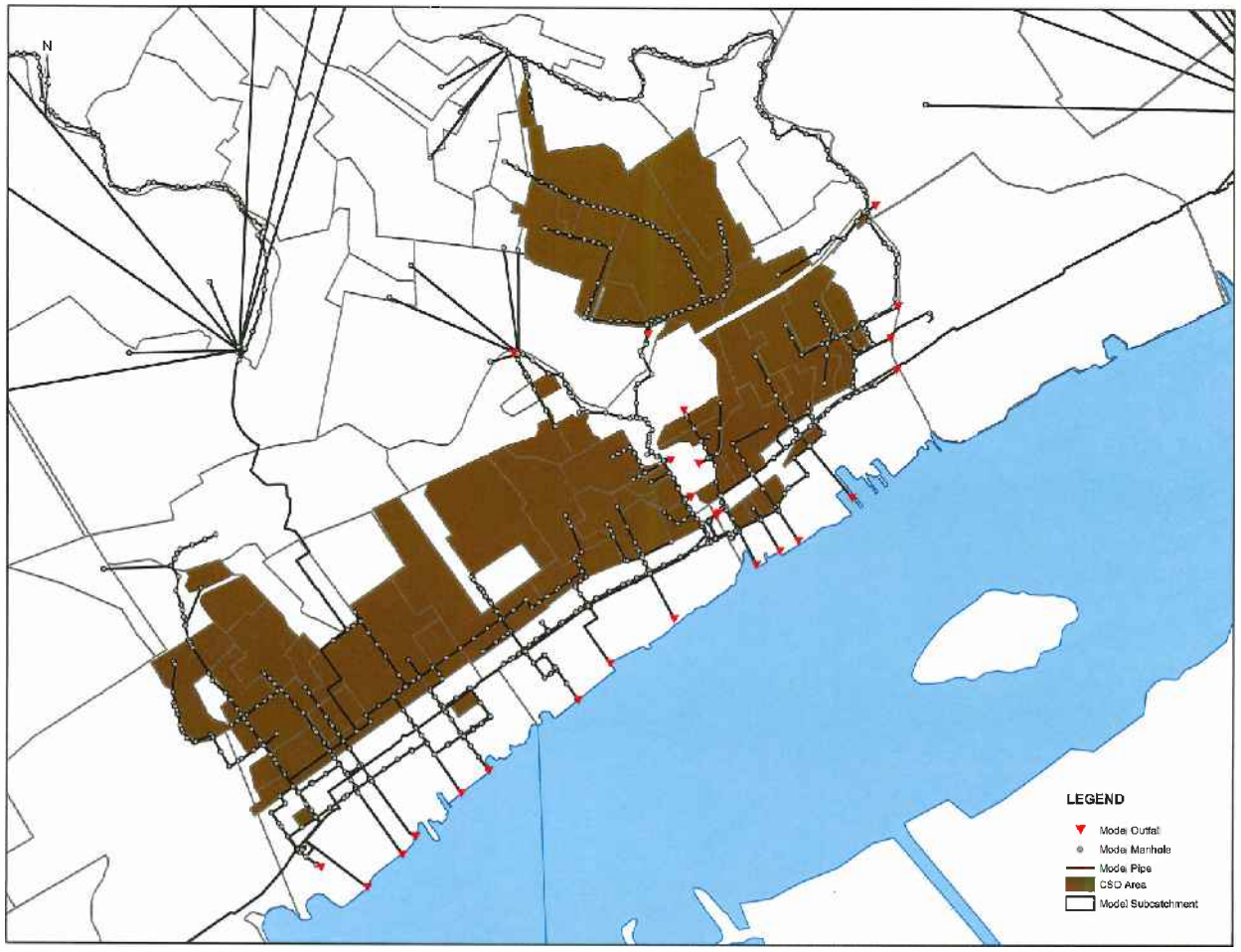


Figure 3-9: Updated H&H Model Layout – CSS Area



Section 4 DELCORA H&H Model Calibration and Validation

4.1 Model Calibration and Validation

Model credibility is developed through model calibration and validation. Model calibration involves application of the model to known external inputs (e.g., rainfall), evaluation of the model's ability to replicate monitored conditions (e.g., flow and volume), and adjustment of key model parameters as needed until an acceptable level of agreement is reached between simulated and monitored conditions.

After the model is satisfactorily calibrated it must be validated by running known storms with known flow results and having the model replicate the known events. Storms used in model validation should be independent from the storms used in the model calibration.

4.1.1 Calibration/Validation Criteria

4.1.1.1 Dry Weather Flow Calibration Criteria

Dry weather flow (DWF) analysis was based on the rainfall and flow monitoring results. DWF distribution in the collection system was based on land use data. Weekday, weekend and monthly diurnal factors from the DWF analysis were applied for each flow meter service area. Upstream meters in the system were calibrated first, then flows through the system to the pumps stations and to the WRTP were balanced. Figure 4-1 shows the arrangement of the meters in the system and meter identification.

DWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be within 1 hour of the observed,
- The simulated peak flow will be within 10% of the observed flow, and
- The simulated flow volume over 24 hours will be within 10% of observed flow.

4.1.1.2 Wet Weather Flow Calibration Criteria

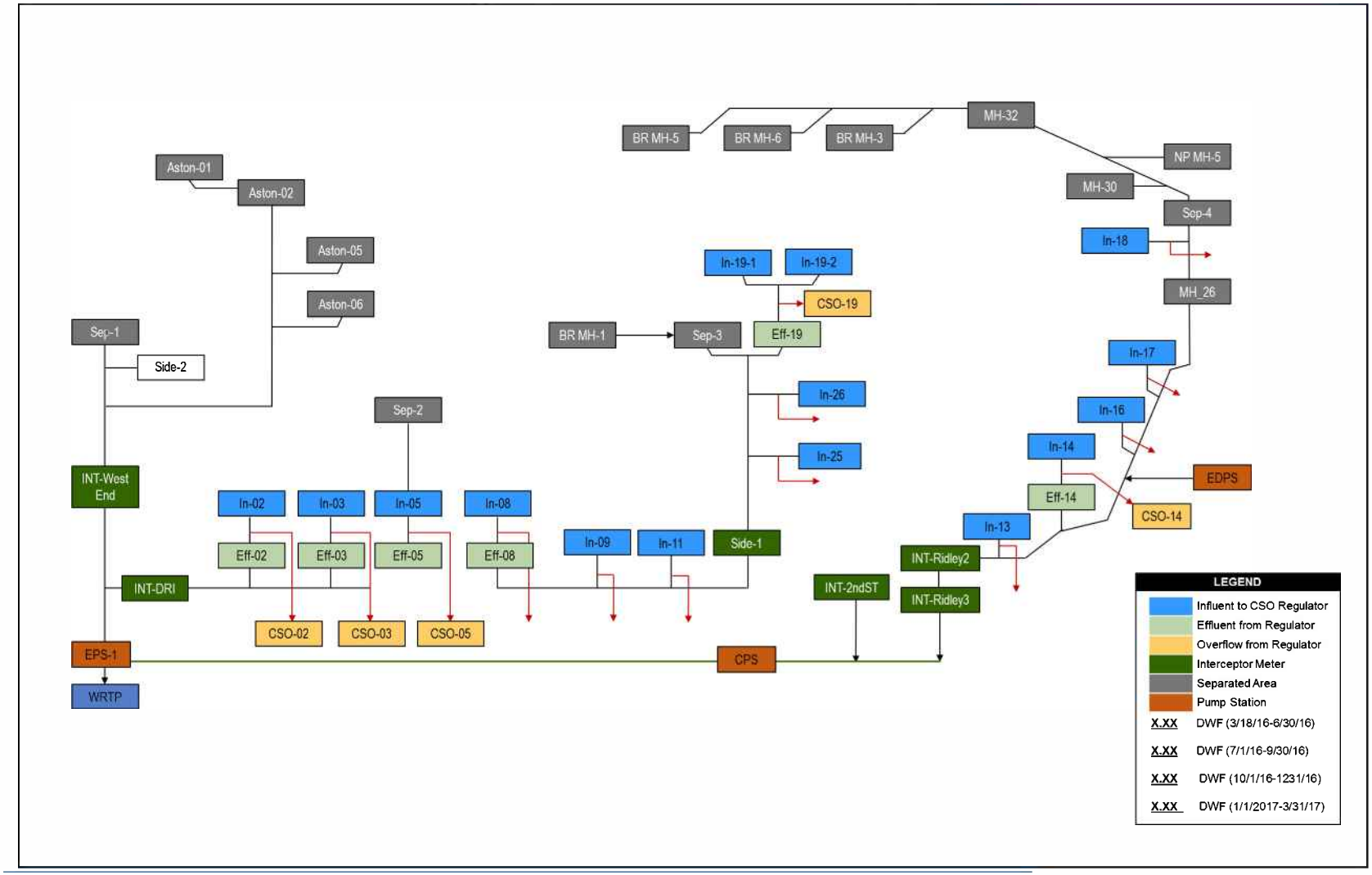
Wet weather flow (WWF) includes surface runoff from the combined area, RDII from the entire service area, and connected rooftops, if any, from the separated area. RDII parameters will be developed based on the separated area, and surface runoff parameters will be adjusted for the combined area to calibrate the system response to the wet weather conditions.

Four (4) wet weather events were selected for wet weather calibration. Final selections include wet weather events with various rainfall intensities and volume.

WWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be similar having regard to the duration of the event,

Figure 4-1: Flow Meter Schematic



- The simulated peak flow for significant peaks will be within the range of -15% to +25%,
- The simulated flow volume will be within the range of -10% to +20%,
- The depth of surcharge will be in the range of -0.1 m to +0.5 m, and
- At key points such as CSOs, the unsurcharged depth will be within ± 100 mm (± 0.33 ft.)

4.1.2 Model Calibration Approach

The runoff calibration for the combined sewer area is achieved by primarily adjusting width and percent imperviousness. The RDII calibration for separated areas was achieved by adjusting RTK values. The calibration of hydraulic control structures (weirs and orifices) is achieved by adjustment the discharge coefficients. The conduit hydraulics calibration is achieved by adjusting Manning's n and head loss coefficients. Flow depth, as well as flow rate, is checked while calibrating the hydraulic model.

After calibration, a different set of flow monitoring data was used to validate the model calibration. Model calibration and validation is an iterative process.

Percent Imperviousness

The percent imperviousness for combined sewer subcatchment is the key parameter to be adjusted to calibrate runoff to the observed wet weather flow volumes. If runoff from a large portion of the impervious surface could not be captured by the combined sewers due to a limited number and size of storm inlets, the percent imperviousness will need to be reduced significantly from its initial value calculated based on impervious land cover. This is done to represent a more reasonable "effectively connected area" and to achieve a satisfactory calibration for runoff volume.

Width

The width for the combined sewer sub catchments, in conjunction with percent imperviousness, will be adjusted to calibrate to the observed wet weather flow peaks.

Depression Storage

The depression storage is another hydrologic parameter for wet weather volume calibration. It can also be adjusted to achieve a satisfactory calibration for the wet weather flow start timing.

RDII Parameters

RDII parameters are to be adjusted to calibrate to the observed wet weather volumes and flow hydrograph shape for the separate sewer areas. Then, the runoff parameters will be adjusted to calibrate to the observed data.

Pipe Roughness

Pipe roughness was adjusted to calibrate to the observed flow depths and velocities at the meter locations.

Orifice and Weir

Orifice and weir parameters discharge coefficients were adjusted to calibrate to the observed overflows at the outfall meter locations.

Minor Loss

Minor loss values were applied in the model where necessary to refine observed flow/depth relationships at the meter locations.

4.1.3 Model Calibration Results

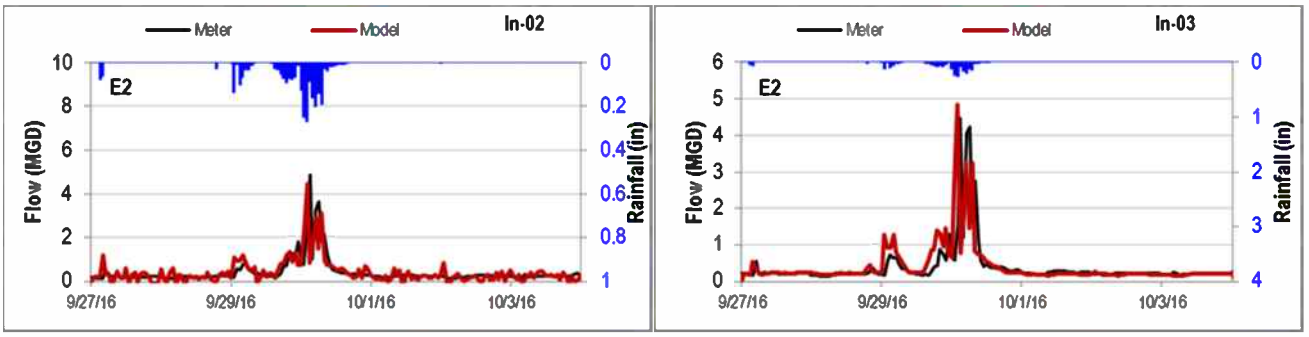
Successful calibration is indicated by satisfying agreements between the model prediction and the flow monitoring data in terms of shape of hydrograph, wet weather volume and peak flow. The calibration was performed and evaluated for various sizes of storms and different antecedent conditions so that the calibrated model can be reasonably applied for various hydrologic conditions. Wet weather events used for model calibration and validation are summarized in listed in Table 4-1. The larger storm events will have more weighting factor in the calibration process because the large events are the ones that dominate the total overflow volume.

Table 4-1: Wet Weather Events for Model Calibration and Validation

Event ID	Start Time	Stop Time	Rainfall Depth* (inches)	Used in Calibration	Used in Validation
E1	5/29/16 19:00	5/30/16 5:00	1.82	C	
E2	9/28/16 12:00	9/30/16 10:00	2.36	C	
E3	11/29/16 7:00	11/29/16 20:00	1.08	C	
E5	5/21/16 11:00	5/22/16 21:00	1.71		V
E6	7/28/16 15:00	7/29/16 9:00	1.26	C	
*At Chester PS rain gauge					

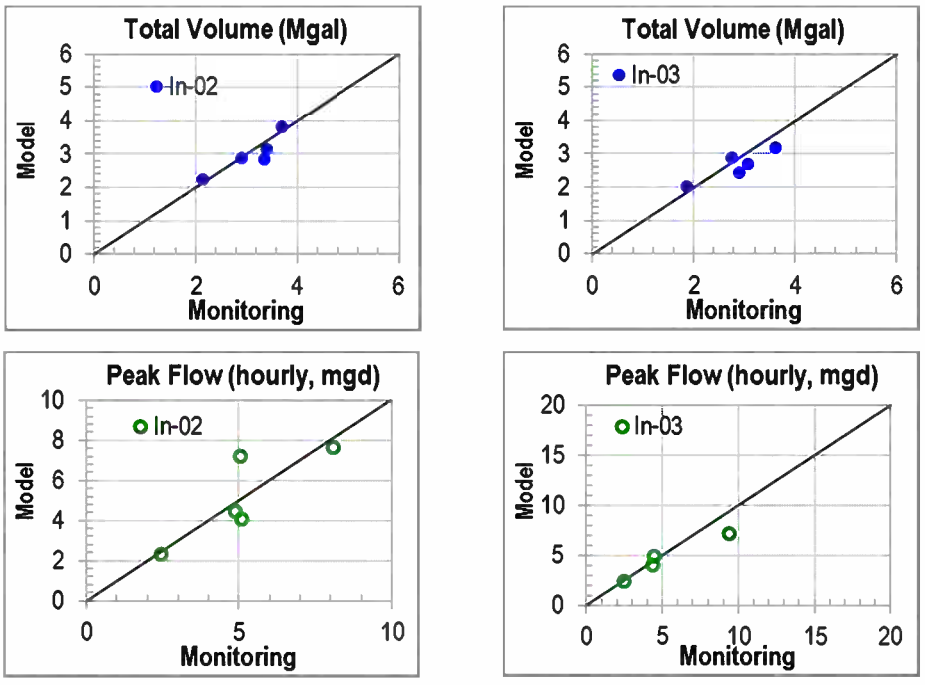
Examples of model calibration results are shown in Figure 4-2. Additional figures for all meters installed at different locations, including meters installed at major trunk interceptor, overflow pipes, influent pipe to overflow control structure, intercepting pipes, previous CSO areas, separate sewer areas and boundaries can be found in Appendix C.

Figure 4-2: Model Calibration Hydrograph (Example Plot)



Comparisons of the predicted total volume against the monitoring total volume and predicted peak flow against monitoring peak flow were analyzed and shown in 1:1 ratio plots for all calibrated meters. This is to evaluate the overall calibration and validation from all the events. The event points in Figure 4-3 are distributed close to the 1:1 ratio line, which means that the model predicted peak flow and wet weather event volume are in good agreement with the metered data. Additional figures for all model calibration plots can be found in Appendix C.

Figure 4-3: Model Calibration Hydrograph (Example Plot)



Section 5 Conclusion

The H&H model from the 2012 DELCORA LTCP Update was reviewed and updated. Data from the rainfall and flow monitoring program was used to calibrate and validate the updated H&H model. The calibrated H&H model will be used to assist DELCORA throughout the remaining steps in the CSO LTCP update process.

In a previous report (Greeley and Hansen, 2016), a typical hydrologic period was selected to represent the average conditions in terms of rainfalls, river flows and combined sewer system response across the DELCORA service area. Subsequent reports will apply the selected typical hydrologic period to the calibrated H&H model to evaluate existing CSO discharge frequency and volume and to evaluate the impacts of proposed LTCP control alternatives on CSO discharges.

Section 6 References

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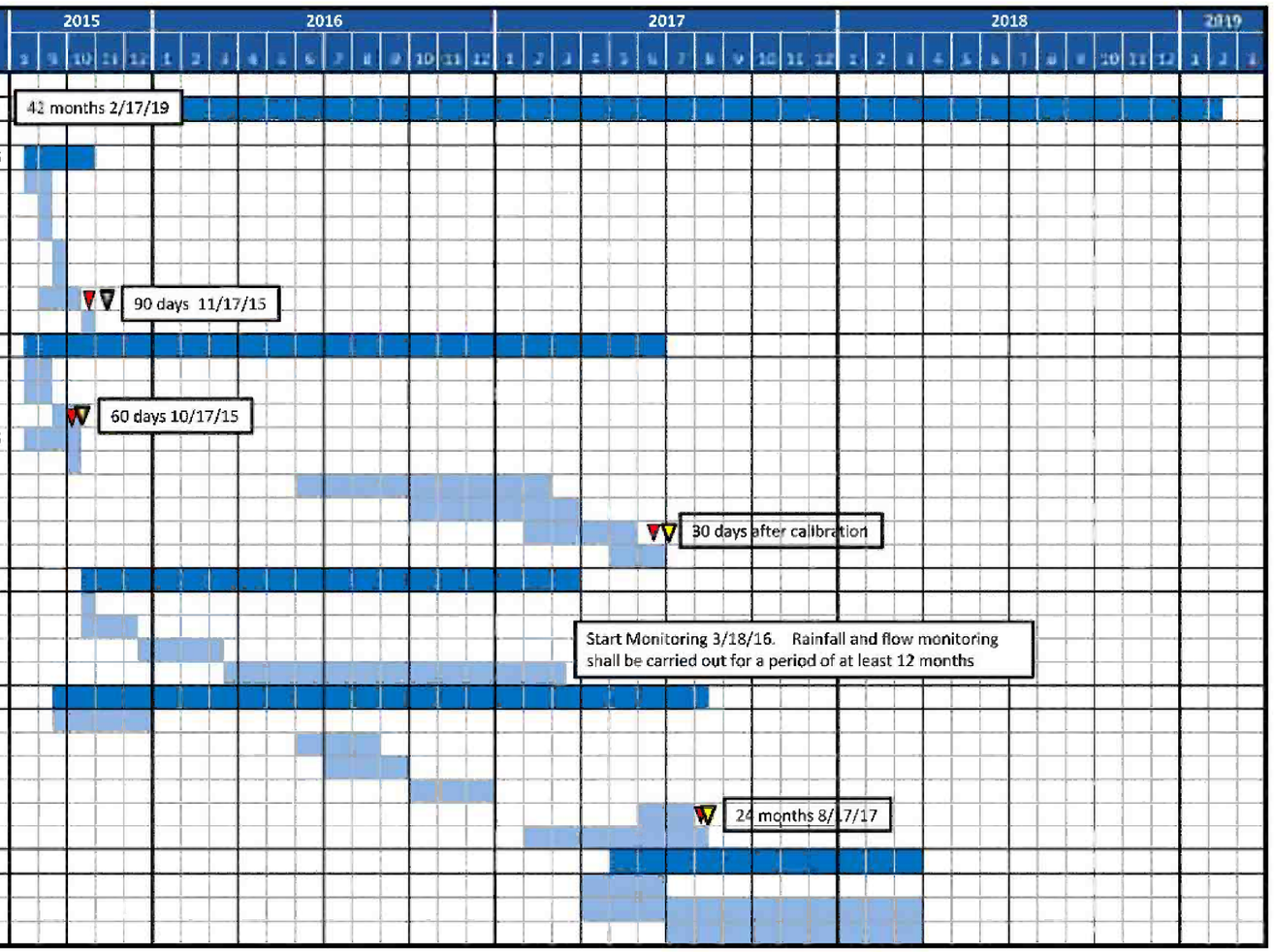
Appendix A H&H Model Update and Calibration Schedule

Figure 6-1 Schedule for H&H Model Development and Implementation (Updated July 28, 2016)

	Tasks of DELCORA H&H Model Development and Implementation	Start	Finish
	Lodging date of Consent Decree (8/17/15)		
	DELCORA Long Term Control Plan Update	8/17/15	2/14/19
	TASK 3 - Typical Year Rainfall Record (90 days)	8/18/15	10/31/15
1	Develop criteria for determination of typical hydrologic period		
2	Review available historic rainfall and flow data		
3	Obtain rainfall data from the Philadelphia National Airport.		
4	Review with DELCORA		
5	Select the typical hydrologic period and document the selection process		
6	Draft Report		
7	Final Report		
	TASK 5 - Hydrologic & Hydraulic Model	8/18/15	8/17/17
1	Initial assessment of GIS Model		
2	Initial assessment of H&H Model		
3	Report summarizing Initial Assessment		
4	Develop an H&H Model Update and Calibration Plan (60 days)	8/18/15	10/14/15
5	Develop Schedule for Model Development and implementation		
6	H&H Model Update		
7	Flow Monitoring Data Analysis		
8	H&H Model Calibration		
9	H&H Model Report		
	TASK 6 - Rainfall and Flow Monitoring	10/15/15	3/31/17
1	Prepare Rainfall and Flow Monitoring Work Plan (from Task 5)		
2	Procure Flow Metering and Rain Gauge Services		
3	Install and Calibrate Rain Gauge and Flow Meters for Official Data Gathering		
4	Conduct Rainfall and Flow Monitoring		
	TASK 7 - Existing Service Area Characterization	9/15/15	8/17/17
1	GIS Mapping Review and Update		
2	Refine Service Area Delineation (Combined and Separated)		
3	Investigate Existing CSO Facilities		
4	Investigate Service Agreements		
5	Perform H&H Modeling of Existing System		
6	Documentation		
	Evaluation of CSO Alternatives (Part of Task 11)	5/1/17	3/31/18
1	Develop Future DWF and Service Area		
2	Develop CSO Alternatives		
3	Evaluate CSO Alternatives using H&H Model		



NOTES:
- Consent Order Deadline
- Draft and Final submittals

Appendix B Description of Hydrologic Soil Groups

Hydrologic Soil Groups (USDA, 2017a)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

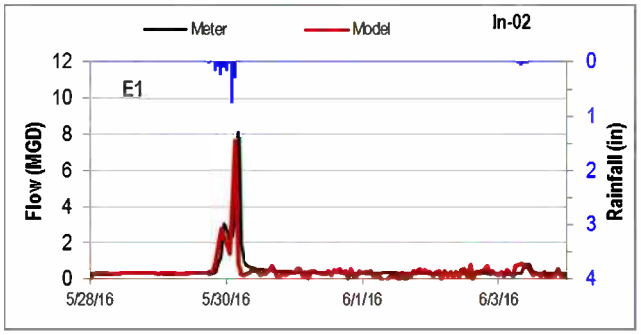
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

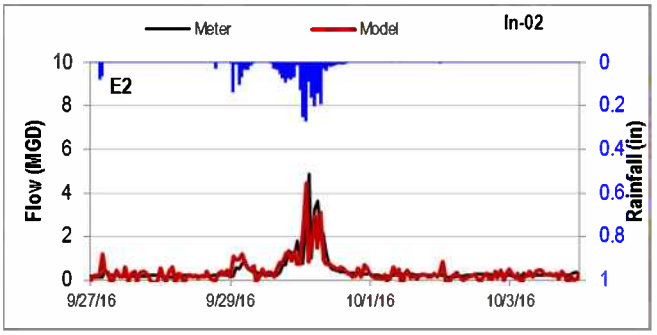
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

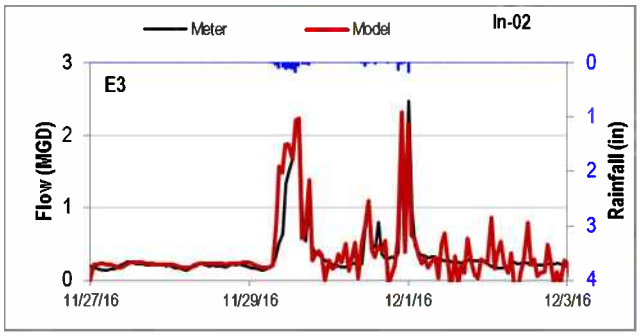
Appendix C Model Calibration and Validation Results

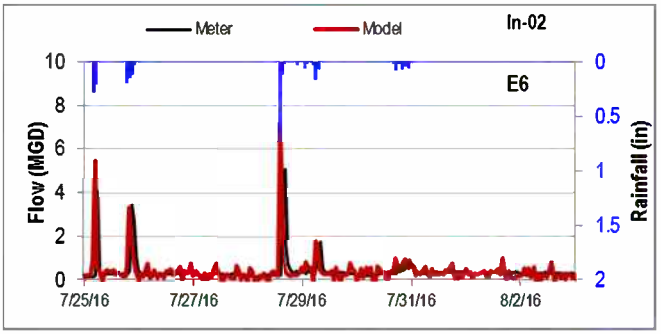
FLOW METER IN-02 MODEL CALIBRATION AND VALIDATION RESULTS

In-02 Model Calibration Results (Metered and Modeled Flow)

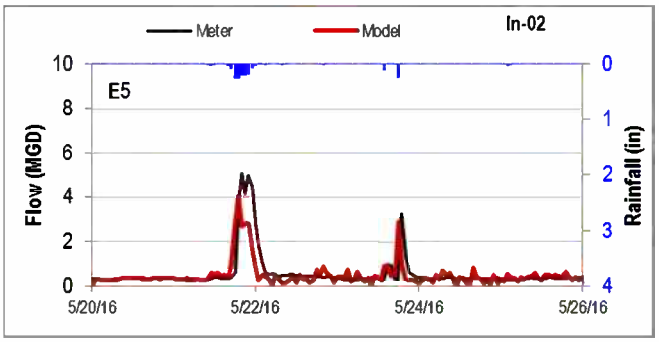




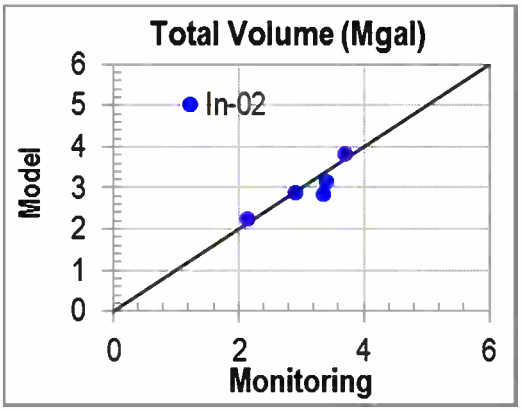


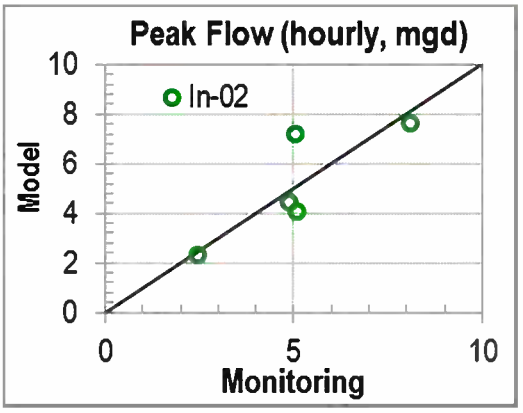


In-02 Model Validation Results (Metered and Modeled Flow)



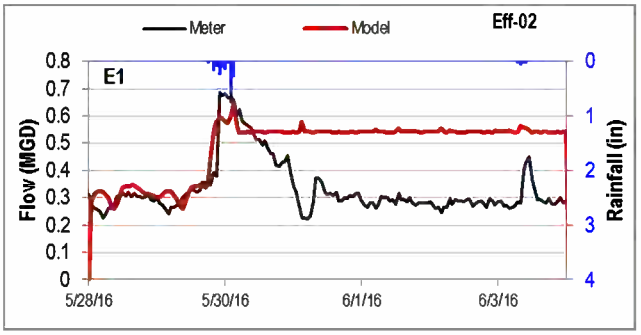
In-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

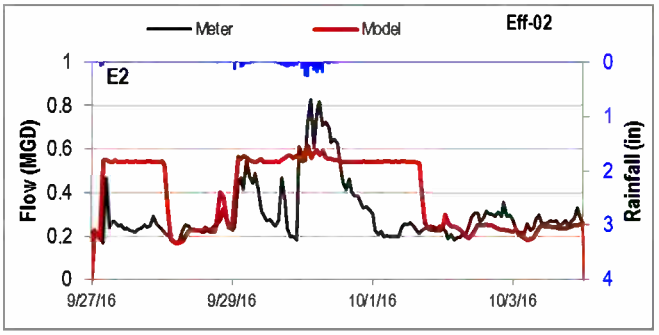


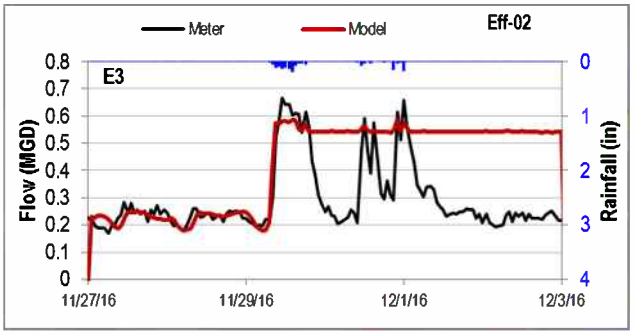


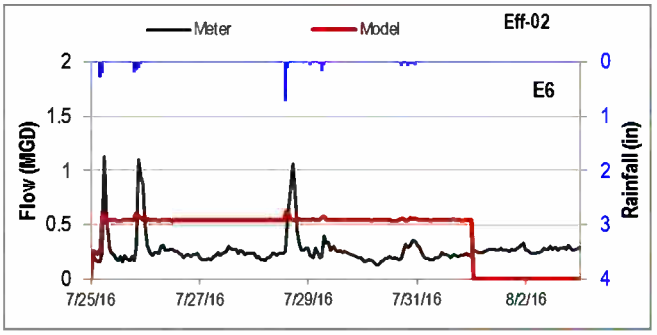
FLOW METER EFF-02 MODEL CALIBRATION AND VALIDATION RESULTS

EFF-02 Model Calibration Results (Metered and Modeled Flow)

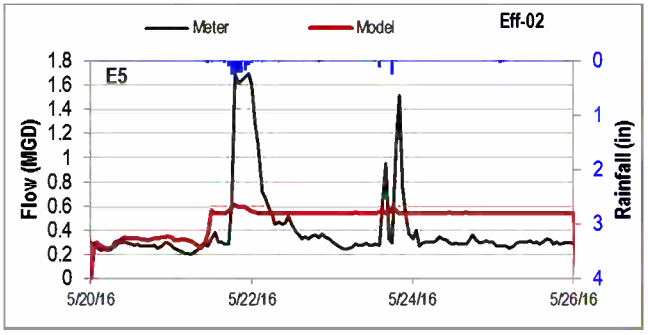




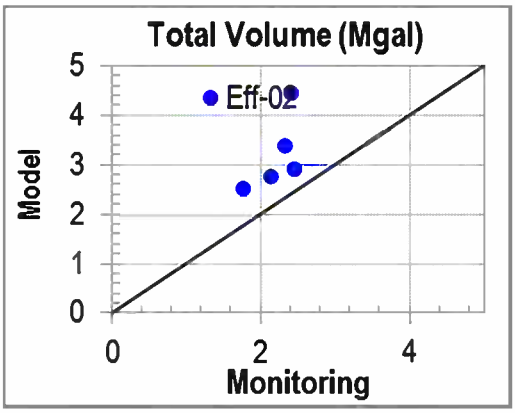


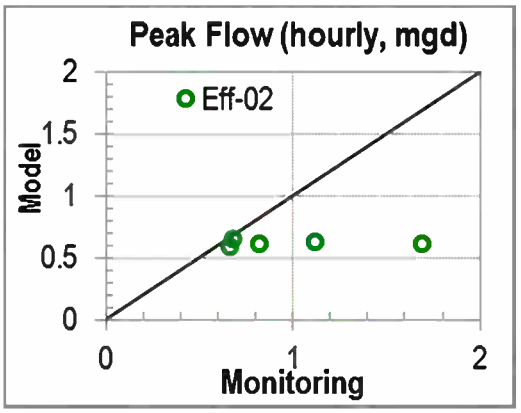


EFF-02 Model Validation Results (Metered and Modeled Flow)



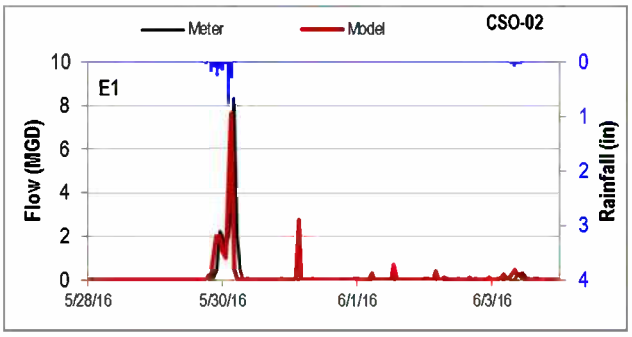
EFF-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

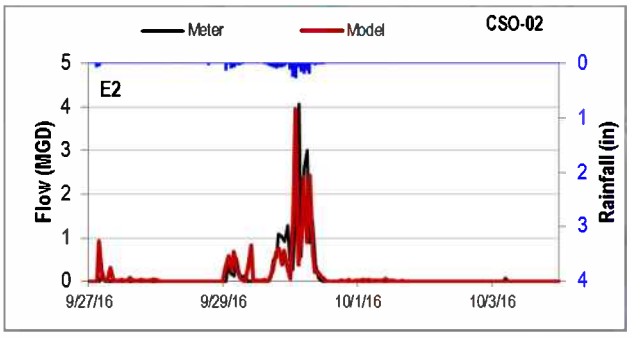


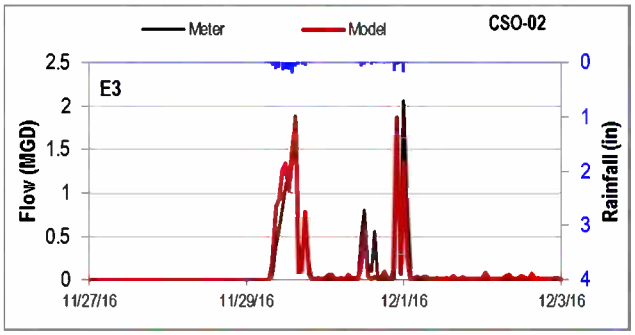


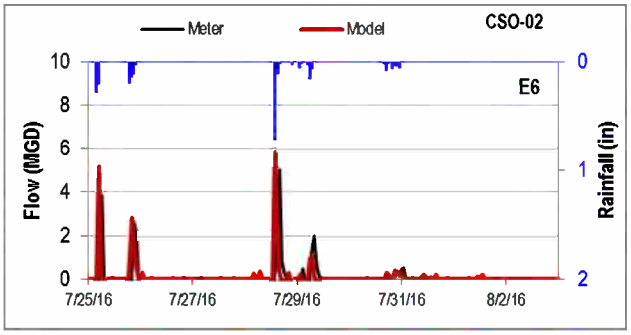
FLOW METER CSO-02 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-02 Model Calibration Results (Metered and Modeled Flow)

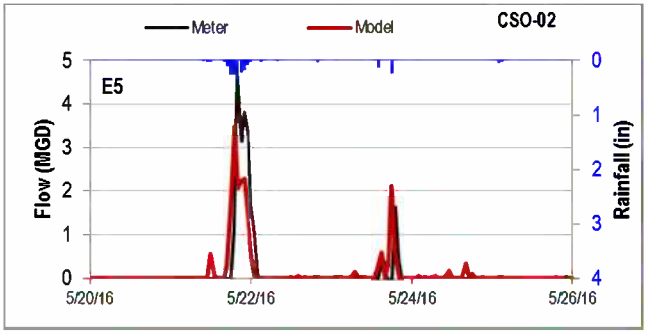




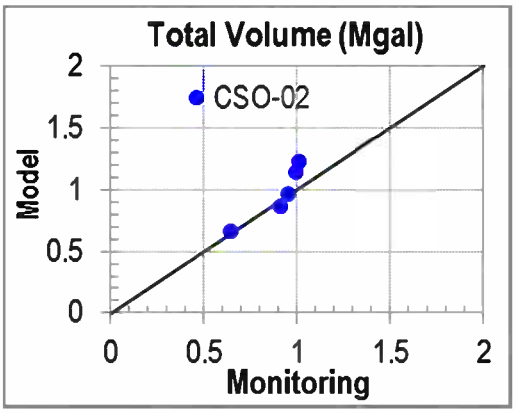


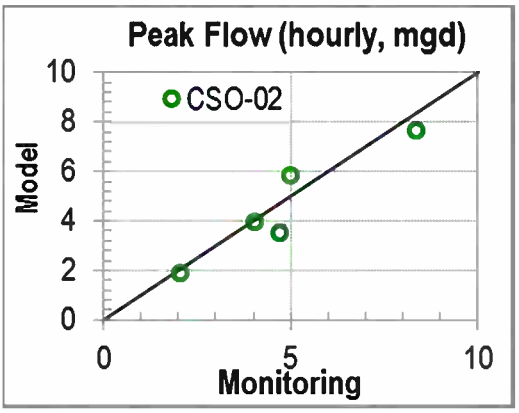


CSO-02 Model Validation Results (Metered and Modeled Flow)



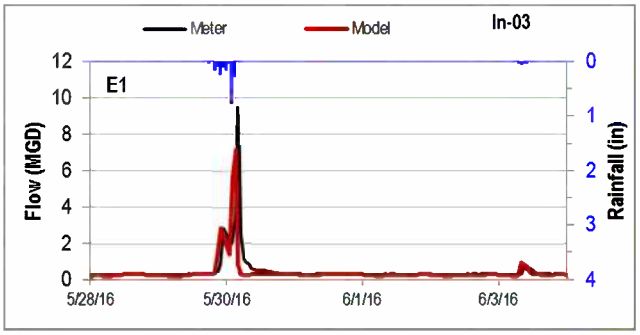
CSO-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

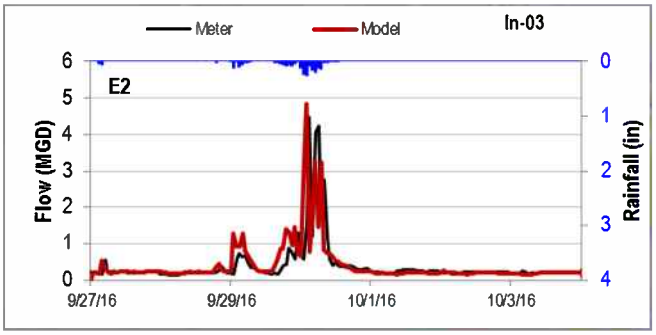


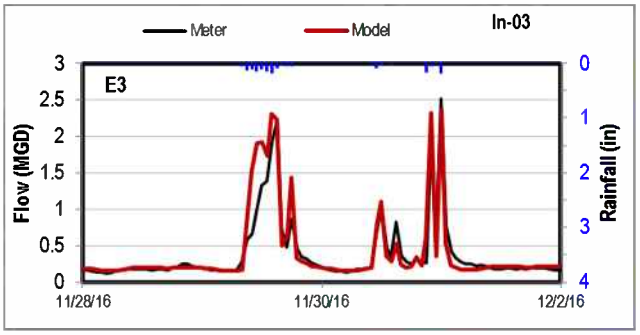


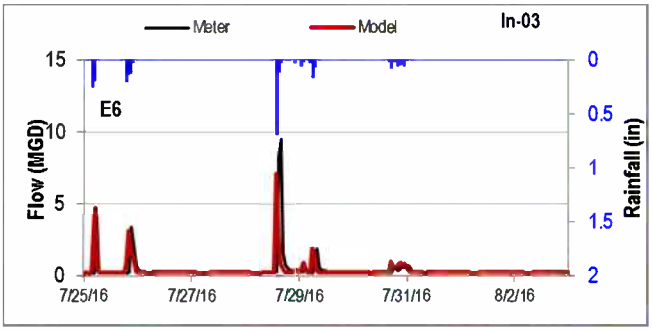
FLOW METER IN-03 MODEL CALIBRATION AND VALIDATION RESULTS

In-03 Model Calibration Results (Metered and Modeled Flow)

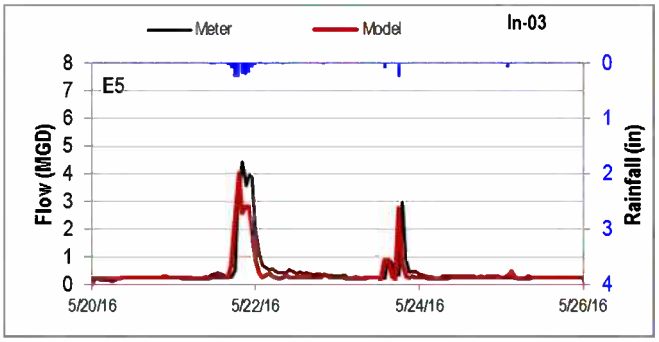




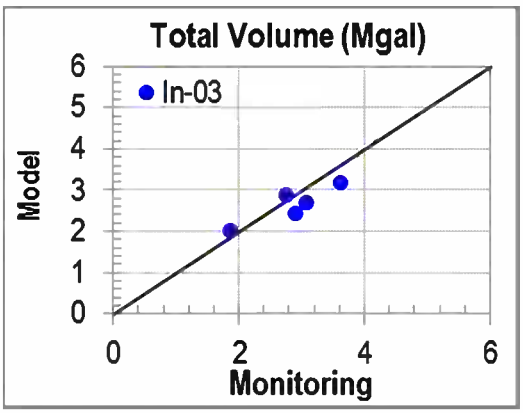


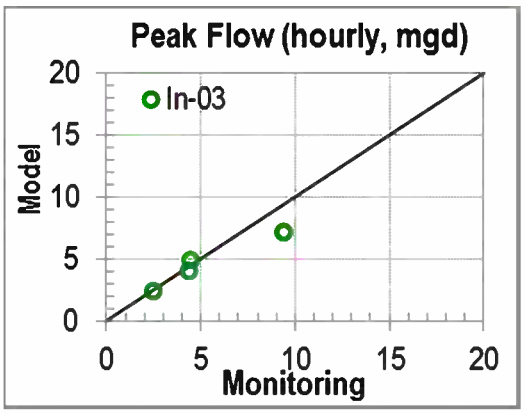


In-03 Model Validation Results (Metered and Modeled Flow)



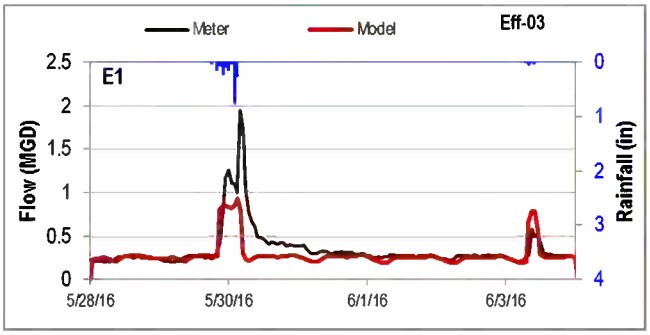
In-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

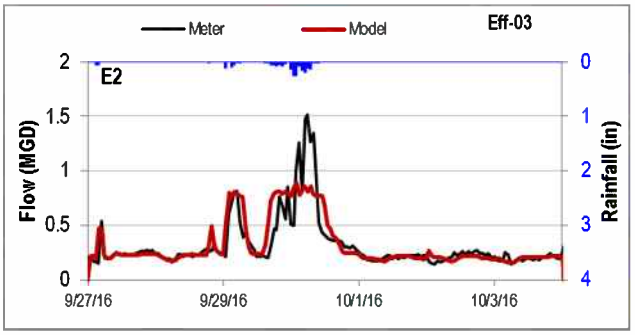


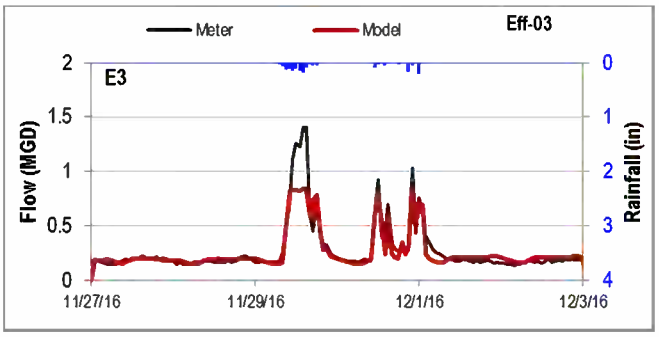


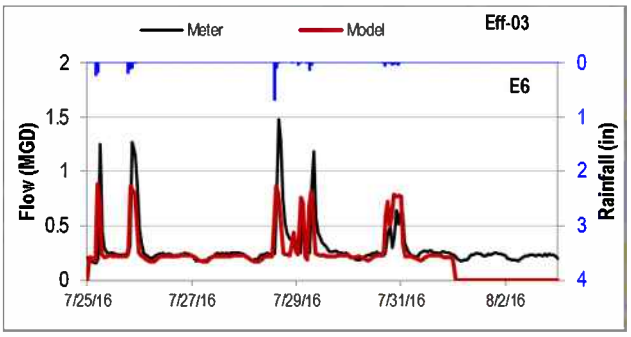
FLOW METER Eff-03 MODEL CALIBRATION AND VALIDATION RESULTS

Eff-03 Model Calibration Results (Metered and Modeled Flow)

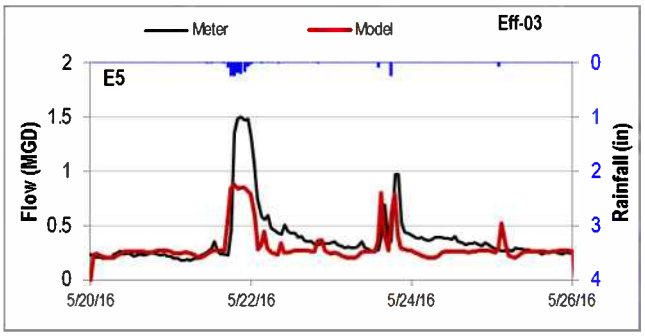




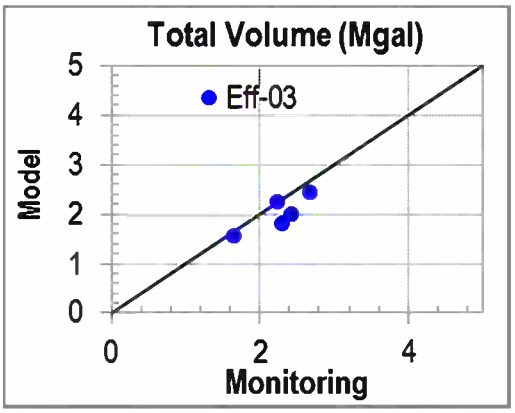


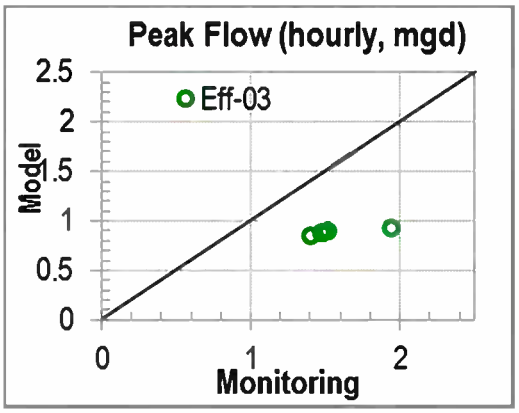


Eff-03 Model Validation Results (Metered and Modeled Flow)



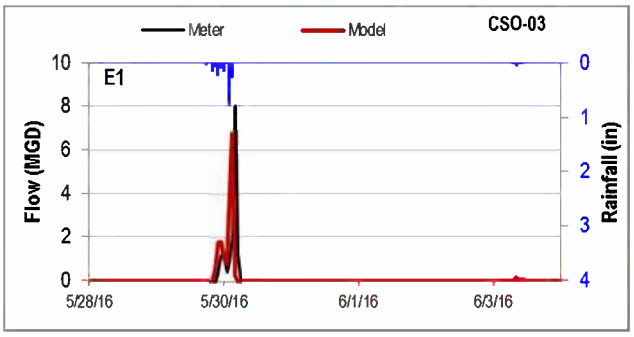
Eff-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

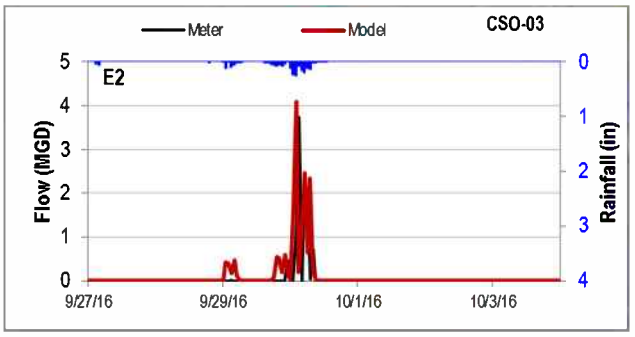


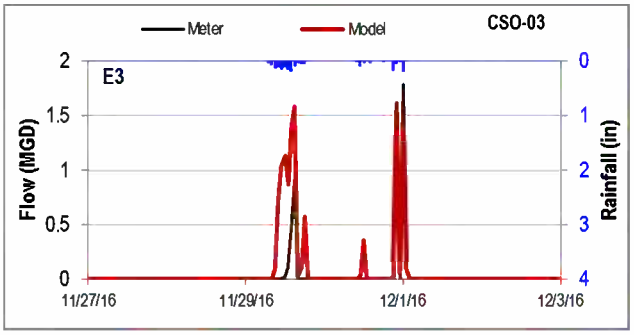


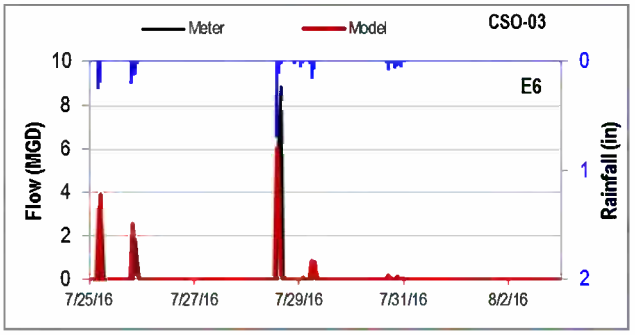
FLOW METER CSO-03 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-03 Model Calibration Results (Metered and Modeled Flow)

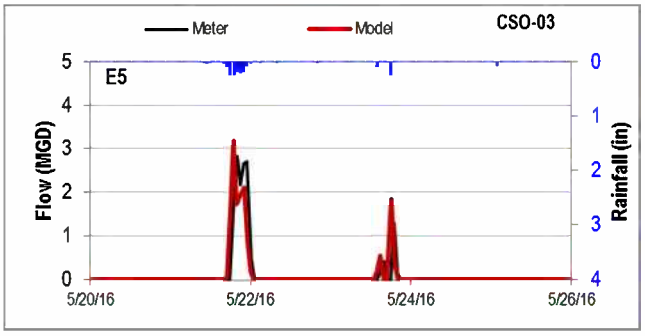




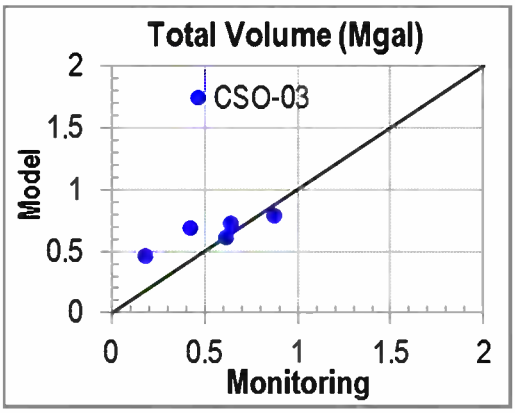


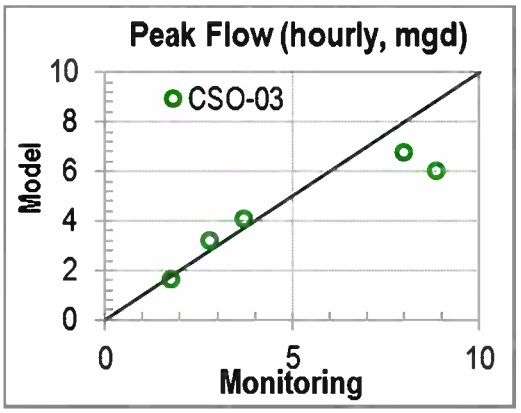


CSO-03 Model Validation Results (Metered and Modeled Flow)



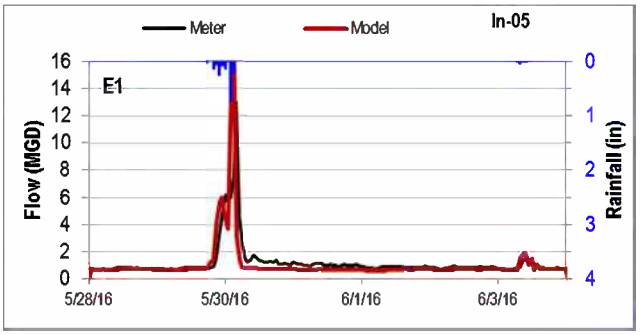
CSO-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

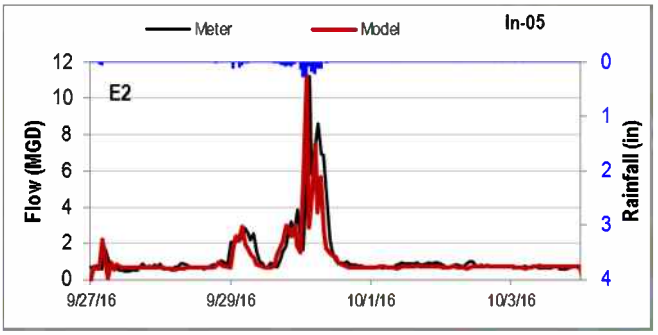


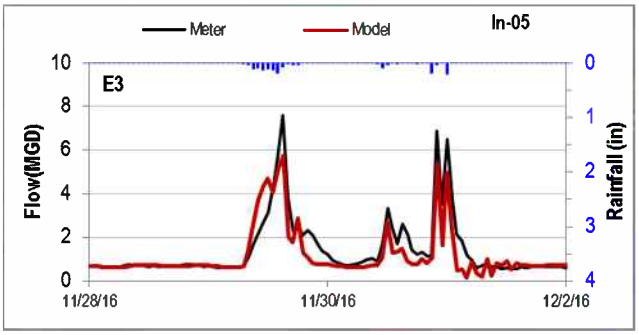


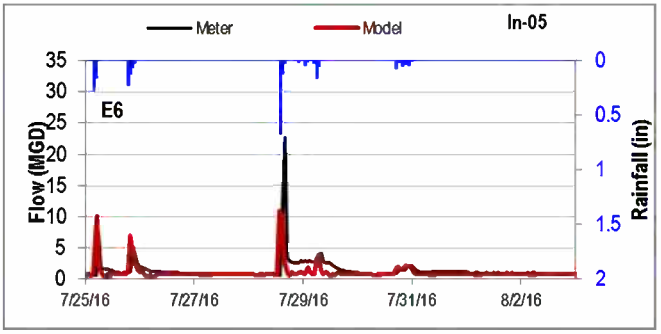
FLOW METER IN-05 MODEL CALIBRATION AND VALIDATION RESULTS

In-05 Model Calibration Results (Metered and Modeled Flow)

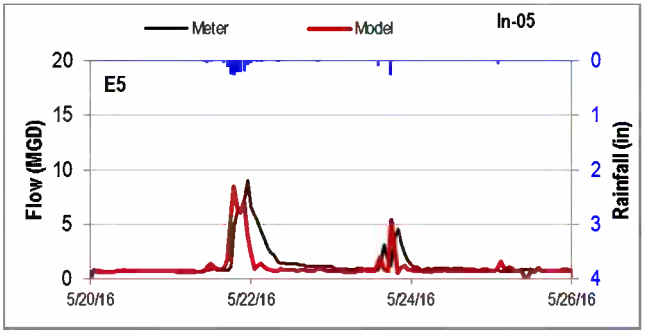




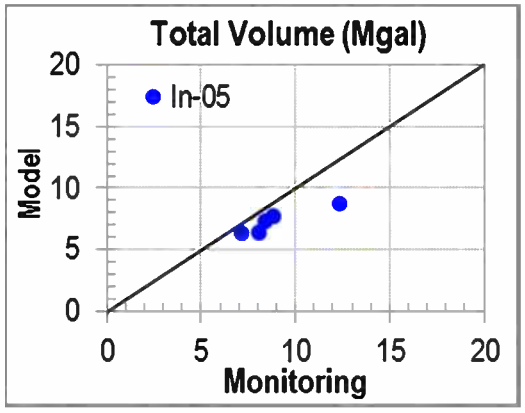


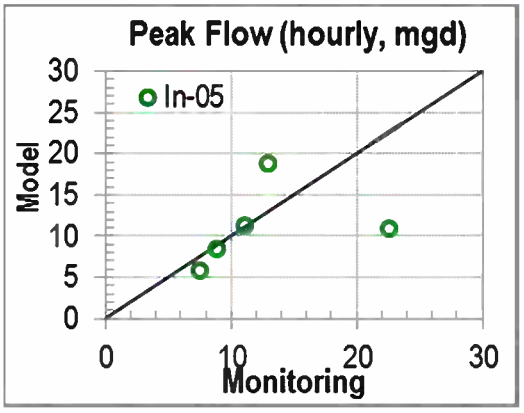


In-05 Model Validation Results (Metered and Modeled Flow)



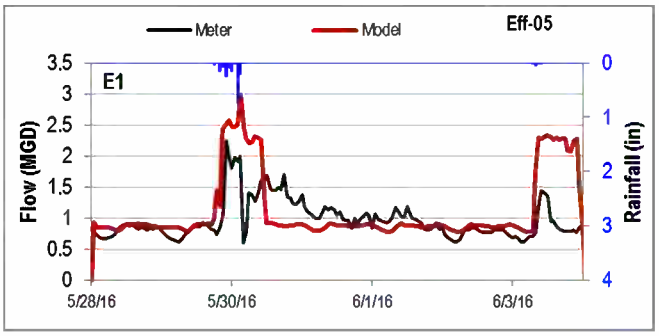
In-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

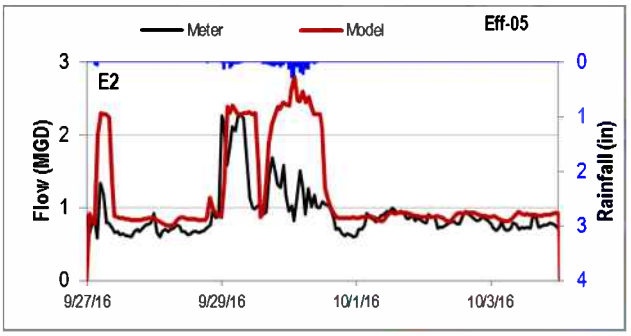


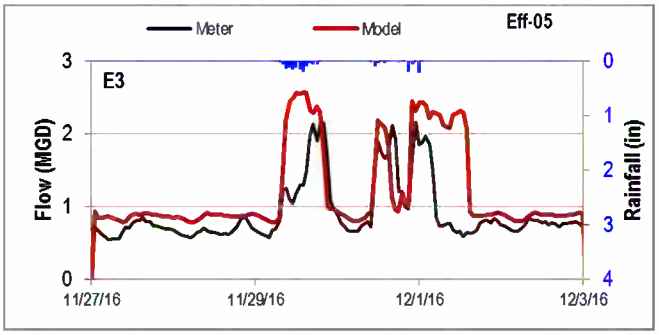


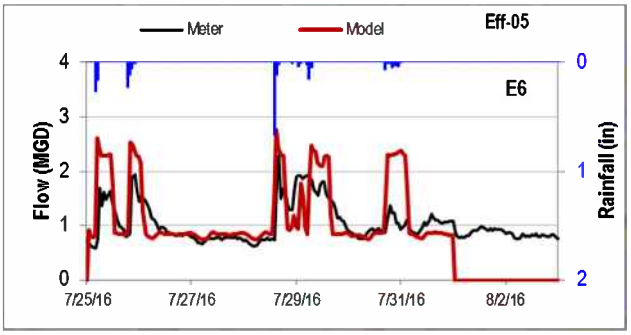
FLOW METER eFF-05 MODEL CALIBRATION AND VALIDATION RESULTS

Eff-05 Model Calibration Results (Metered and Modeled Flow)

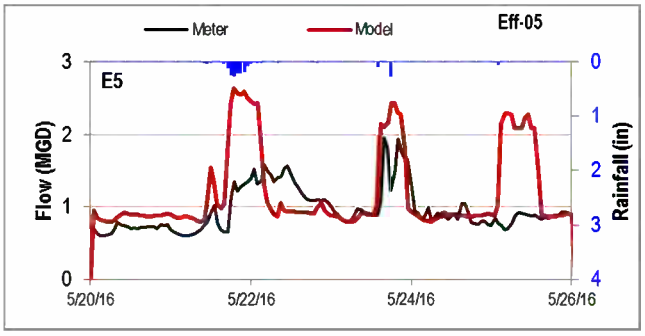




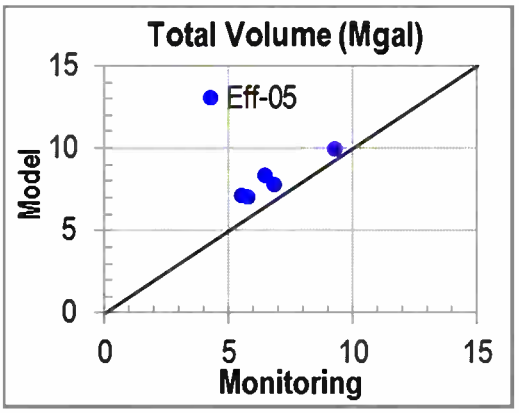


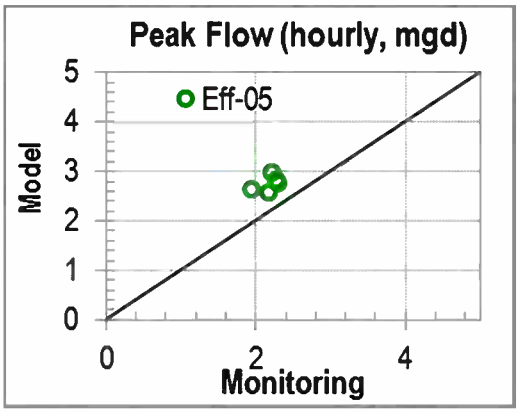


Eff-05 Model Validation Results (Metered and Modeled Flow)



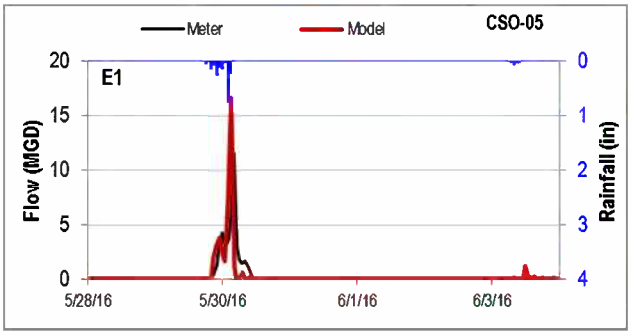
Eff-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

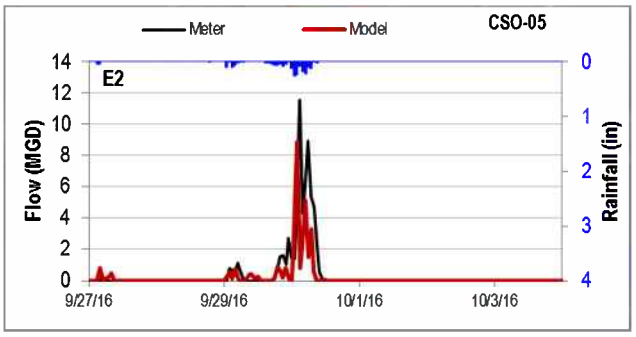


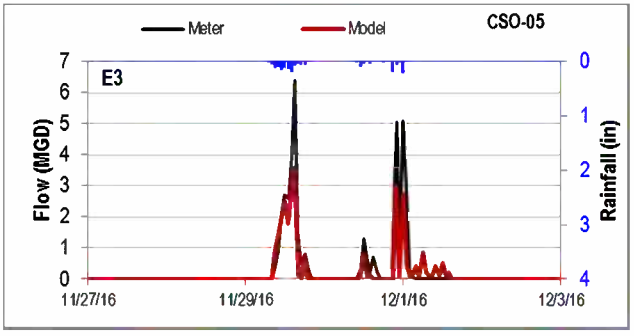


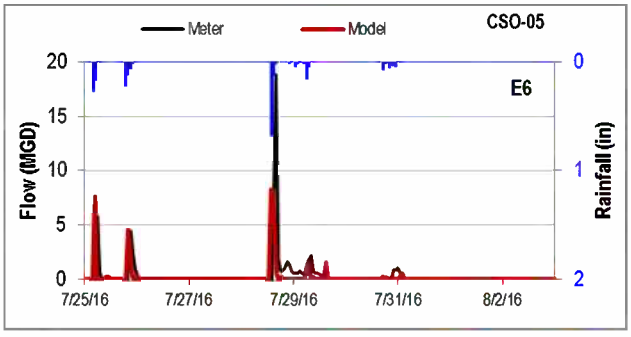
FLOW METER CSO-05 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-05 Model Calibration Results (Metered and Modeled Flow)

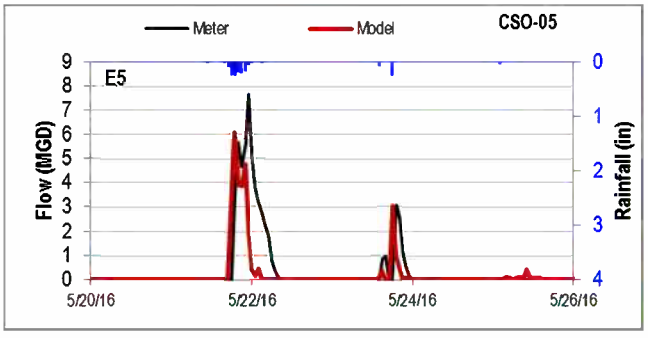




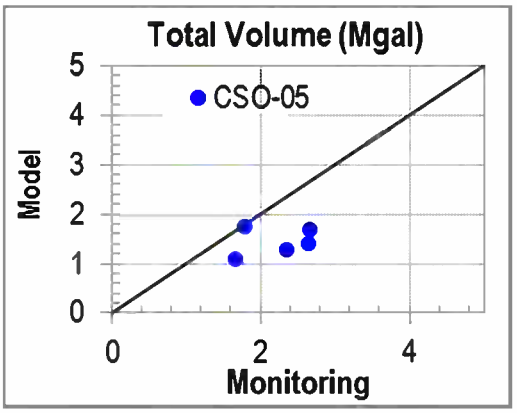


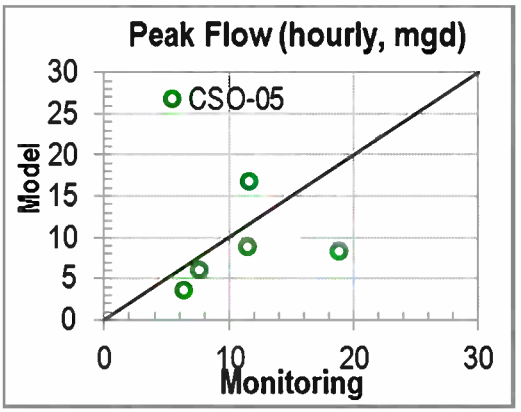


CSO-05 Model Validation Results (Metered and Modeled Flow)



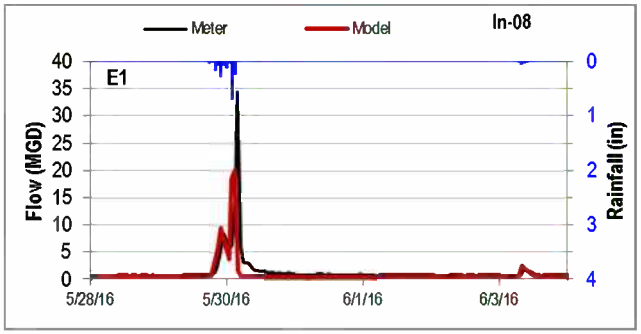
CSO-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

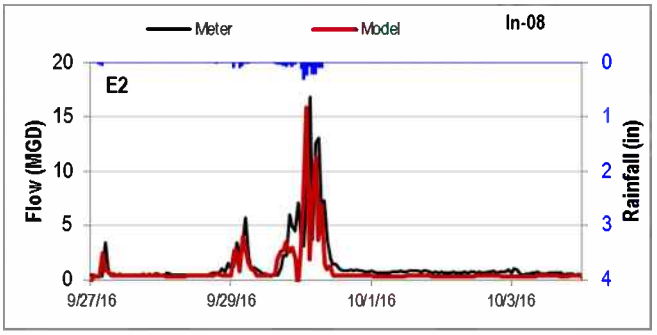


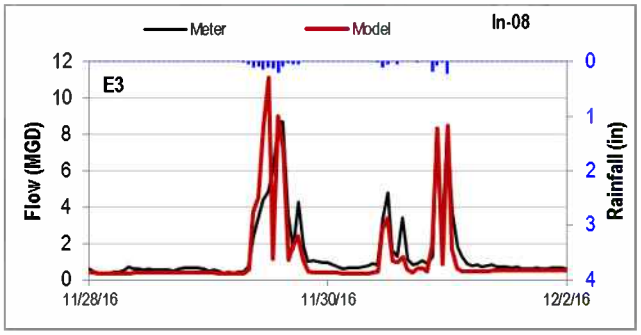


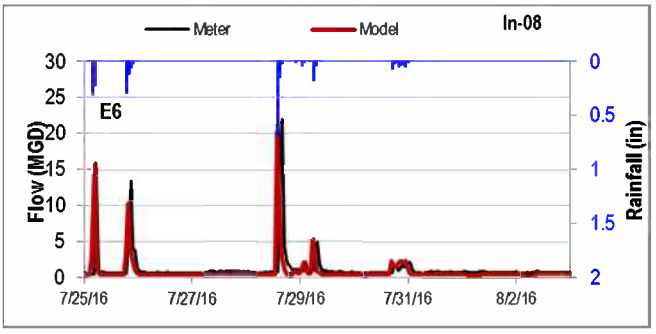
FLOW METER IN-08 MODEL CALIBRATION AND VALIDATION RESULTS

In-08 Model Calibration Results (Metered and Modeled Flow)

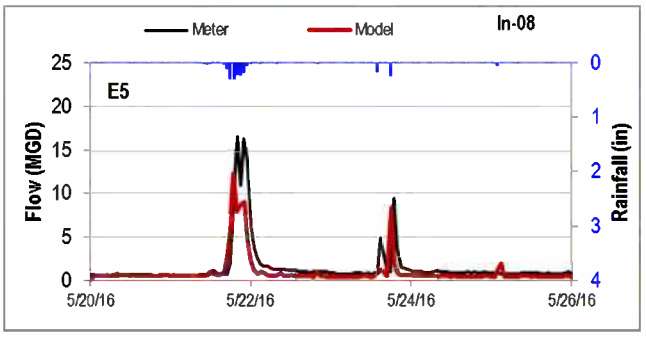




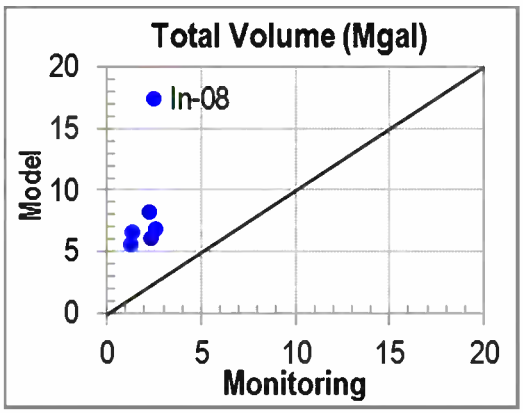


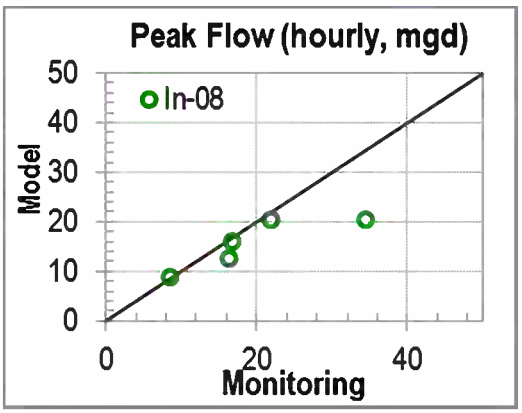


In-08 Model Validation Results (Metered and Modeled Flow)



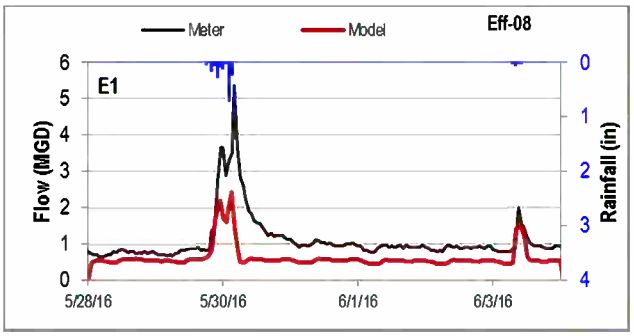
In-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

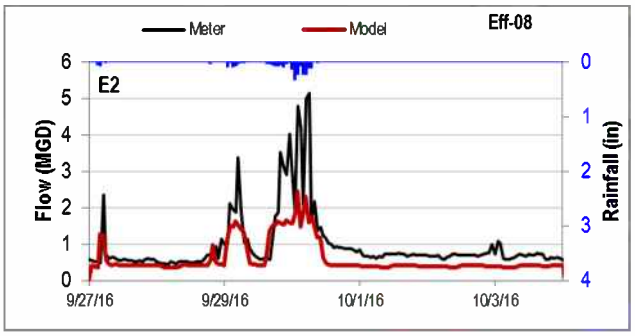


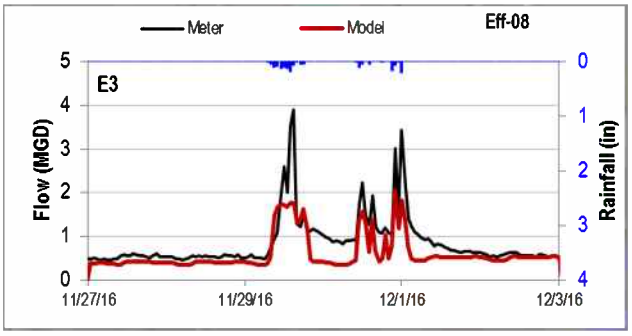


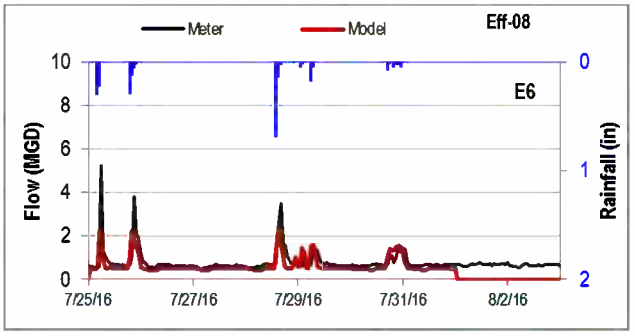
FLOW METER Eff-08 MODEL CALIBRATION AND VALIDATION RESULTS

Eff-08 Model Calibration Results (Metered and Modeled Flow)

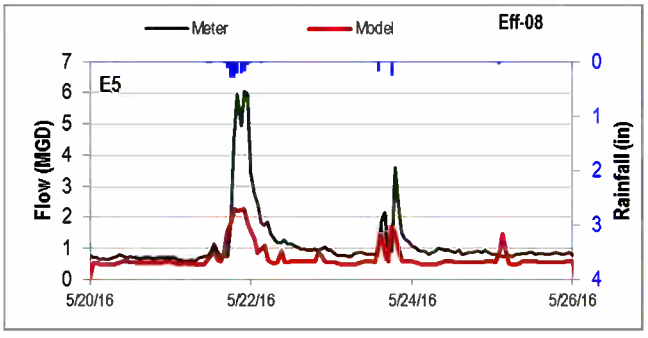




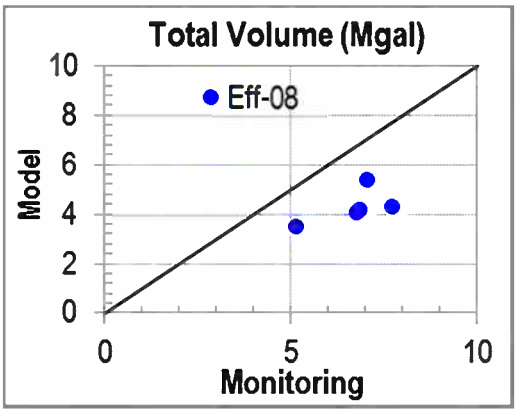


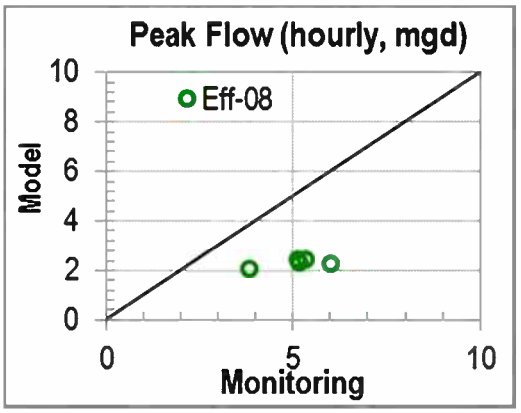


Eff-08 Model Validation Results (Metered and Modeled Flow)



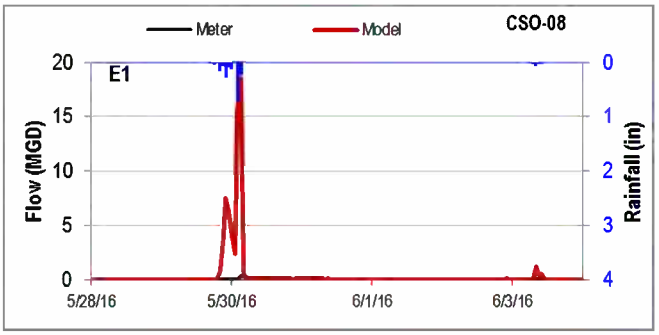
Eff-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

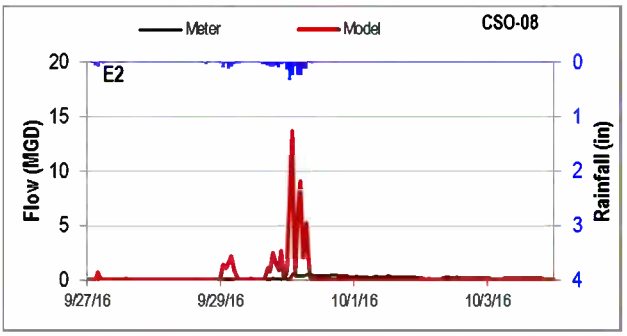


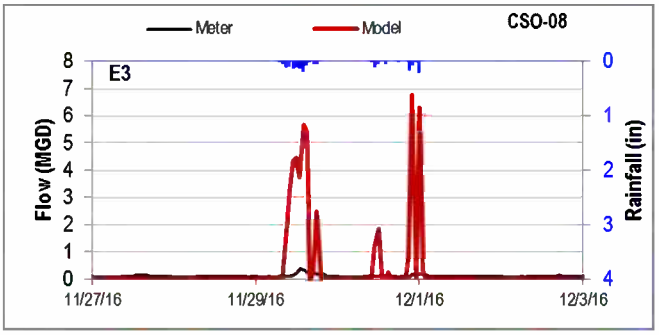


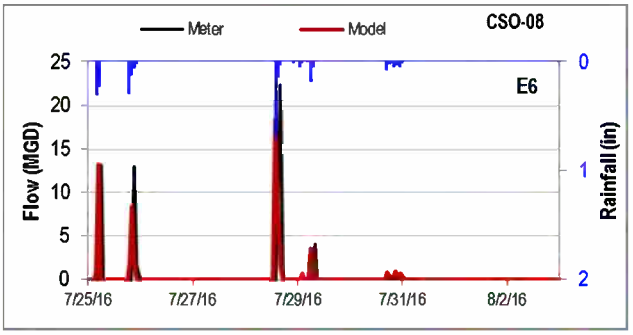
FLOW METER CSO-08 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-08 Model Calibration Results (Metered and Modeled Flow)

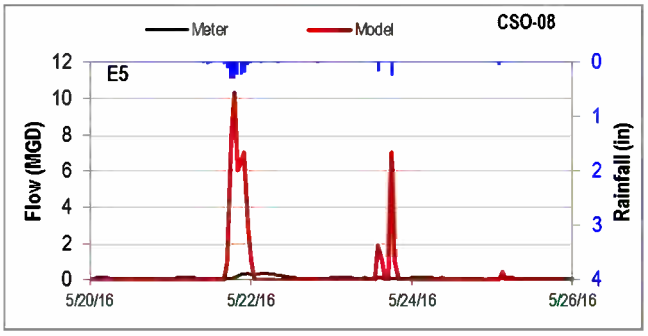




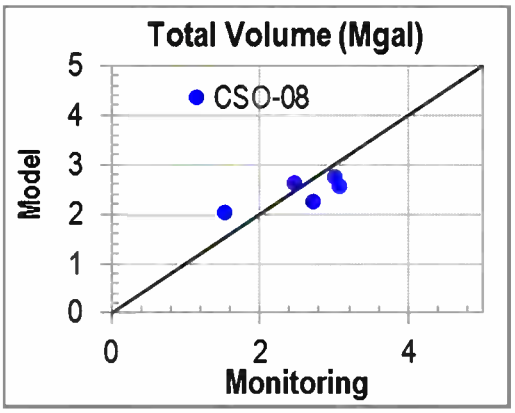


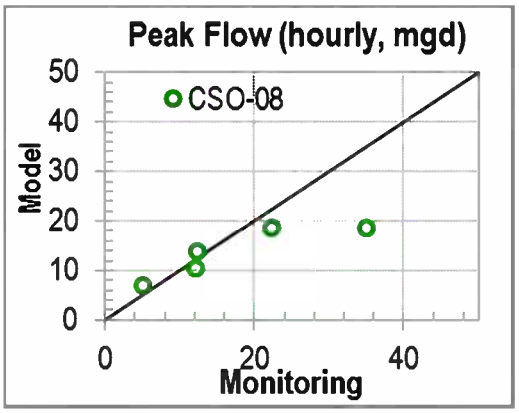


CSO-08 Model Validation Results (Metered and Modeled Flow)



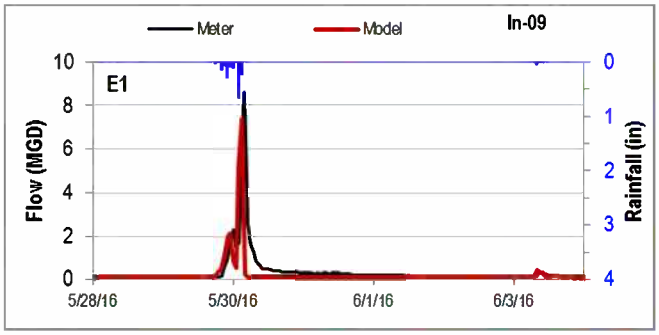
CSO-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

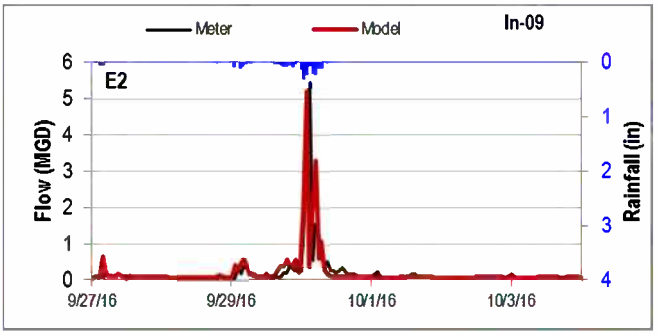


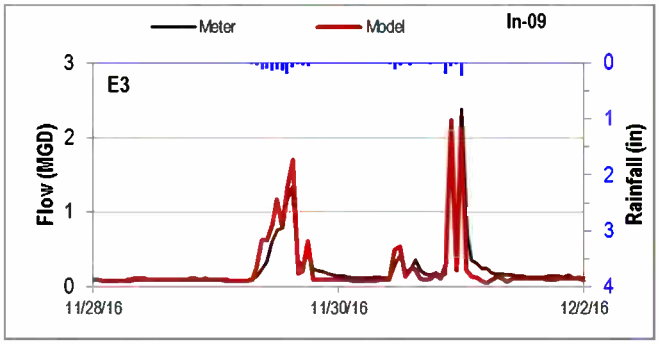


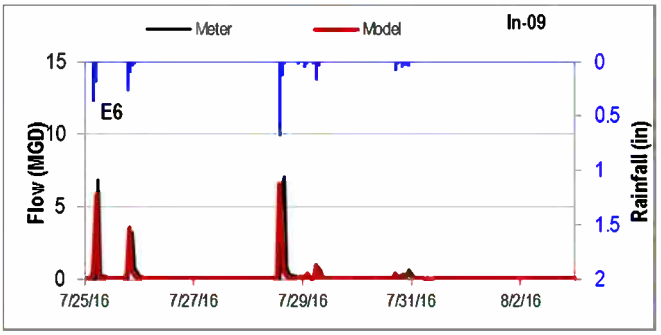
FLOW METER IN-09 MODEL CALIBRATION AND VALIDATION RESULTS

In-09 Model Calibration Results (Metered and Modeled Flow)

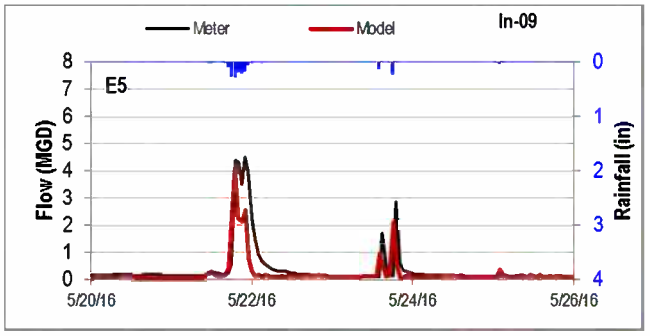




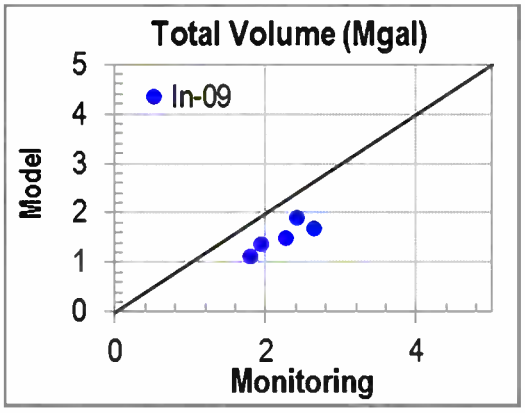


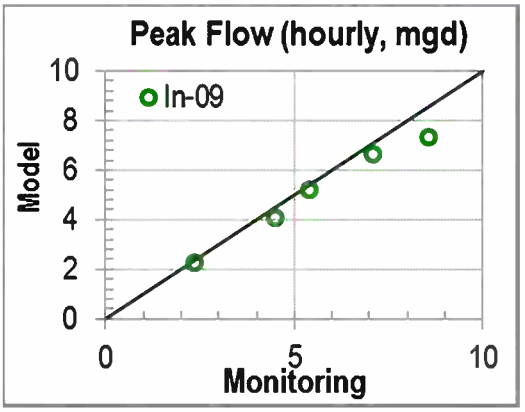


In-09 Model Validation Results (Metered and Modeled Flow)



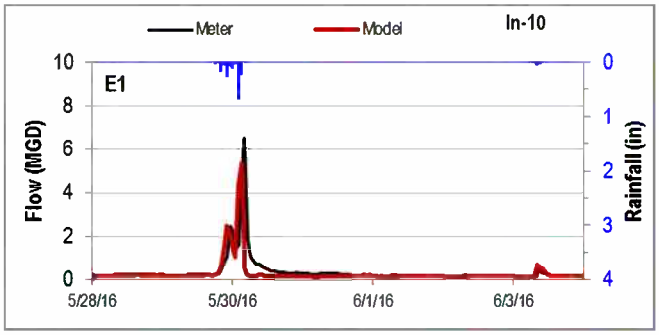
In-09 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

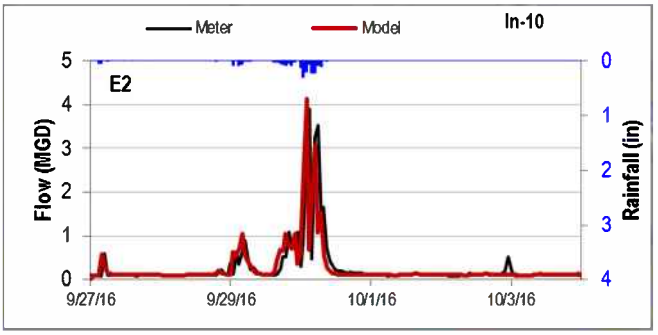


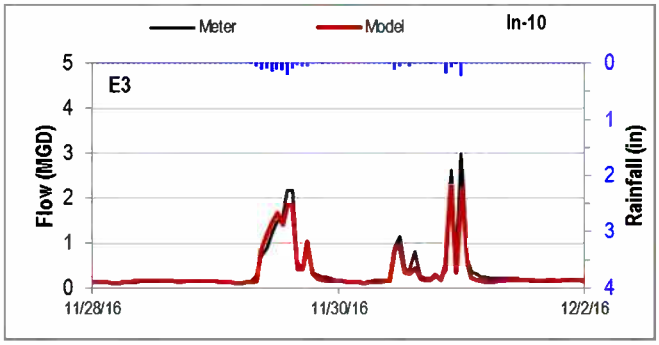


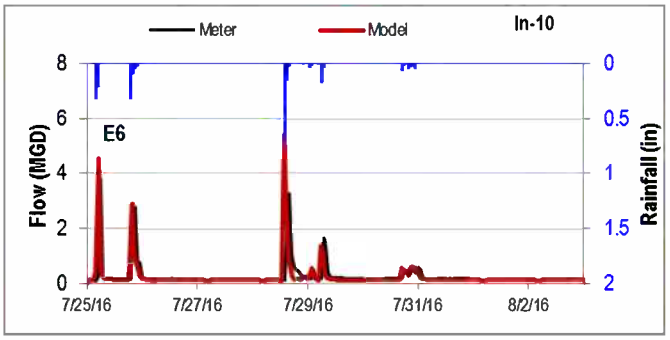
FLOW METER IN-10 MODEL CALIBRATION AND VALIDATION RESULTS

In-10 Model Calibration Results (Metered and Modeled Flow)

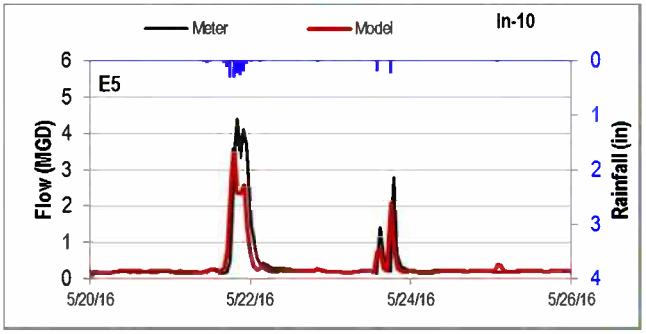




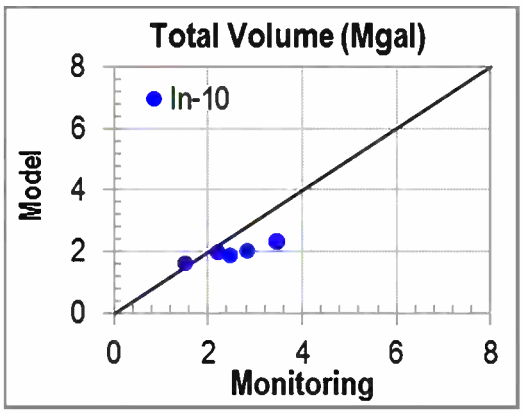


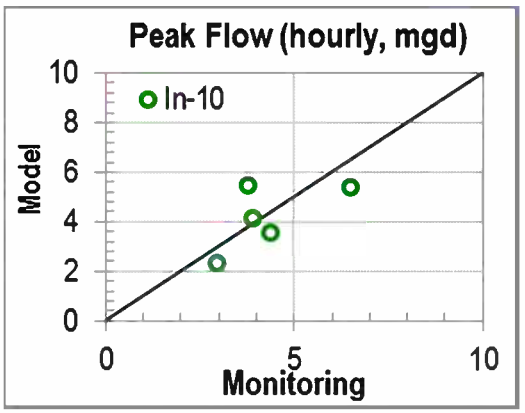


In-10 Model Validation Results (Metered and Modeled Flow)



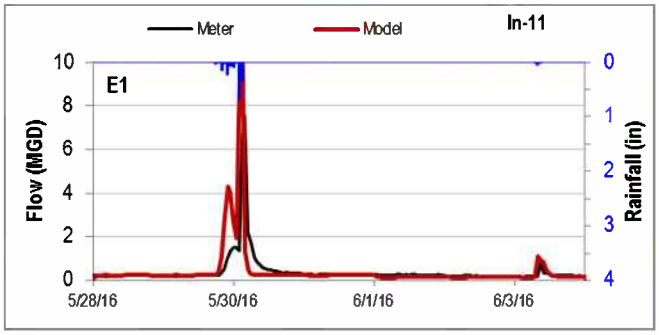
In-10 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

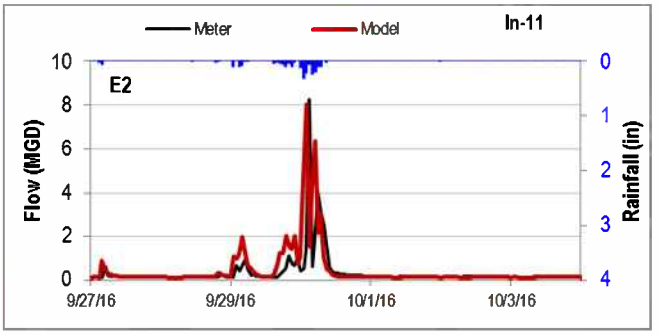


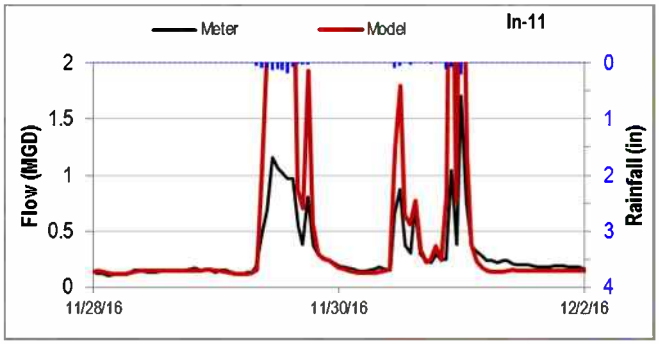


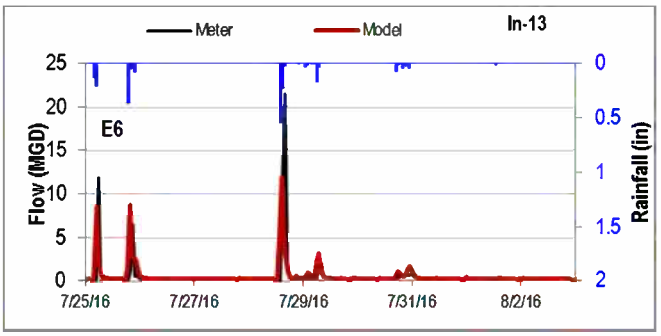
FLOW METER IN-11 MODEL CALIBRATION AND VALIDATION RESULTS

In-11 Model Calibration Results (Metered and Modeled Flow)

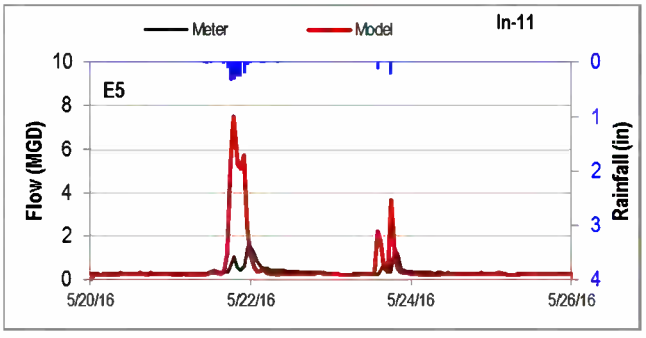




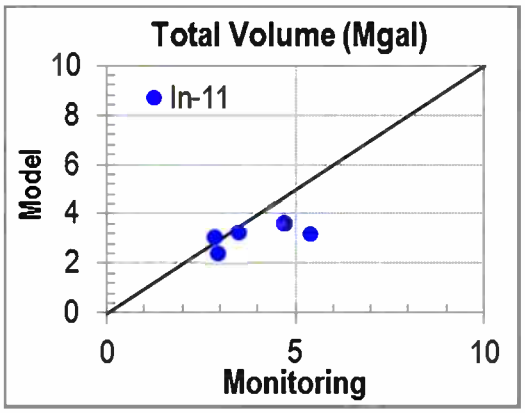


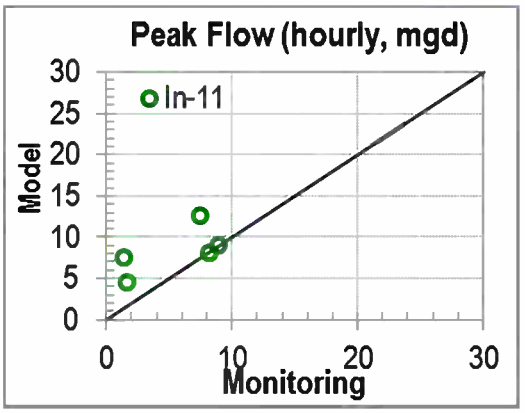


In-11 Model Validation Results (Metered and Modeled Flow)



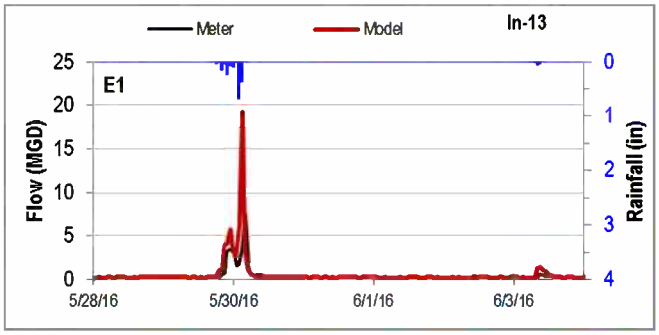
In-11 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

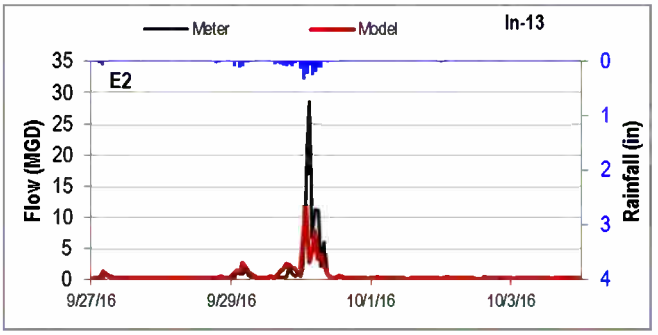


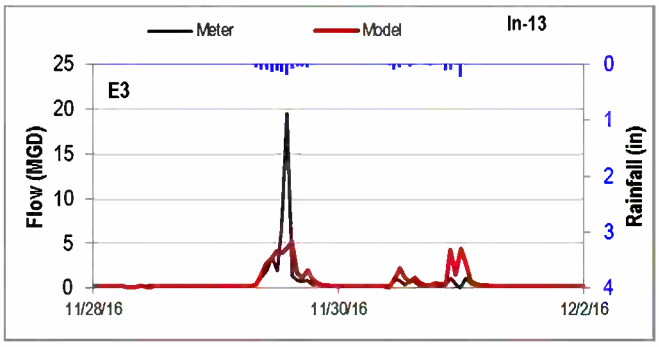


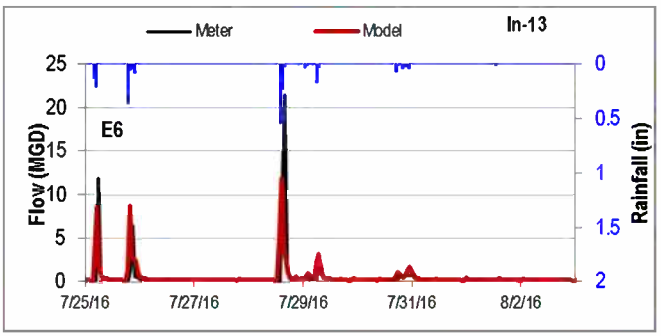
FLOW METER IN-13 MODEL CALIBRATION AND VALIDATION RESULTS

In-13 Model Calibration Results (Metered and Modeled Flow)

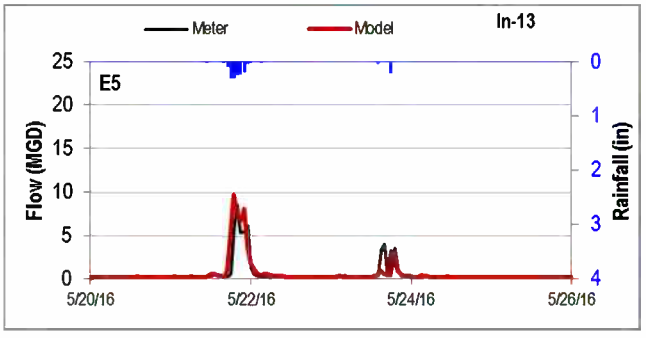




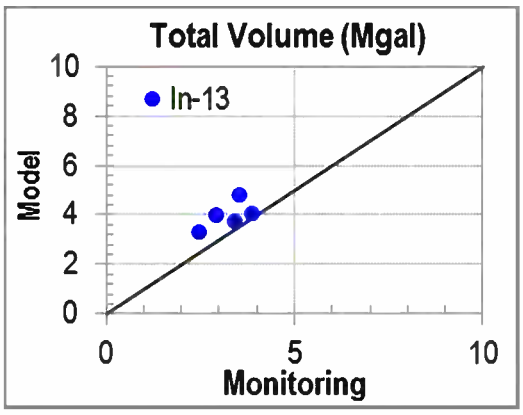


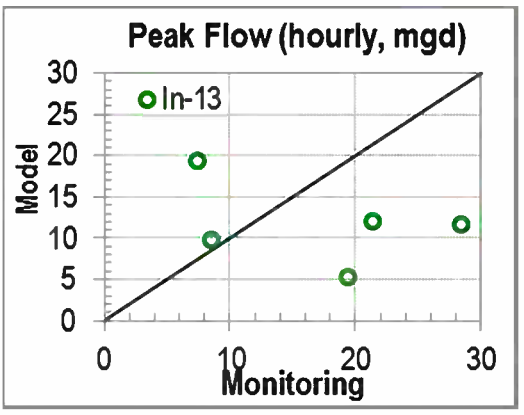


In-13 Model Validation Results (Metered and Modeled Flow)



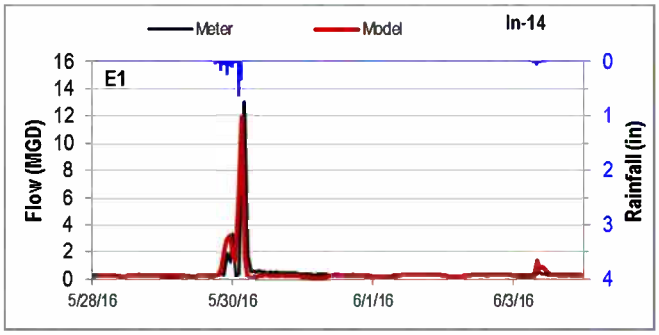
In-13 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

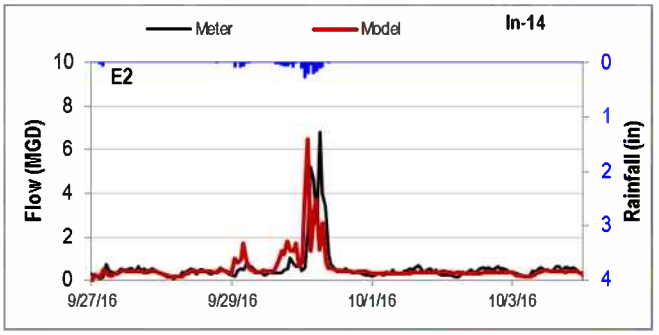


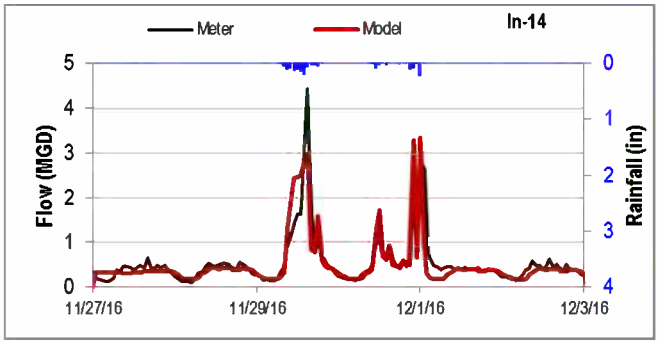


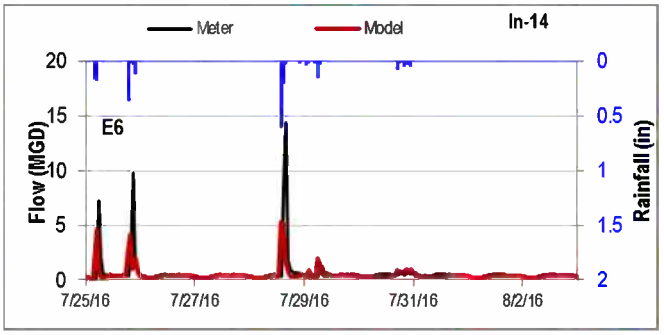
FLOW METER IN-14 MODEL CALIBRATION AND VALIDATION RESULTS

In-14 Model Calibration Results (Metered and Modeled Flow)

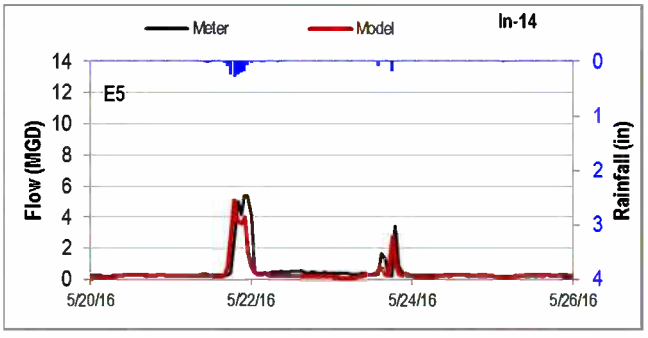




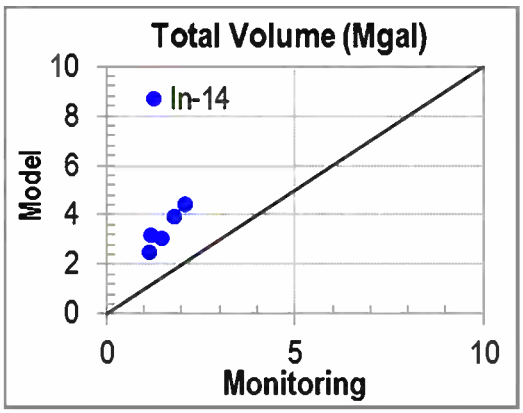


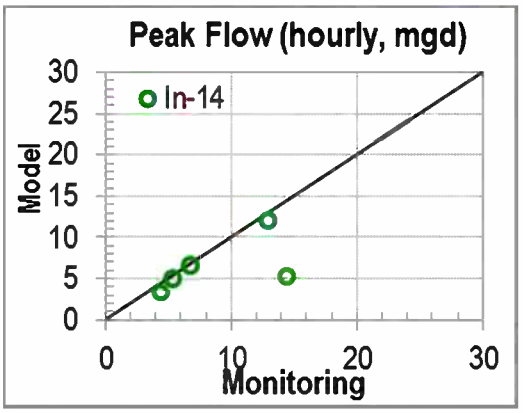


In-14 Model Validation Results (Metered and Modeled Flow)



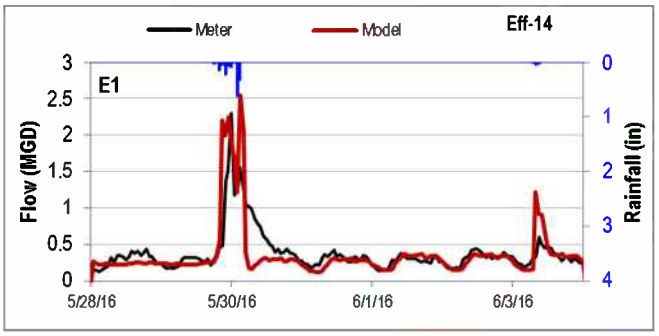
In-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

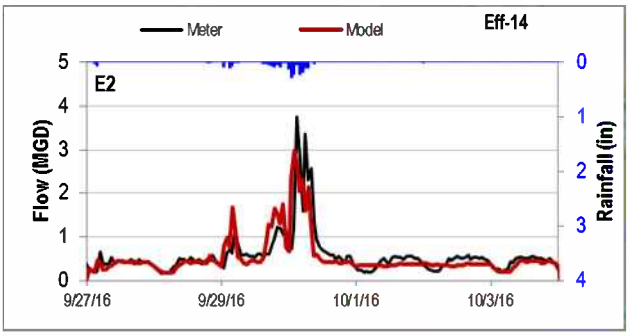


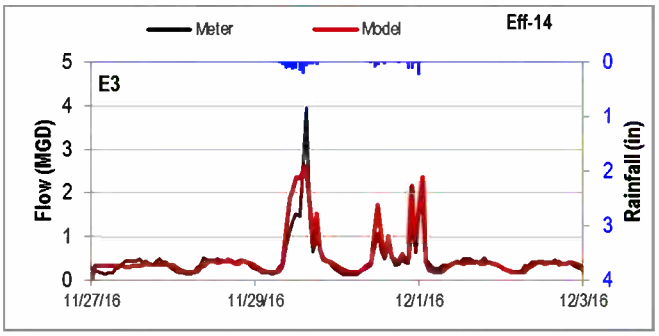


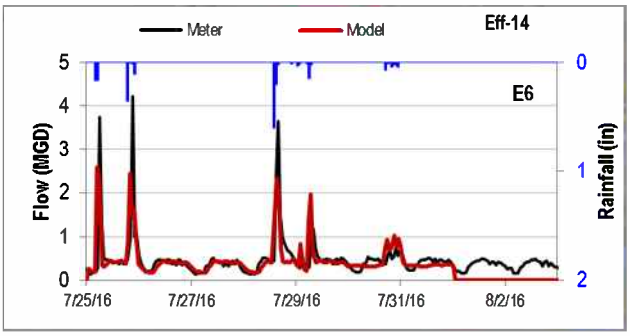
FLOW METER Eff-14 MODEL CALIBRATION AND VALIDATION RESULTS

Eff-14 Model Calibration Results (Metered and Modeled Flow)

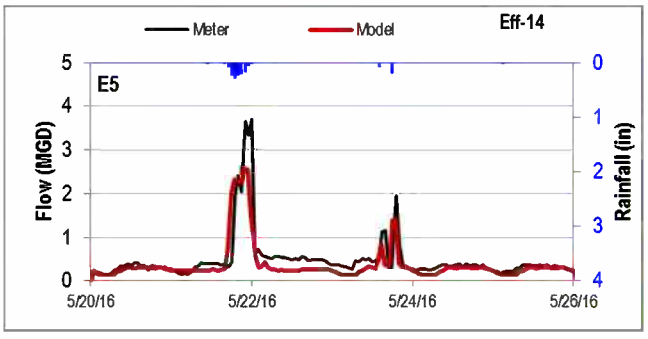




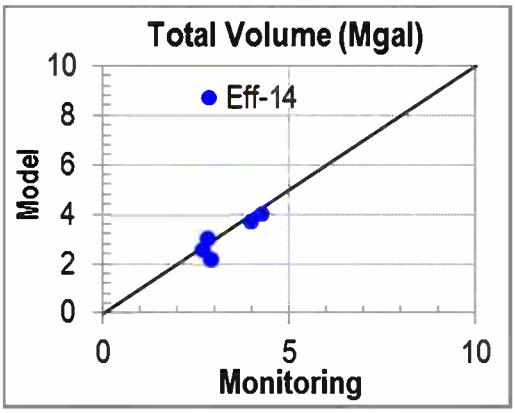


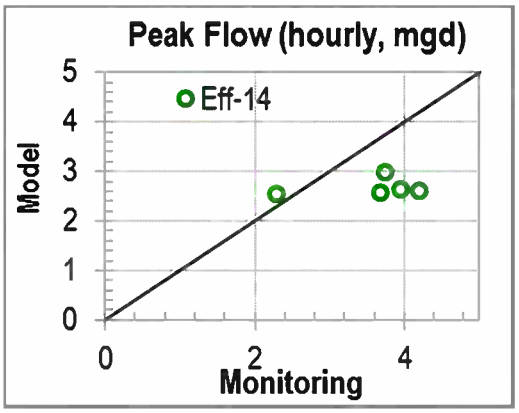


Eff-14 Model Validation Results (Metered and Modeled Flow)



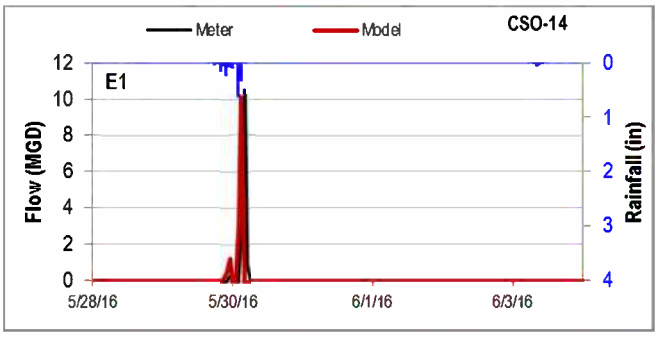
Eff-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

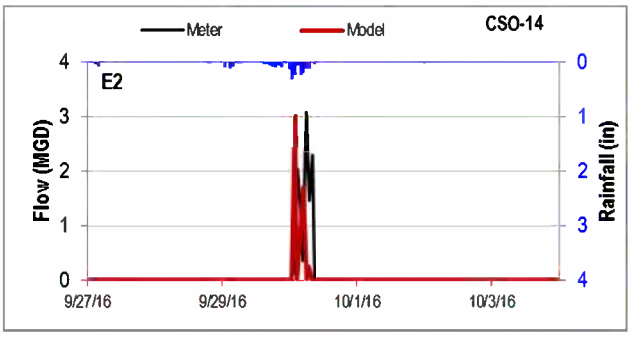


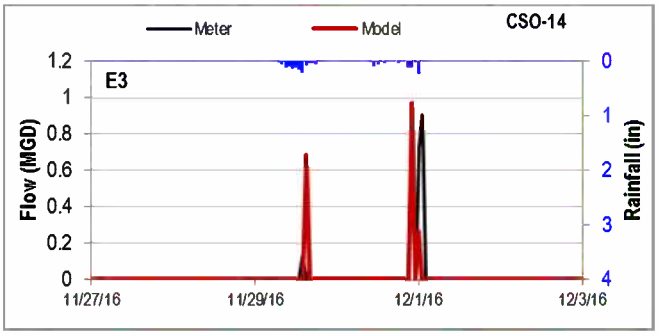


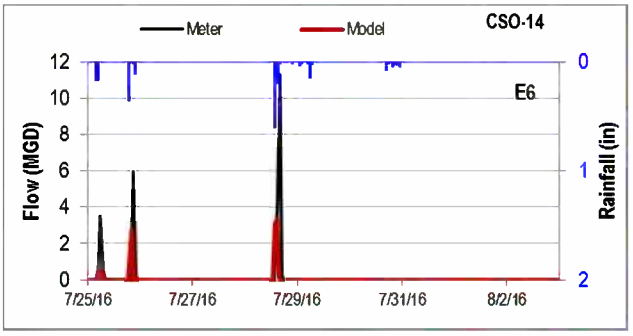
FLOW METER CSO-14 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-14 Model Calibration Results (Metered and Modeled Flow)

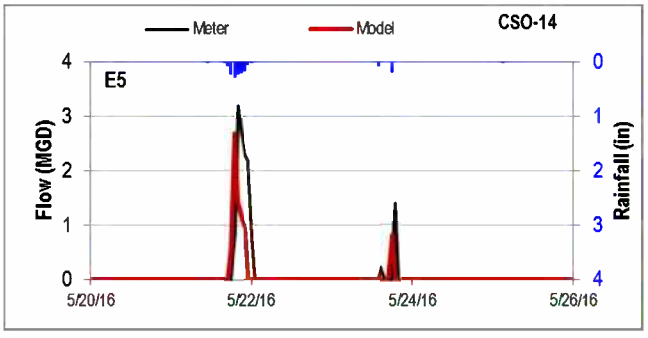




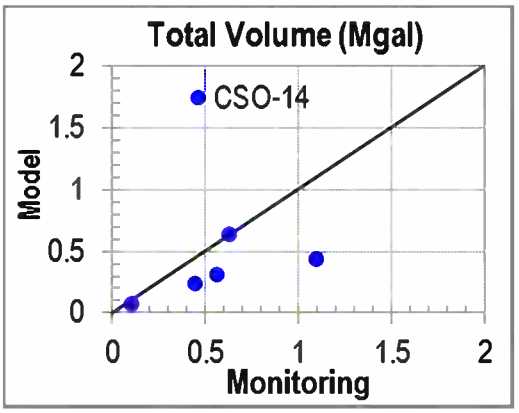


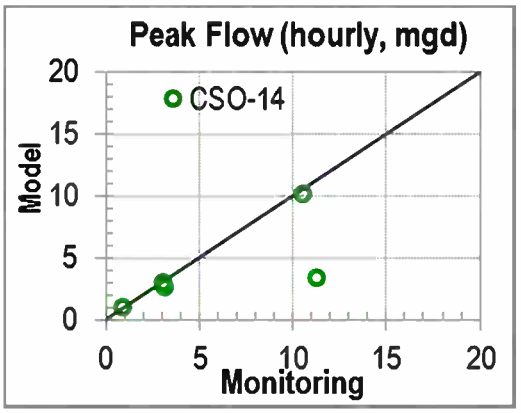


CSO-14 Model Validation Results (Metered and Modeled Flow)



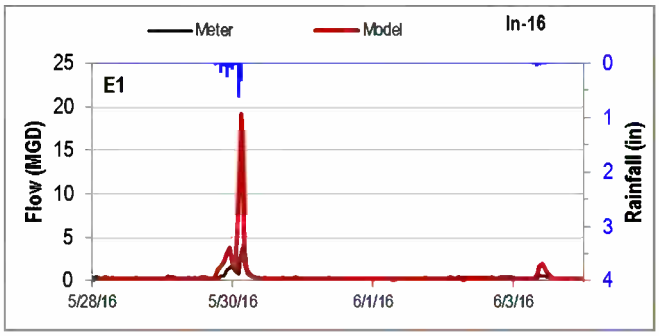
CSO-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

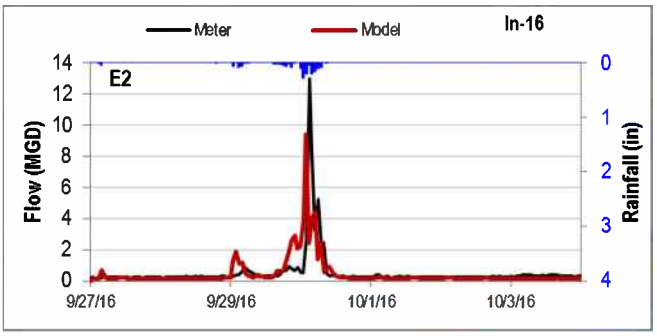


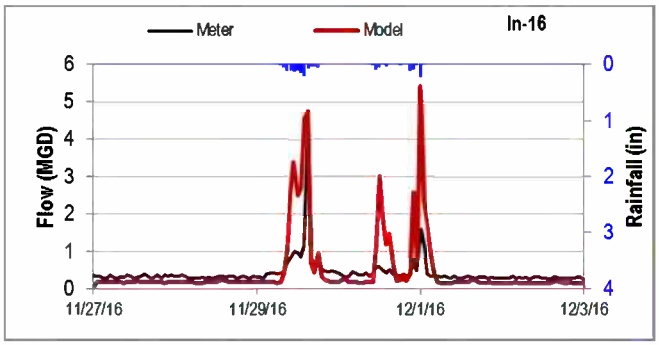


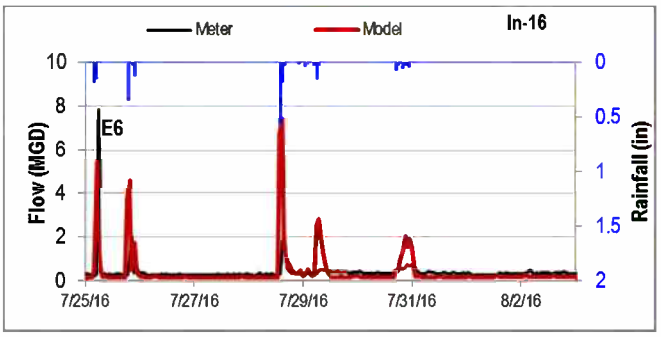
FLOW METER IN-16 MODEL CALIBRATION AND VALIDATION RESULTS

In-16 Model Calibration Results (Metered and Modeled Flow)

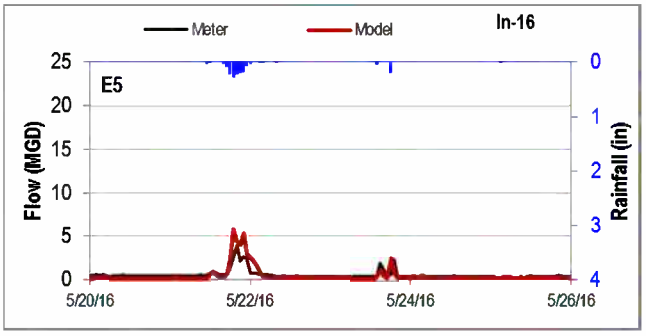




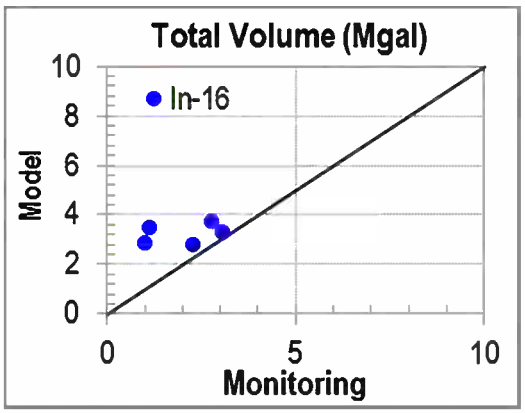


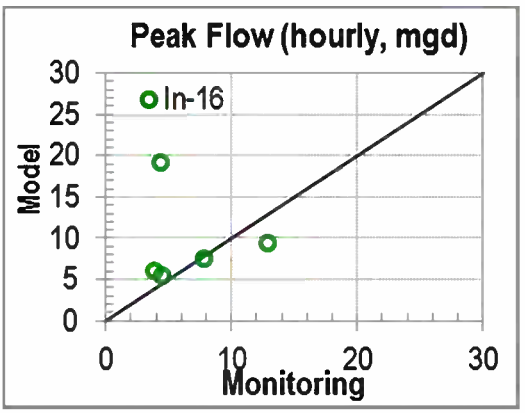


In-16 Model Validation Results (Metered and Modeled Flow)



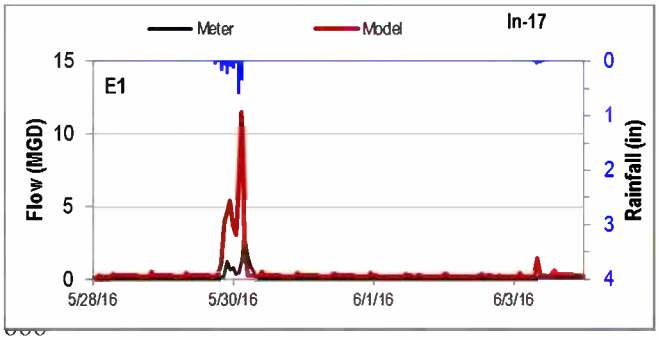
In-16 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

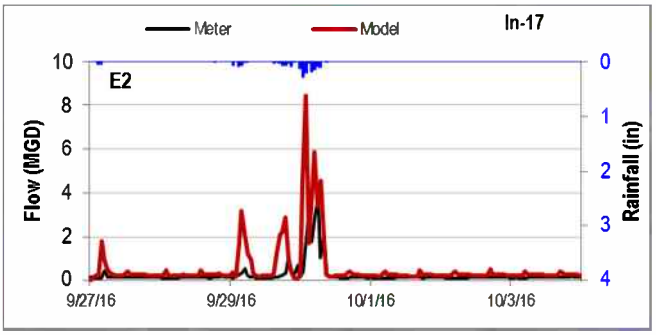


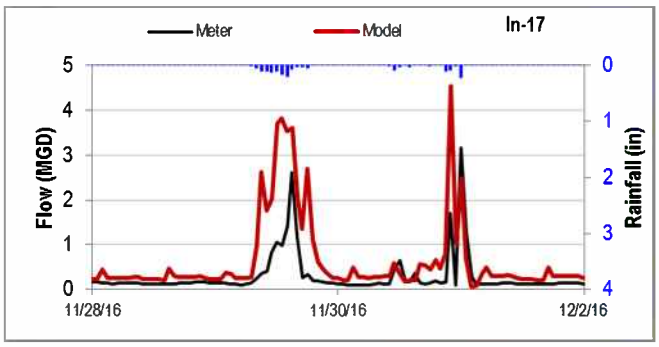


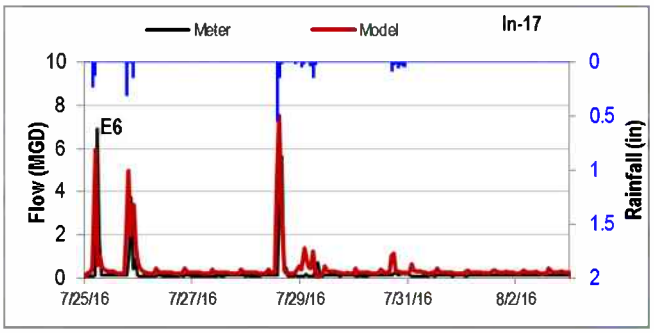
FLOW METER IN-17 MODEL CALIBRATION AND VALIDATION RESULTS

In-17 Model Calibration Results (Metered and Modeled Flow)

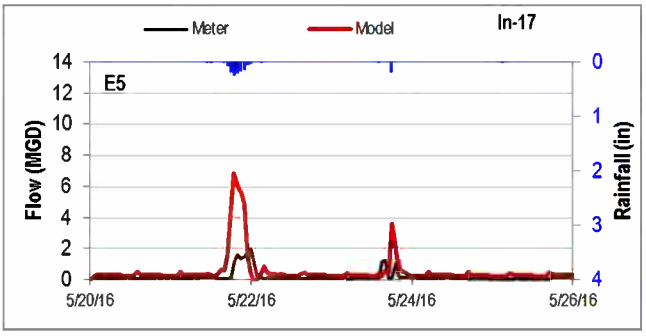




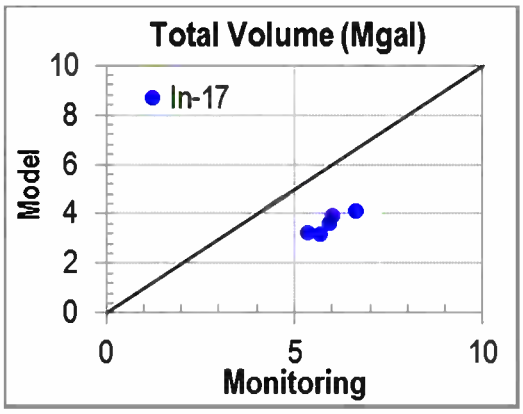


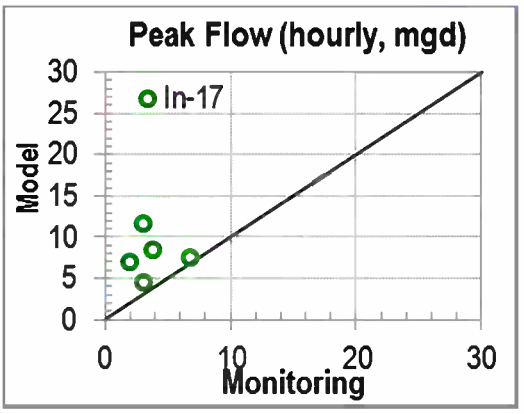


In-17 Model Validation Results (Metered and Modeled Flow)



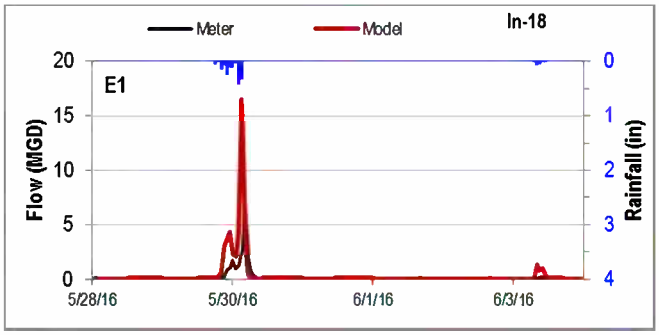
In-17 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

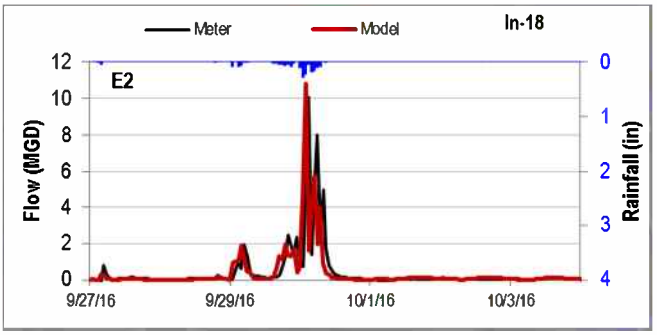


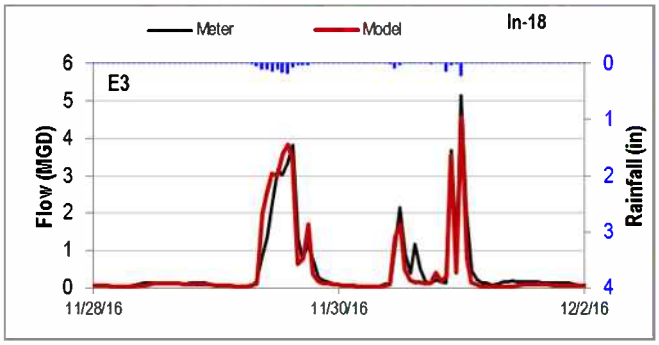


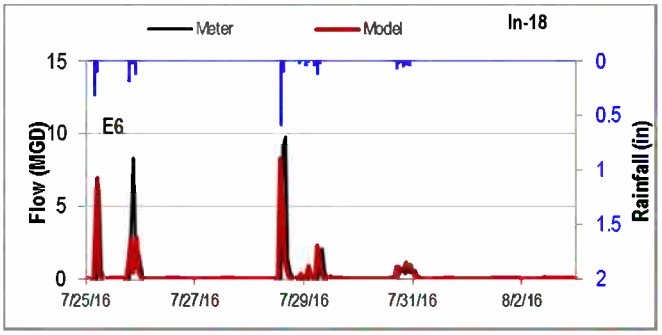
FLOW METER IN-18 MODEL CALIBRATION AND VALIDATION RESULTS

In-18 Model Calibration Results (Metered and Modeled Flow)

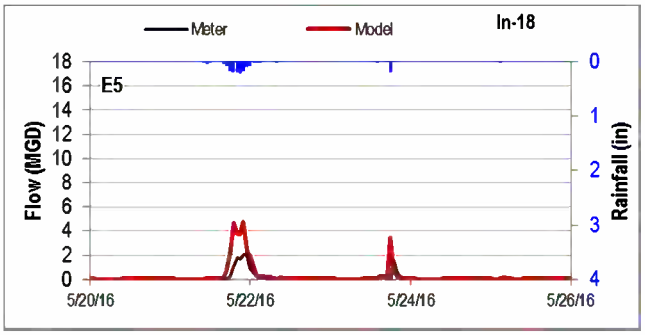




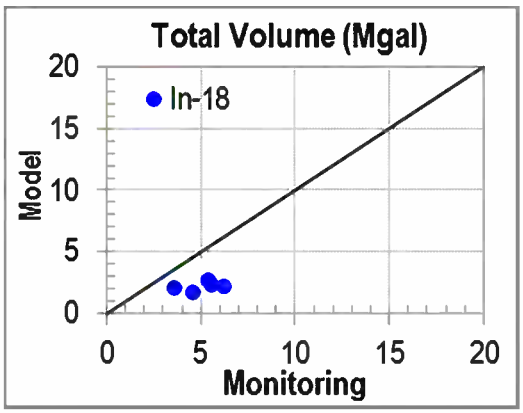


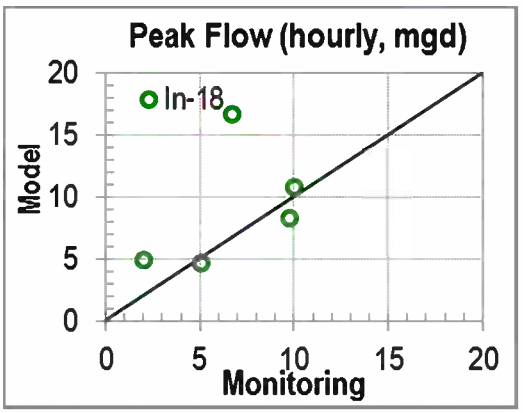


In-18 Model Validation Results (Metered and Modeled Flow)



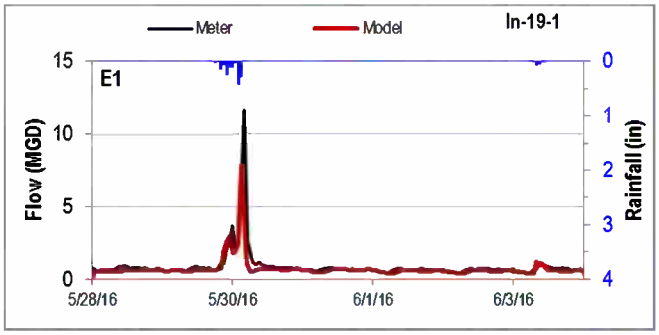
In-18 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

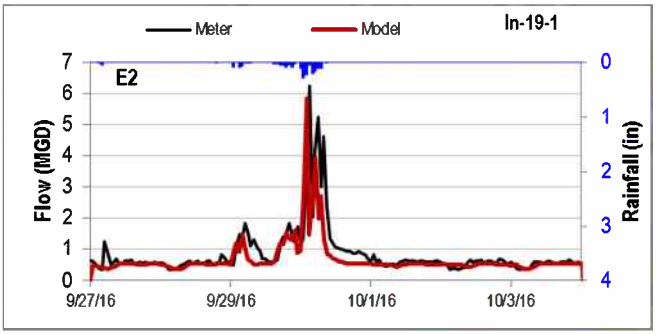


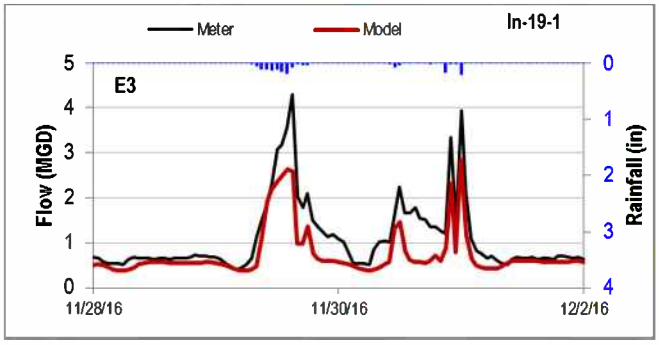


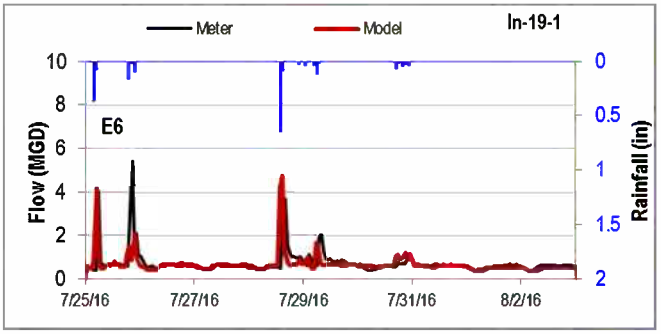
FLOW METER IN-19-1 MODEL CALIBRATION AND VALIDATION RESULTS

In-19-1 Model Calibration Results (Metered and Modeled Flow)

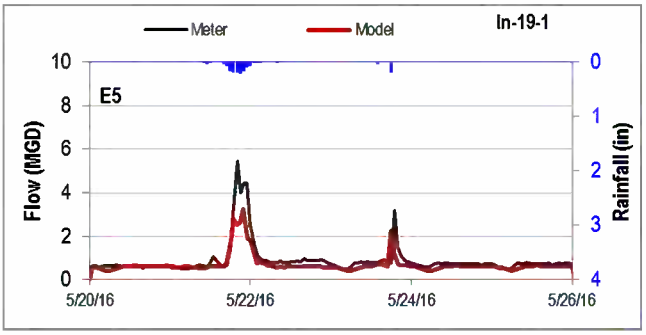




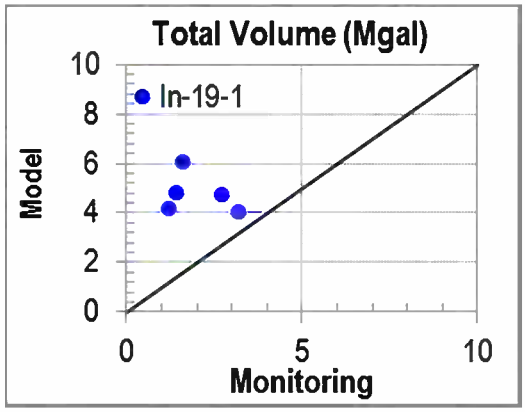


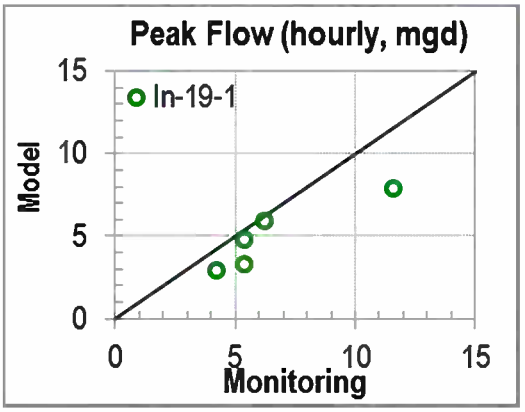


In-19-1 Model Validation Results (Metered and Modeled Flow)



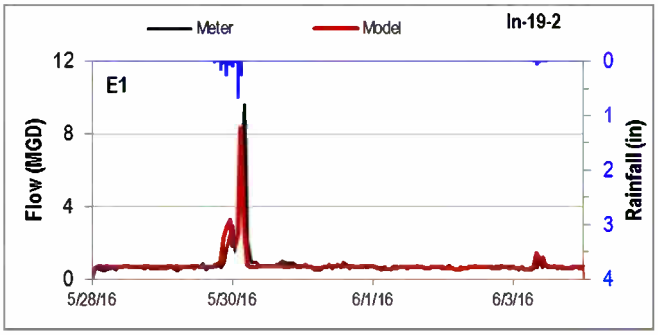
In-19-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

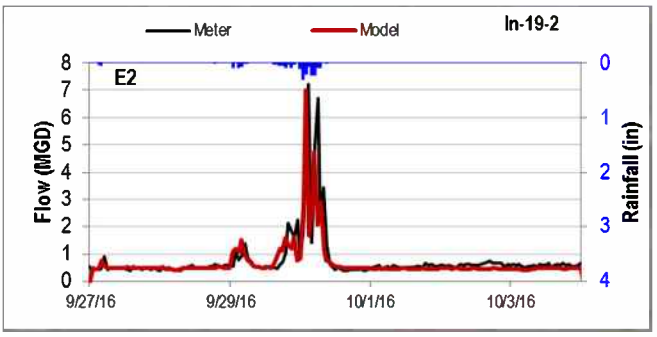


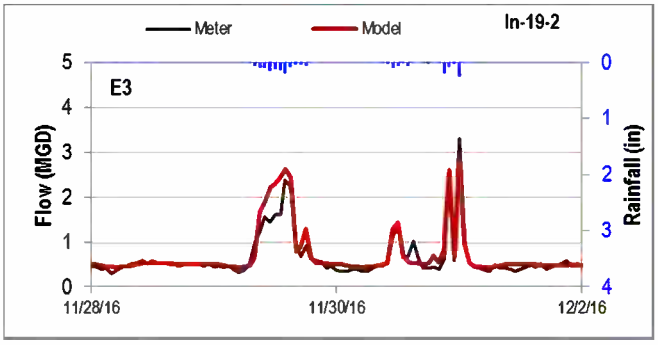


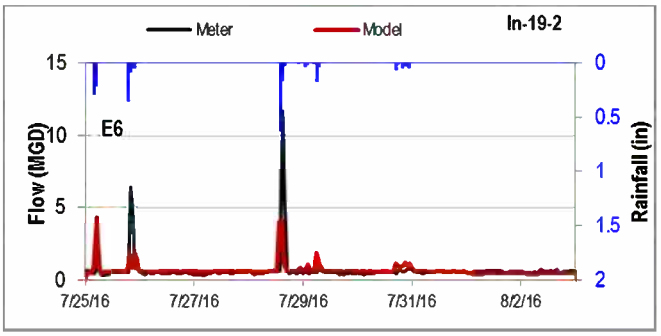
FLOW METER IN-19-2 MODEL CALIBRATION AND VALIDATION RESULTS

In-19-2 Model Calibration Results (Metered and Modeled Flow)

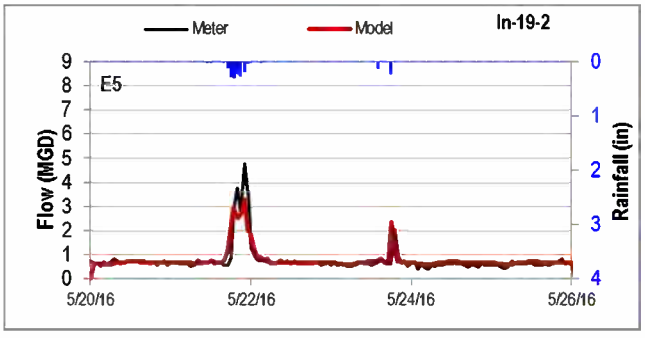




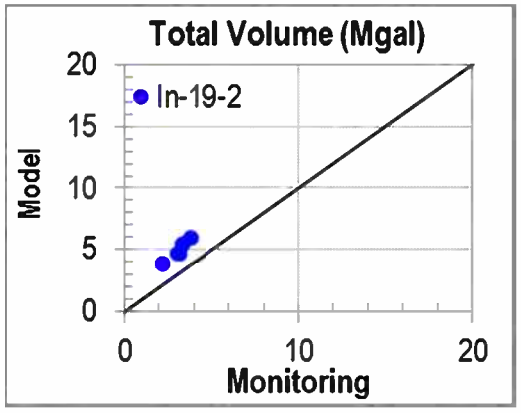


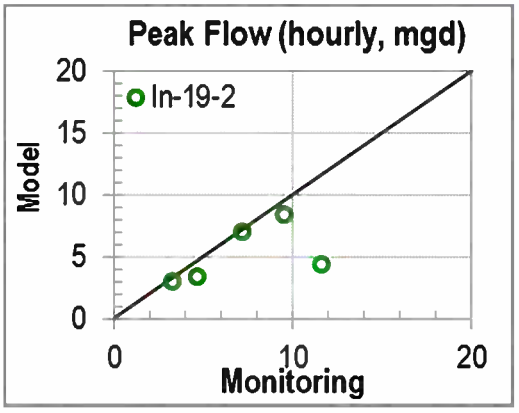


In-19-2 Model Validation Results (Metered and Modeled Flow)



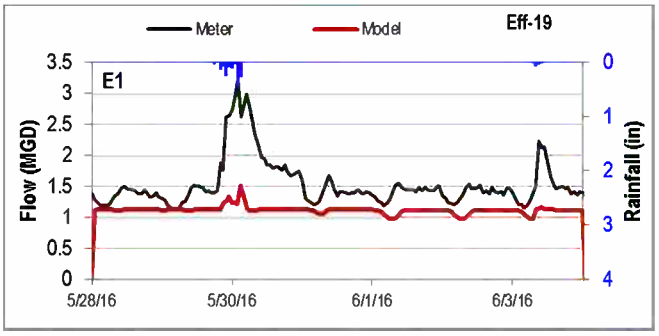
In-19-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

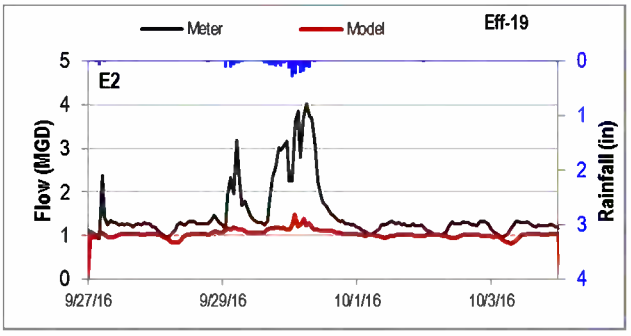


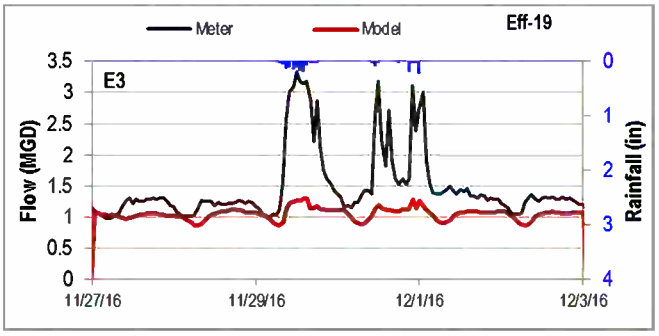


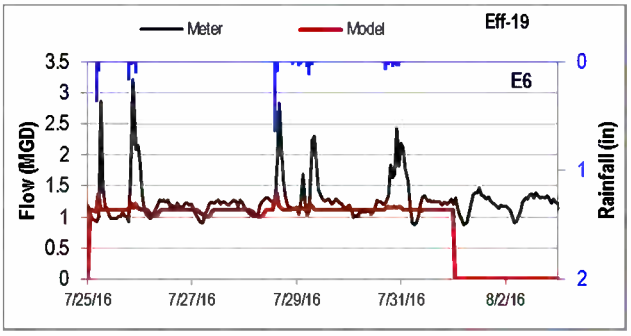
FLOW METER Eff-19 MODEL CALIBRATION AND VALIDATION RESULTS

Eff-19 Model Calibration Results (Metered and Modeled Flow)

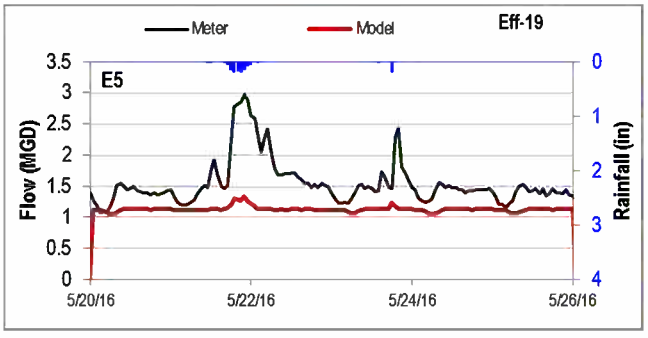




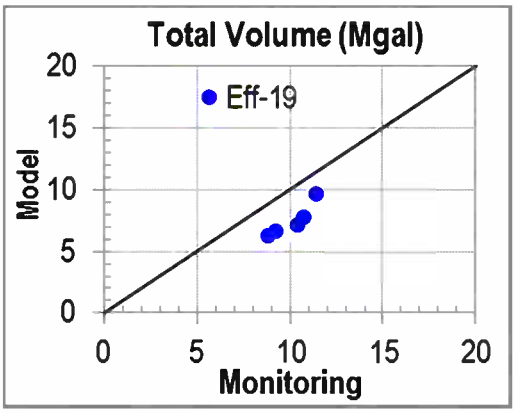


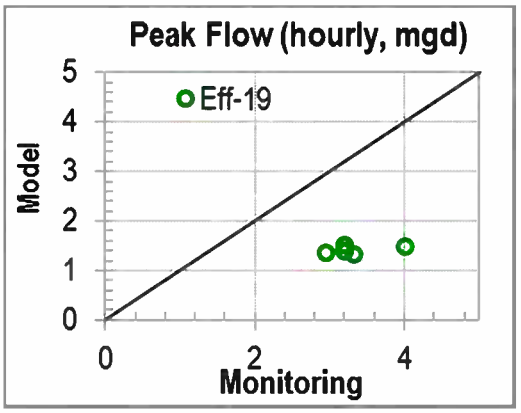


Eff-19 Model Validation Results (Metered and Modeled Flow)



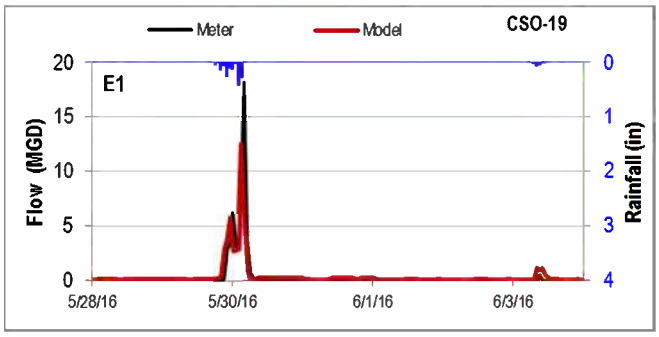
Eff-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

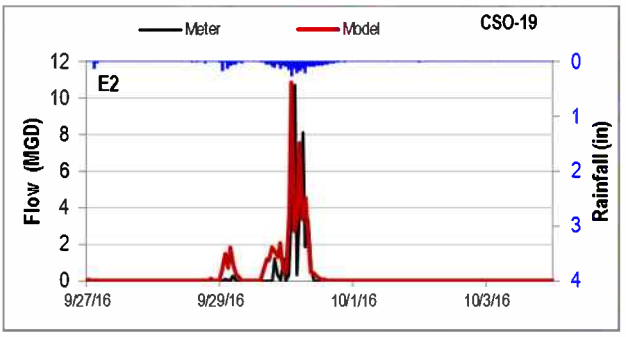


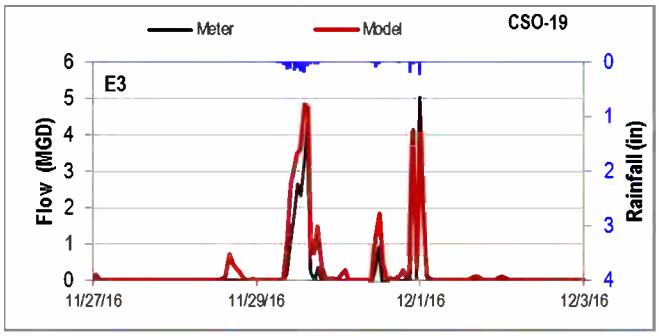


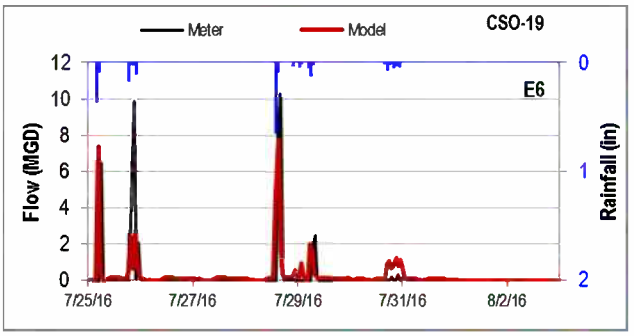
FLOW METER CSO-19 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-19 Model Calibration Results (Metered and Modeled Flow)

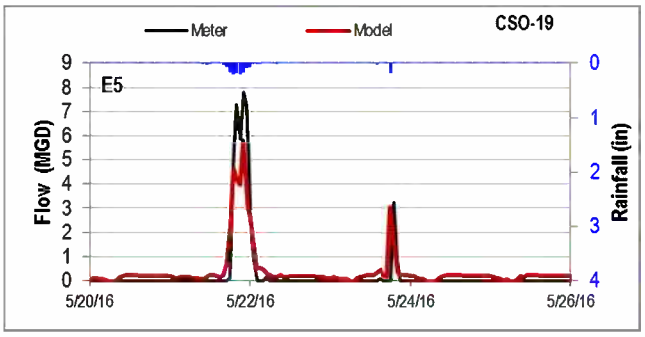




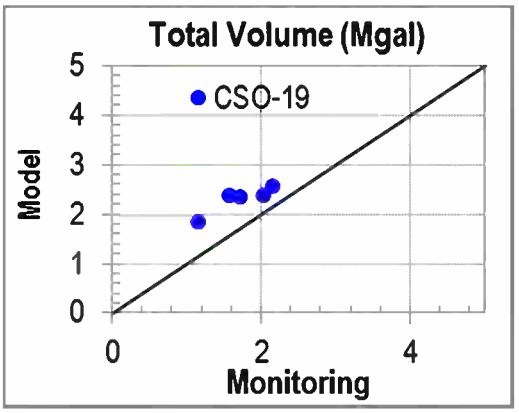


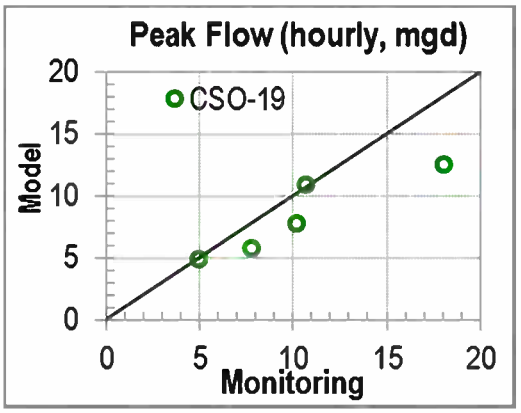


CSO-19 Model Validation Results (Metered and Modeled Flow)



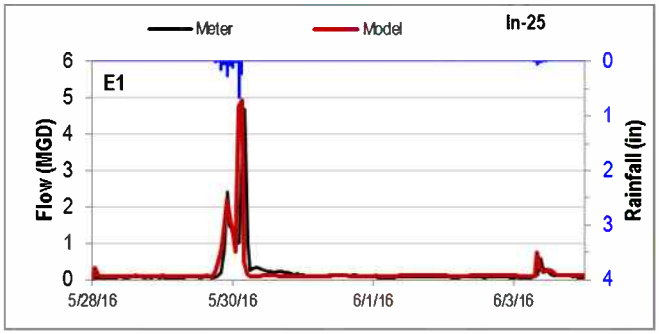
CSO-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

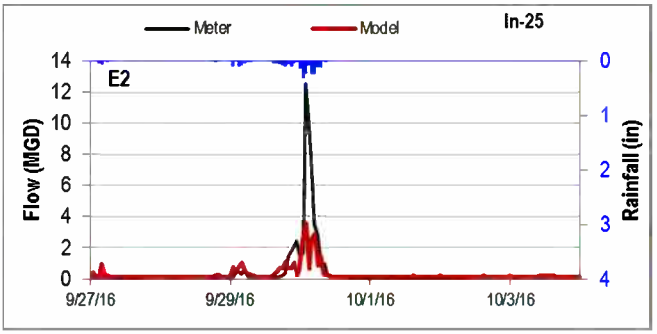


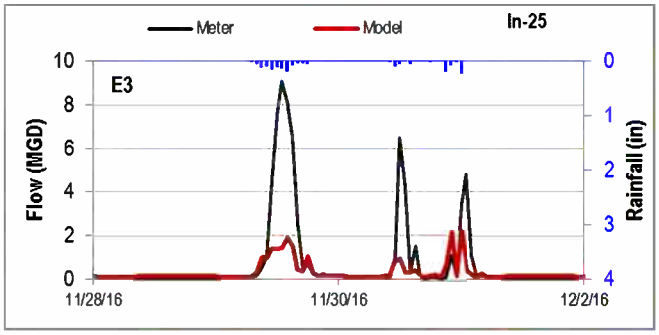


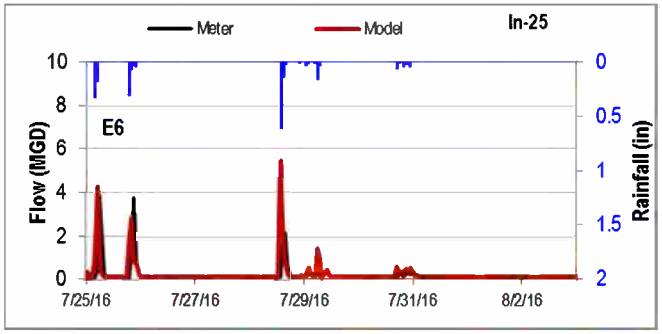
FLOW METER IN-25 MODEL CALIBRATION AND VALIDATION RESULTS

In-25 Model Calibration Results (Metered and Modeled Flow)

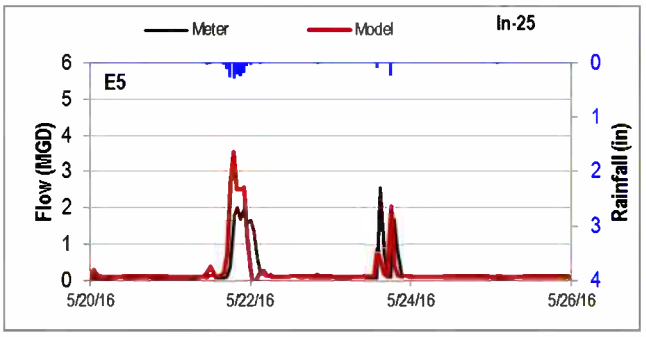




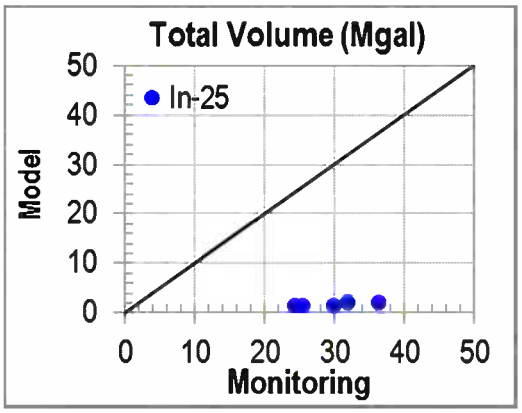


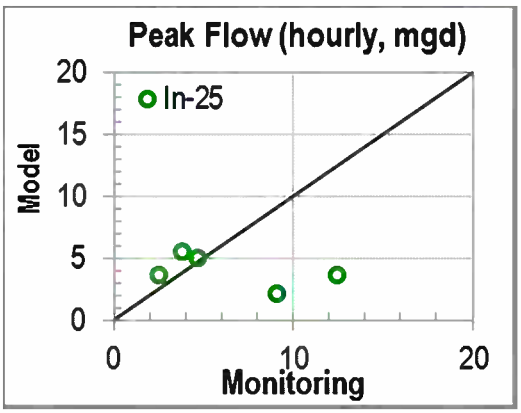


In-25 Model Validation Results (Metered and Modeled Flow)



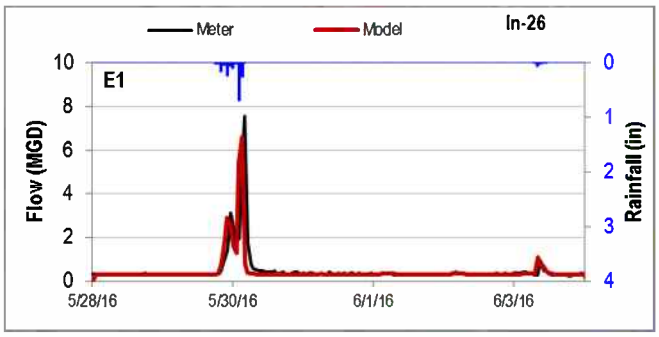
In-25 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

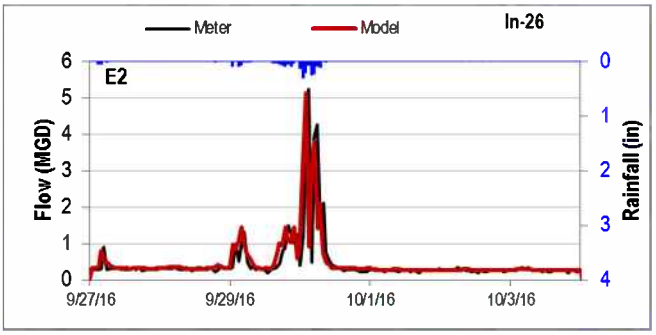


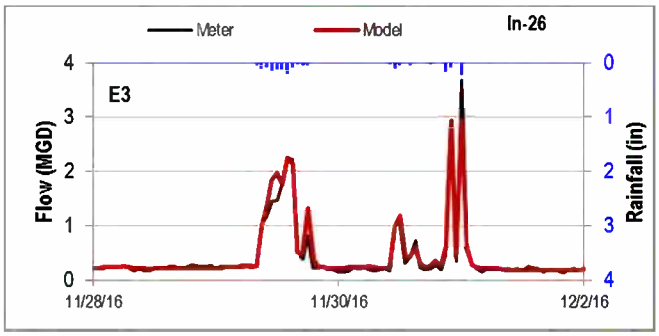


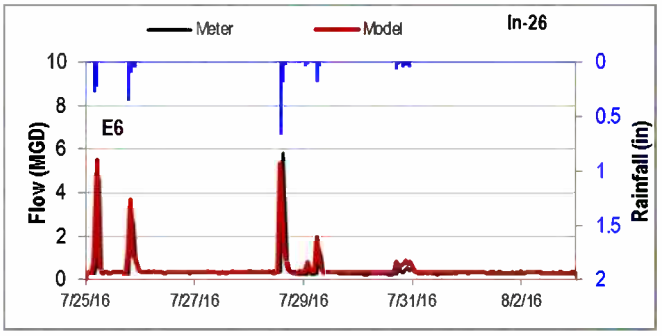
FLOW METER IN-26 MODEL CALIBRATION AND VALIDATION RESULTS

In-26 Model Calibration Results (Metered and Modeled Flow)

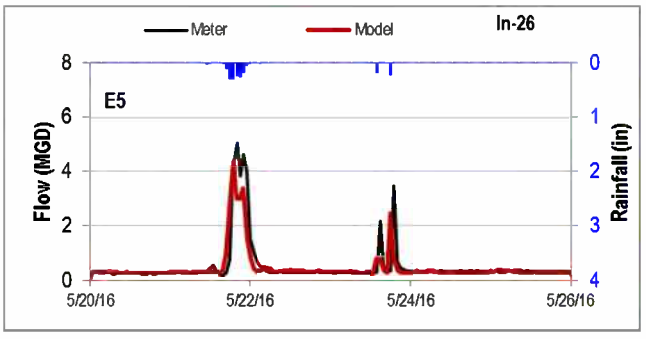




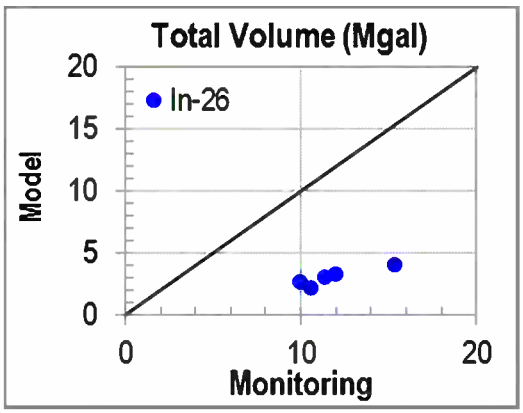


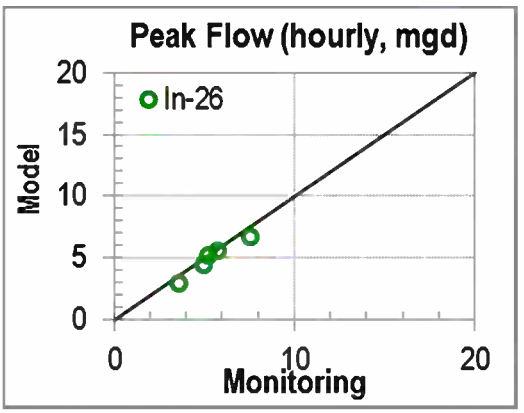


In-26 Model Validation Results (Metered and Modeled Flow)



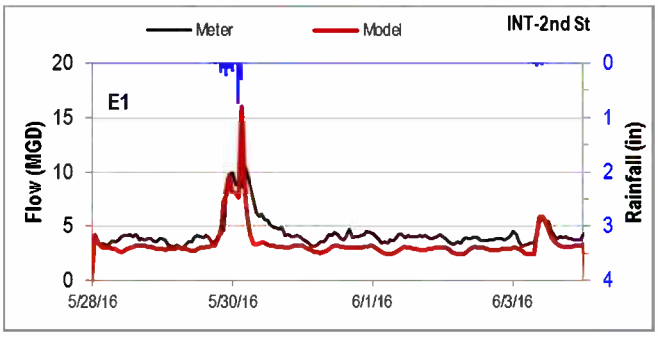
In-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

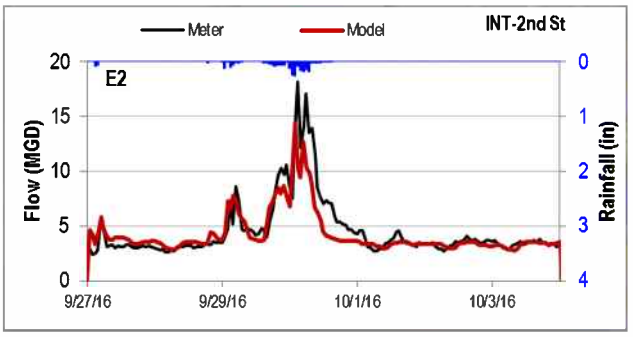


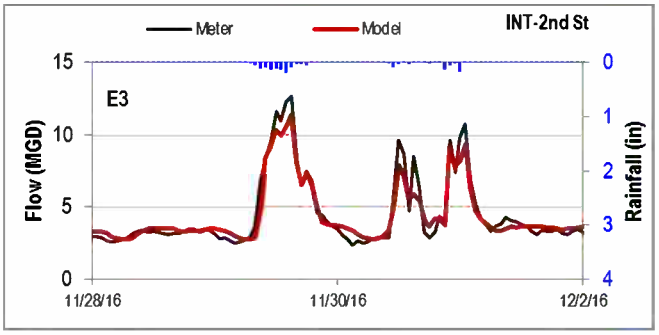


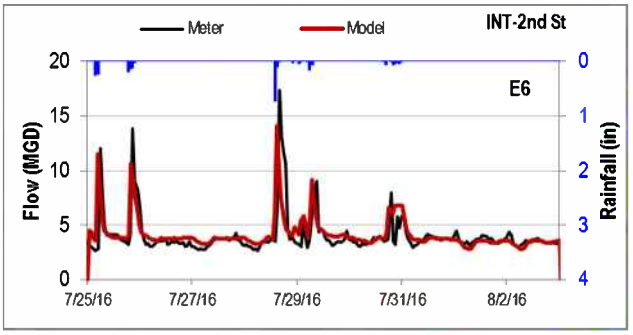
FLOW METER INT-2nd St MODEL CALIBRATION AND VALIDATION RESULTS

INT-2nd St Model Calibration Results (Metered and Modeled Flow)

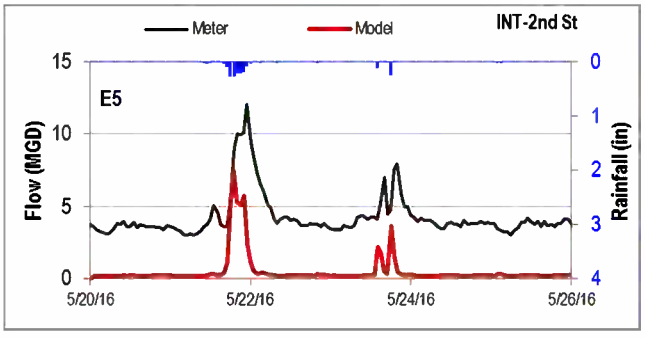




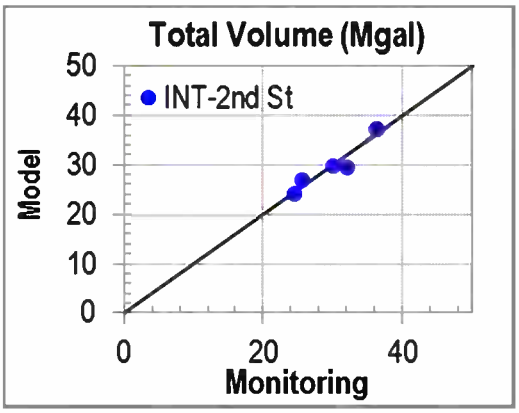


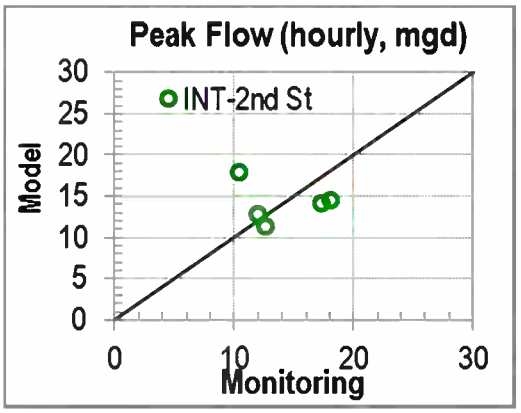


INT-2nd St Model Validation Results (Metered and Modeled Flow)



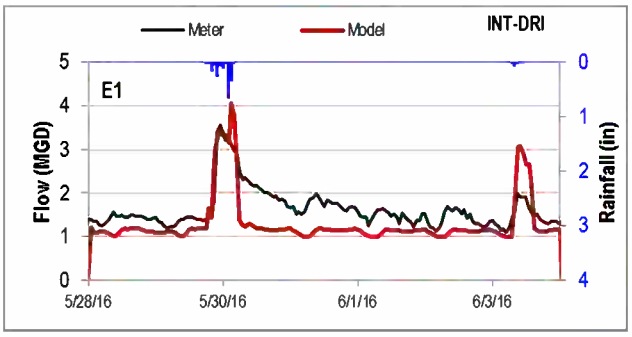
INT-2nd St Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

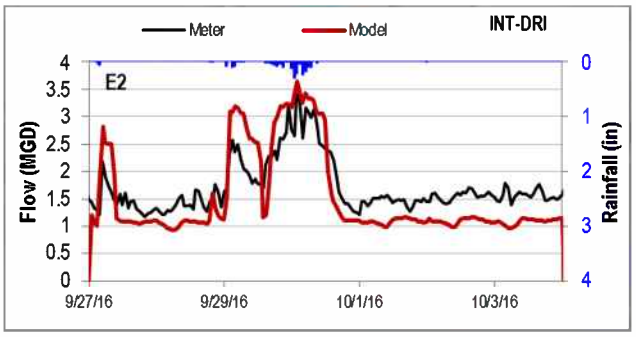


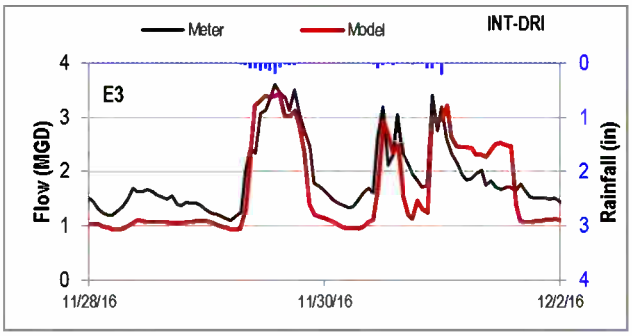


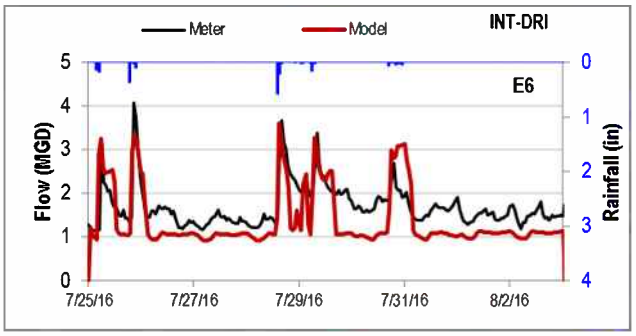
FLOW METER INT-DRI MODEL CALIBRATION AND VALIDATION RESULTS

INT-DRI Model Calibration Results (Metered and Modeled Flow)

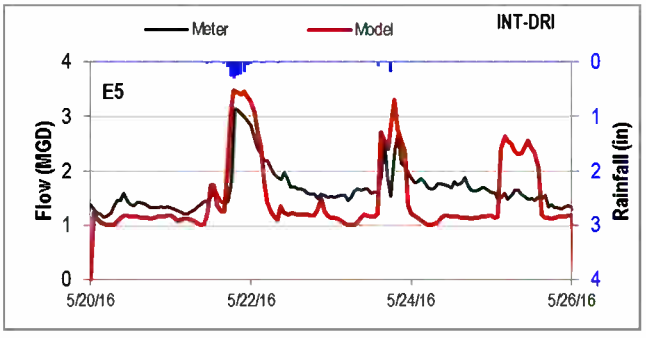




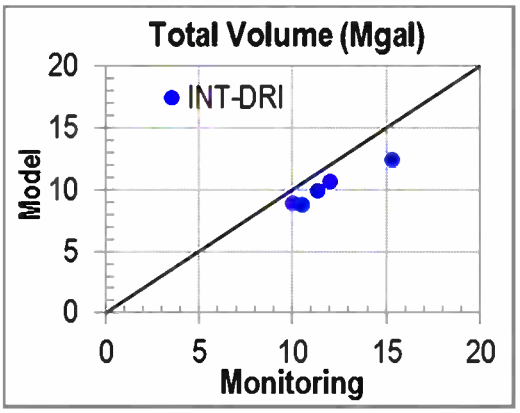


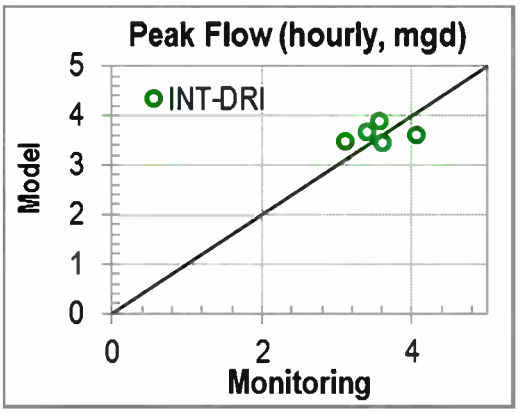


INT-DRI Model Validation Results (Metered and Modeled Flow)



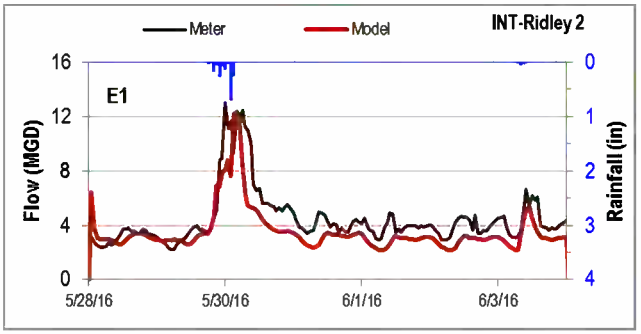
INT-DRI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

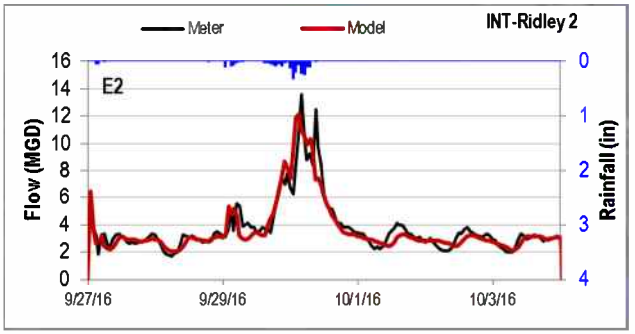


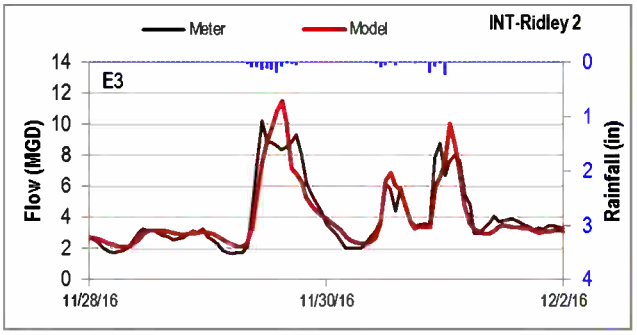


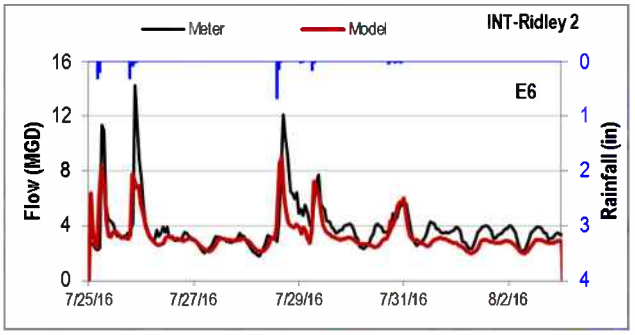
FLOW METER INT-Ridley 2 MODEL CALIBRATION AND VALIDATION RESULTS

INT-Ridley 2 Model Calibration Results (Metered and Modeled Flow)

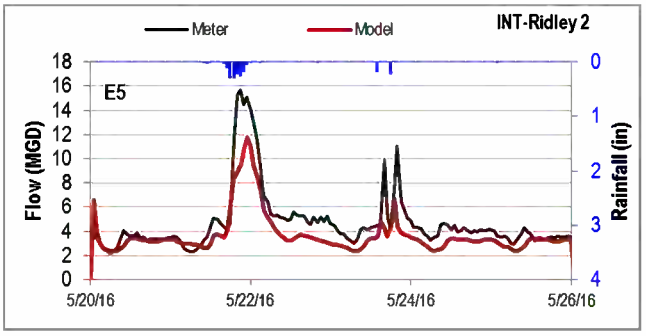




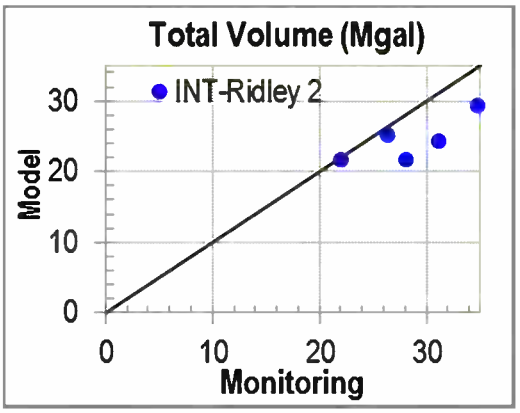


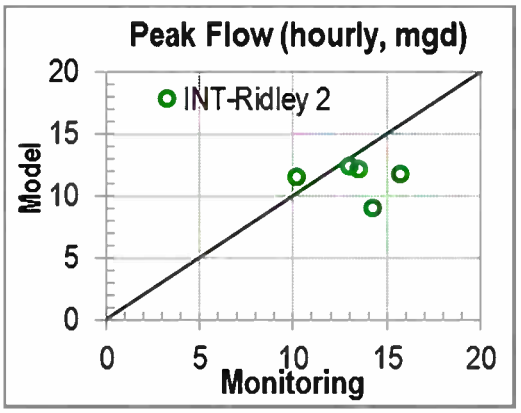


INT-Ridley 2 Model Validation Results (Metered and Modeled Flow)



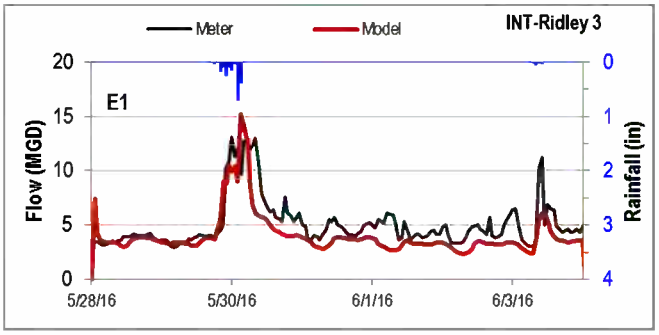
INT-Ridley-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

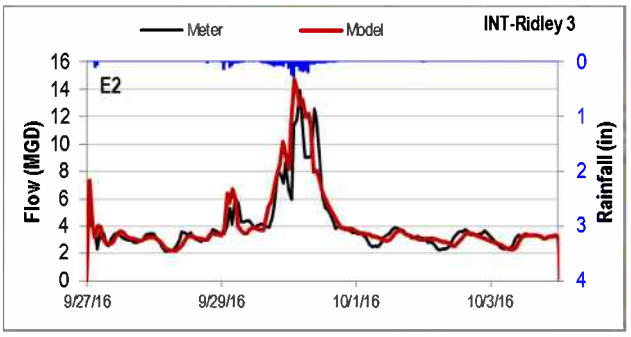


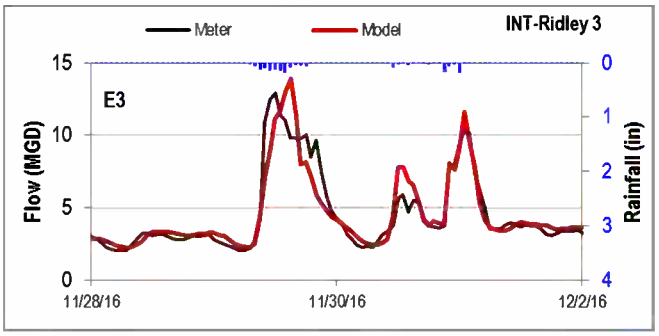


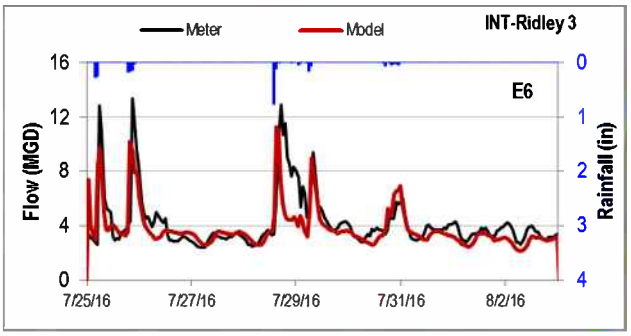
FLOW METER INT-Ridley 3 MODEL CALIBRATION AND VALIDATION RESULTS

INT-Ridley 3 Model Calibration Results (Metered and Modeled Flow)

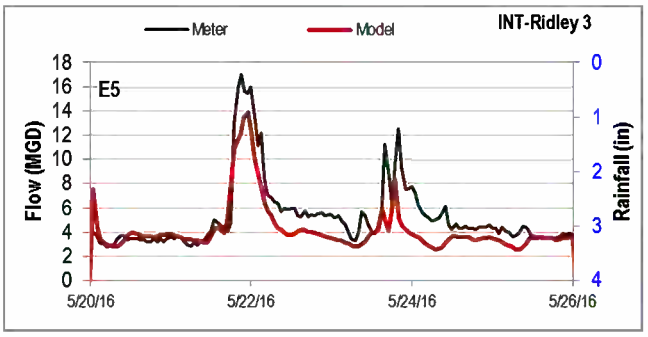




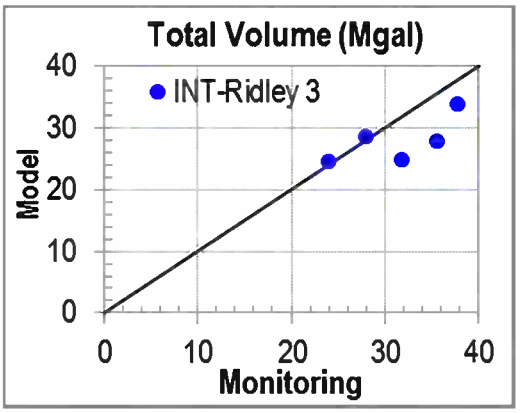


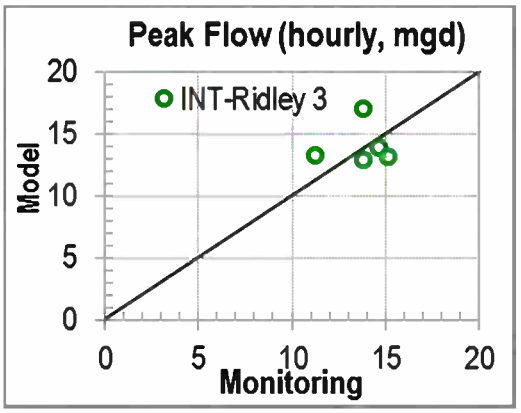


INT-Ridley 3 Model Validation Results (Metered and Modeled Flow)



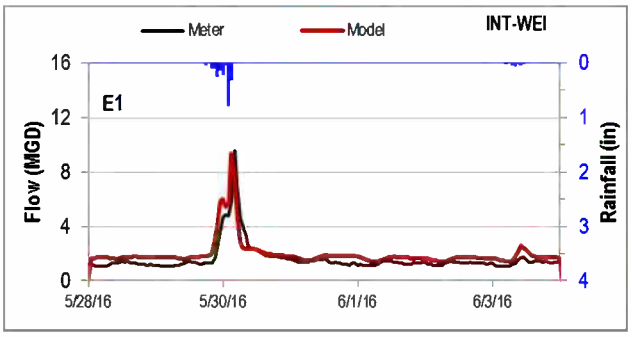
INT-Ridley 3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

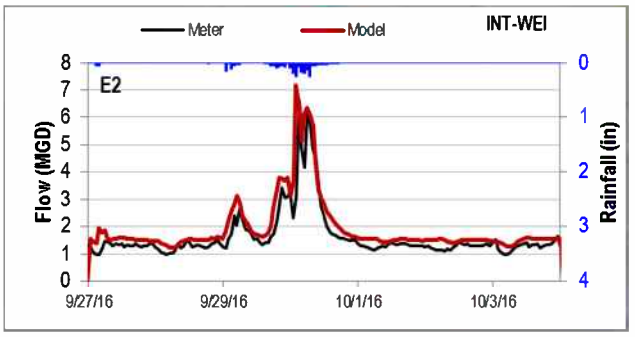


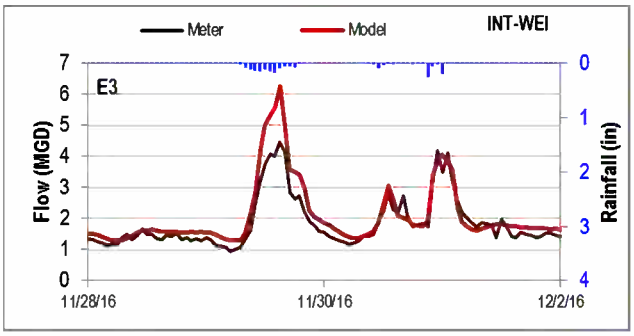


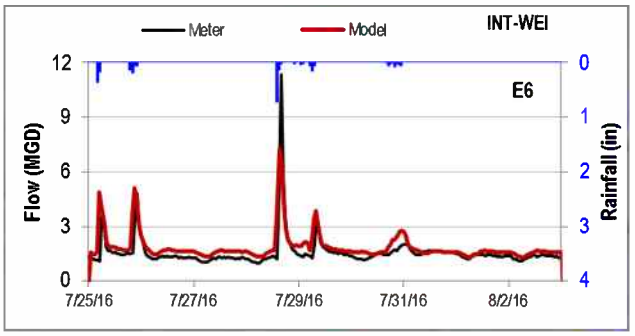
FLOW METER INT-WEI MODEL CALIBRATION AND VALIDATION RESULTS

INT-WEI Model Calibration Results (Metered and Modeled Flow)

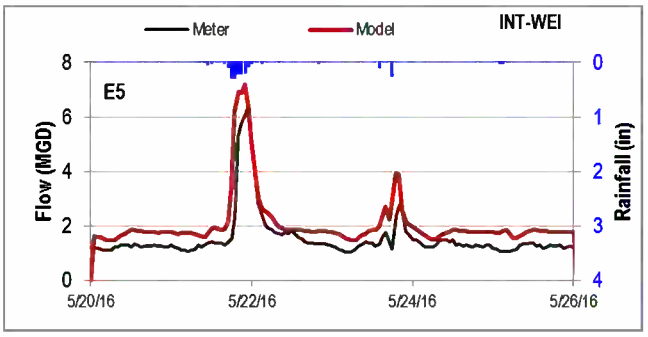




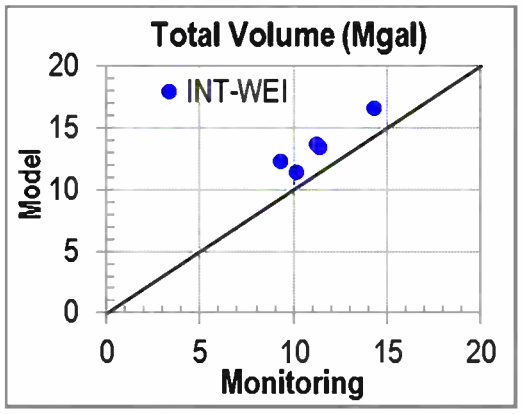


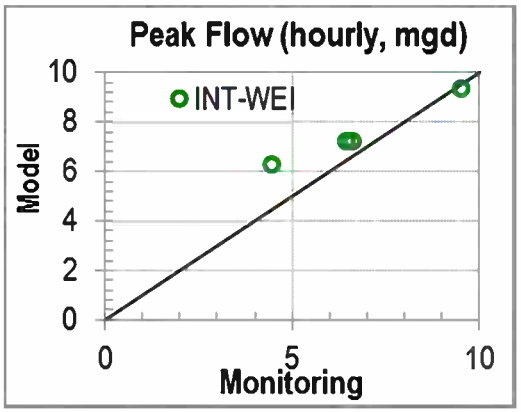


INT-WEI Model Validation Results (Metered and Modeled Flow)



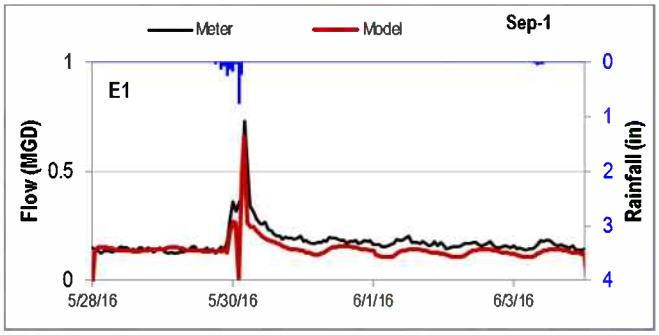
INT-WEI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

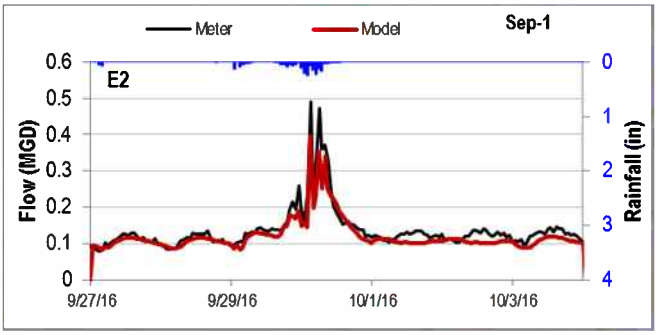


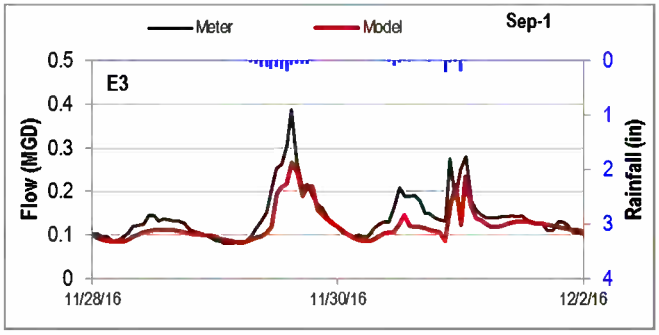


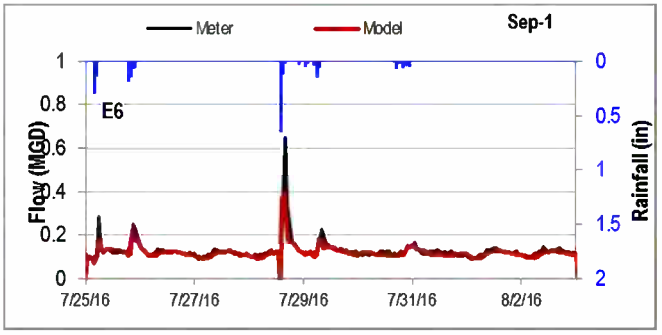
FLOW METER Sep-1 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-1 Model Calibration Results (Metered and Modeled Flow)

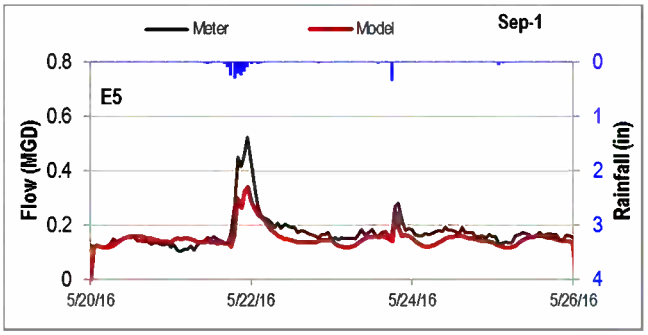




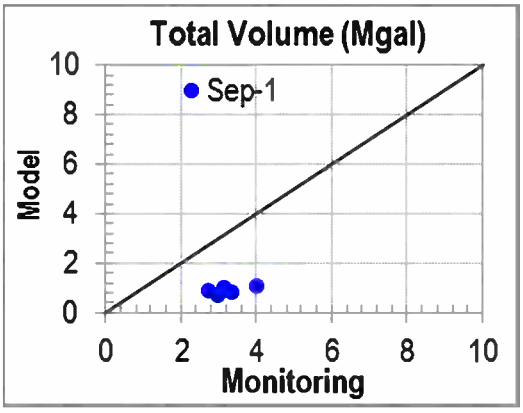


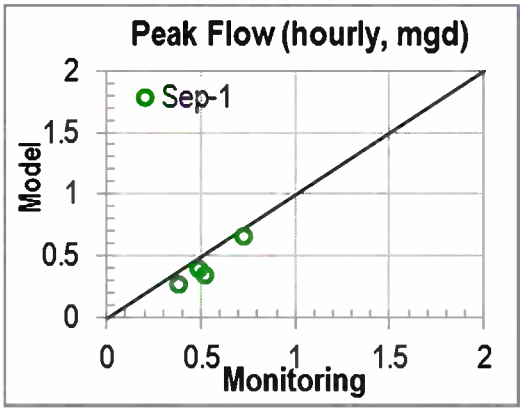


Sep-1 Model Validation Results (Metered and Modeled Flow)



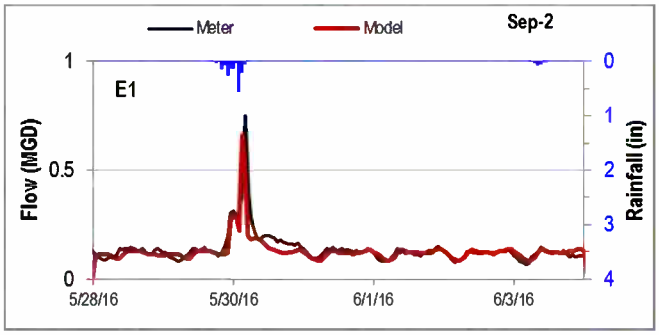
Sep-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

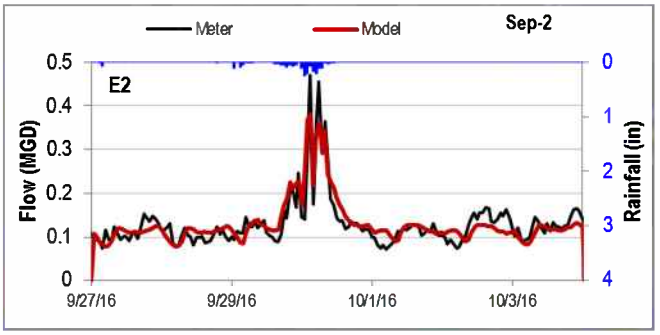


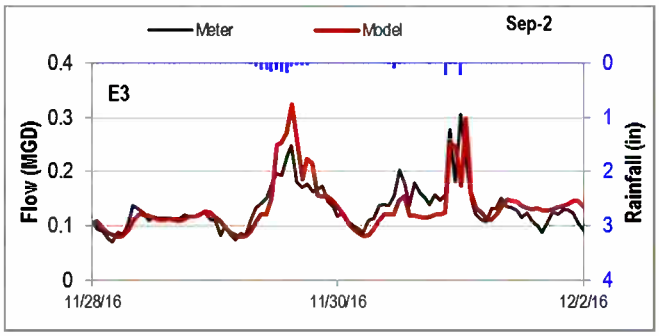


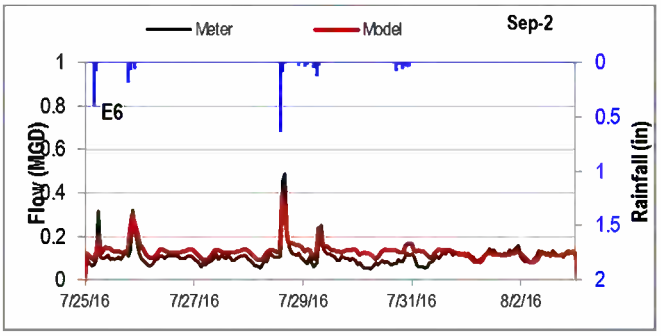
FLOW METER Sep-2 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-2 Model Calibration Results (Metered and Modeled Flow)

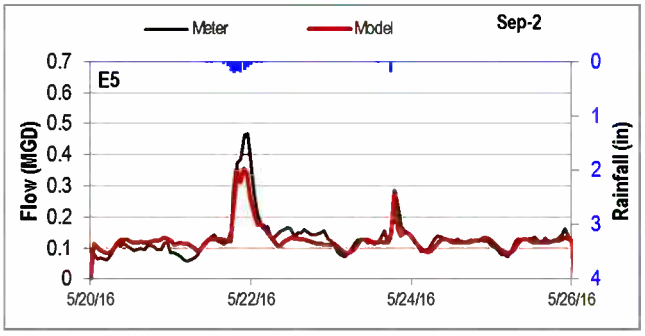




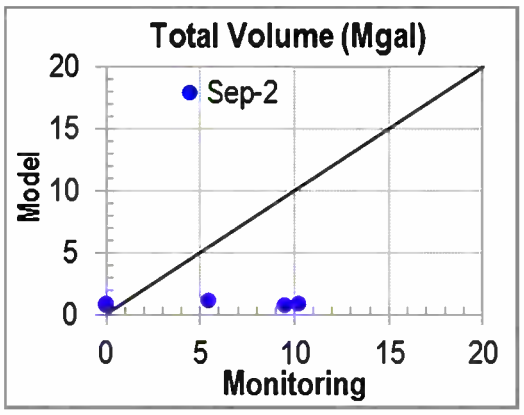


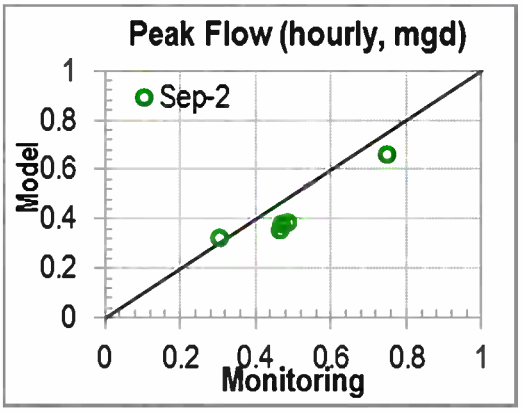


Sep-2 Model Validation Results (Metered and Modeled Flow)



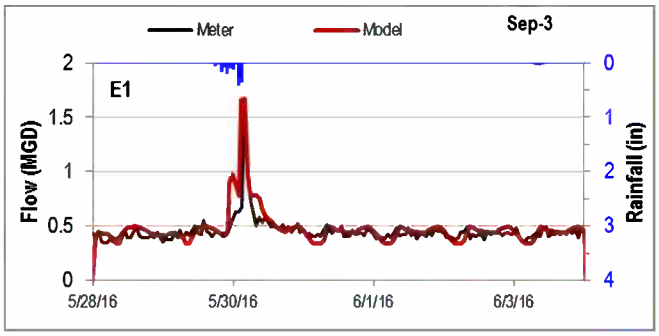
Sep-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

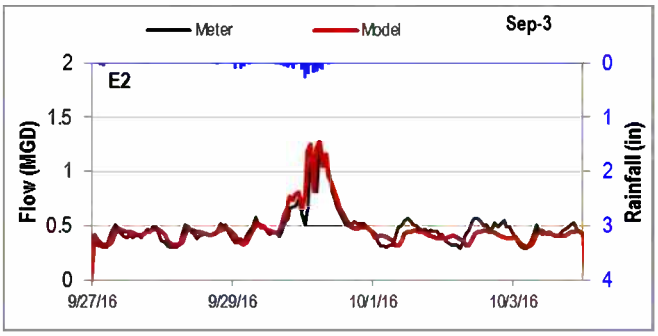


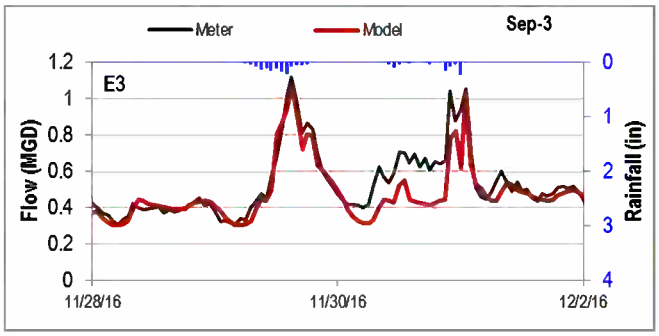


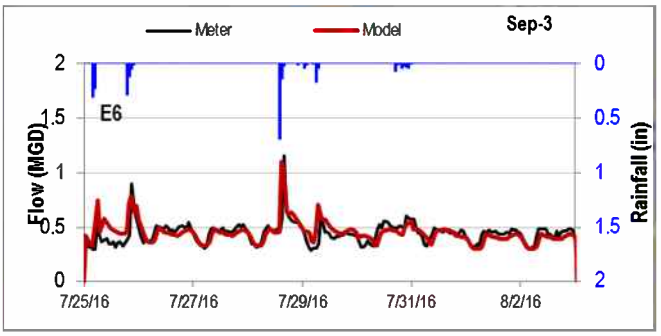
FLOW METER Sep-3 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-3 Model Calibration Results (Metered and Modeled Flow)

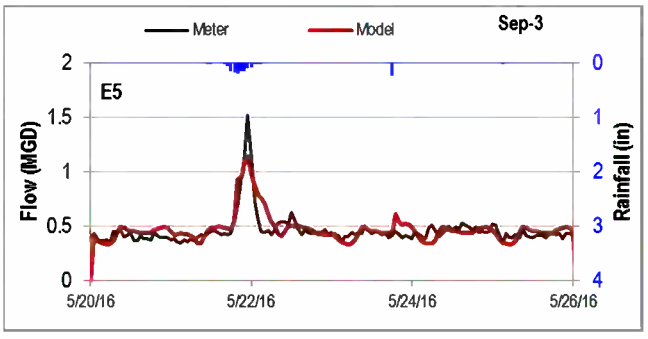




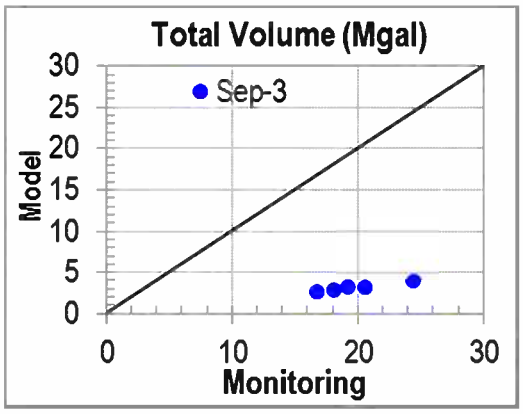


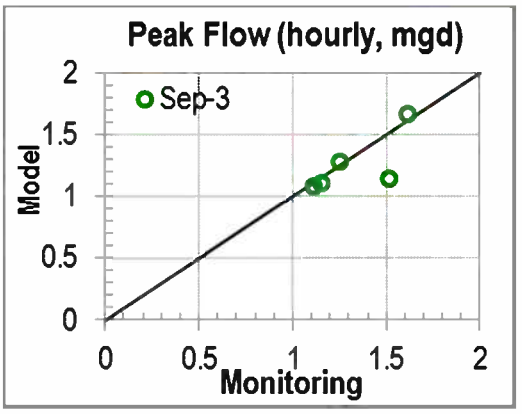


Sep-3 Model Validation Results (Metered and Modeled Flow)



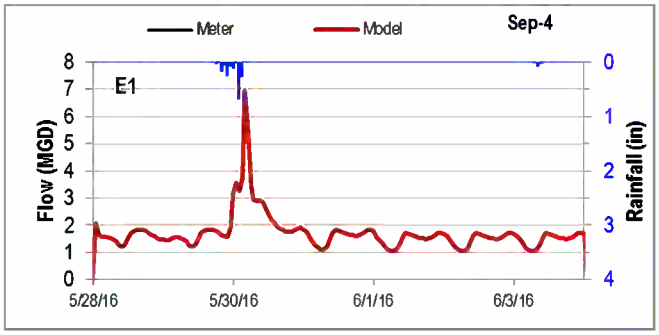
Sep-3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

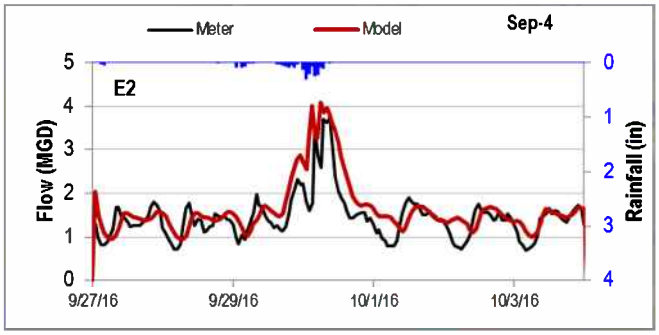


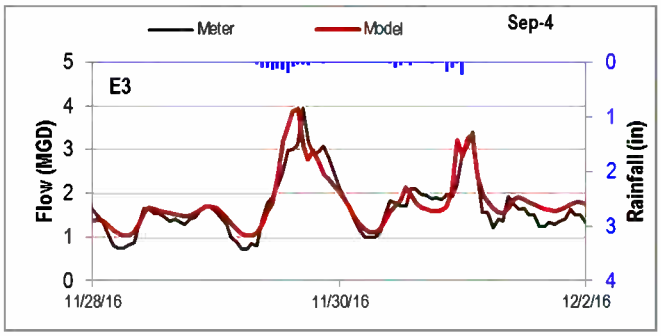


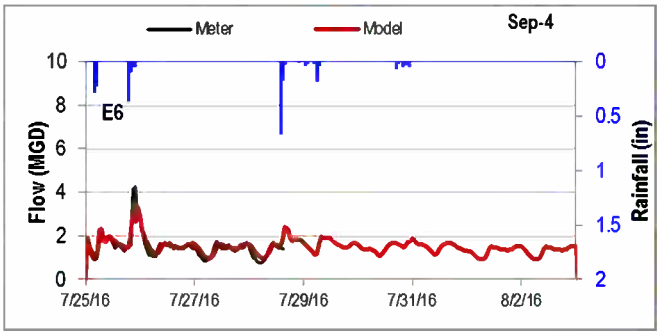
FLOW METER Sep-4 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-4 Model Calibration Results (Metered and Modeled Flow)

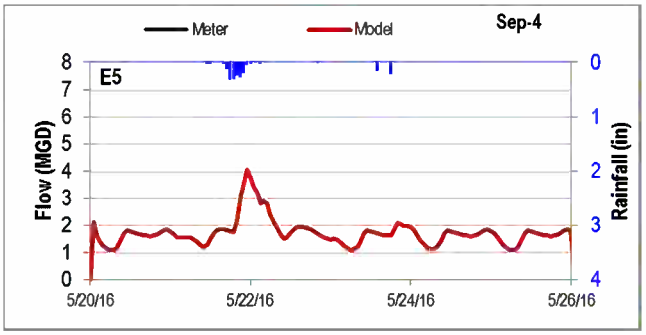




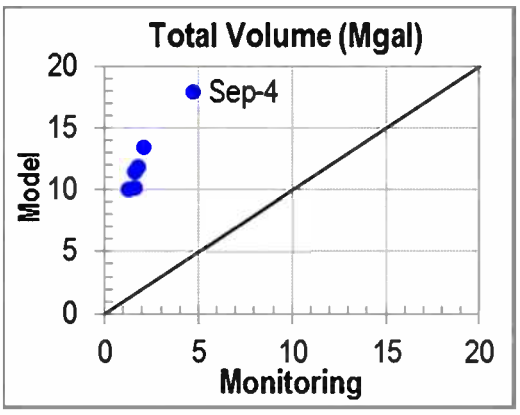


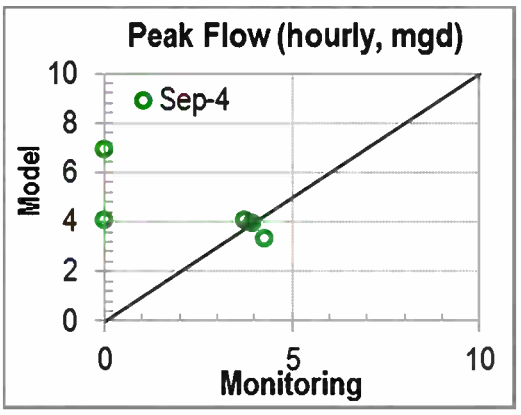


Sep-4 Model Validation Results (Metered and Modeled Flow)



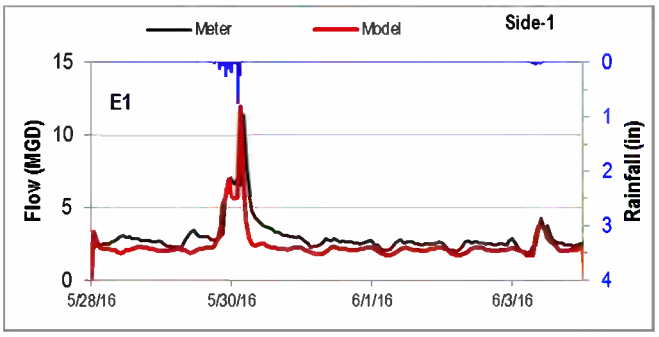
Sep-4 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

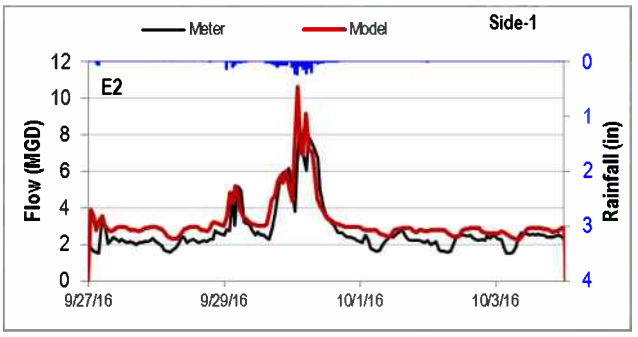


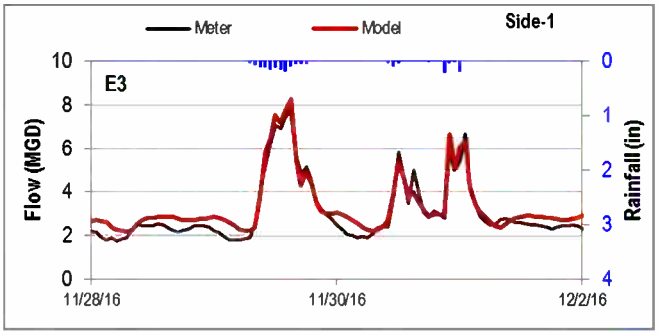


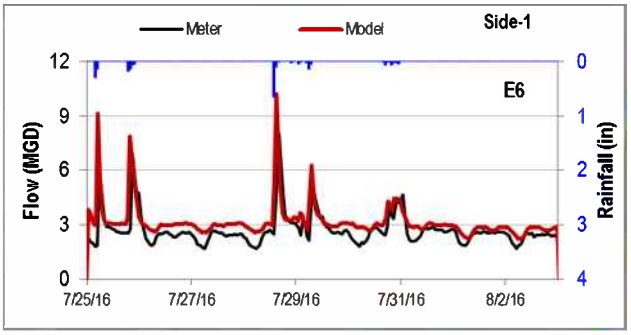
FLOW METER Side-1 MODEL CALIBRATION AND VALIDATION RESULTS

Side-1 Model Calibration Results (Metered and Modeled Flow)

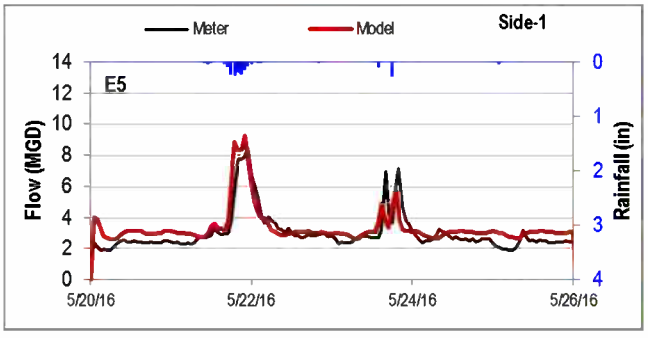




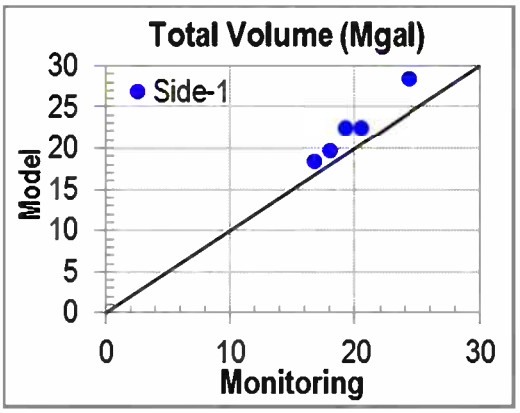


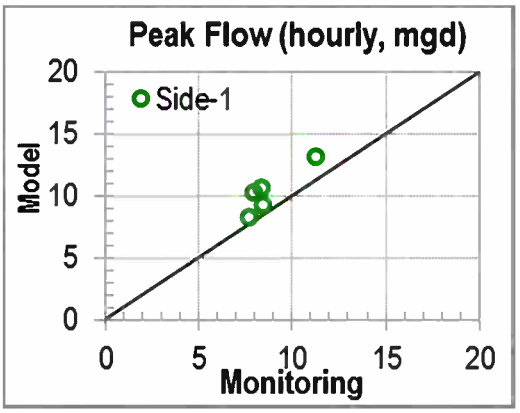


Side-1 Model Validation Results (Metered and Modeled Flow)



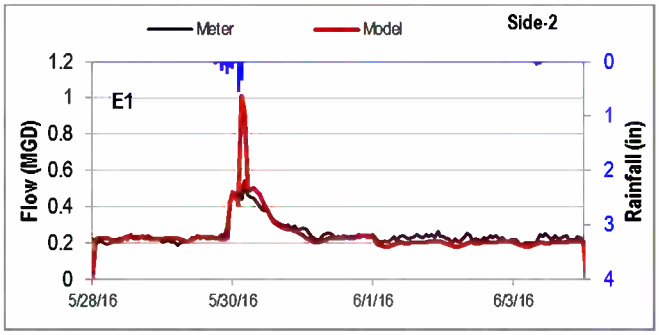
Side-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

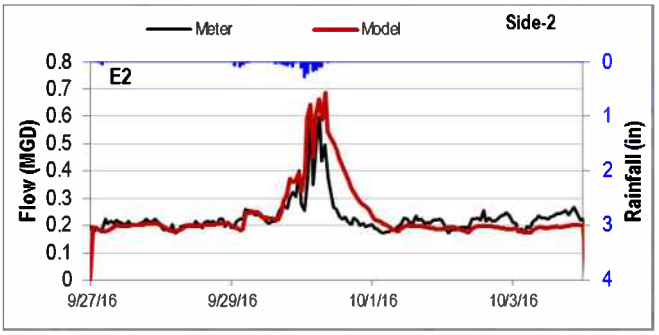


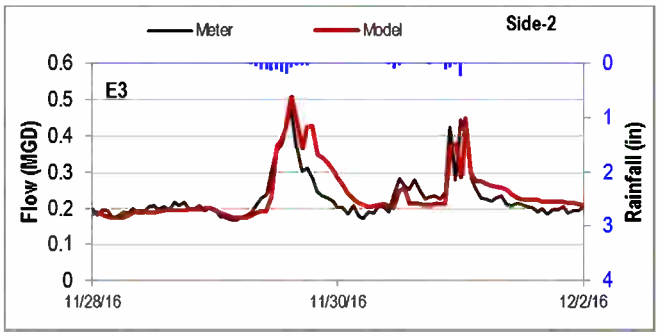


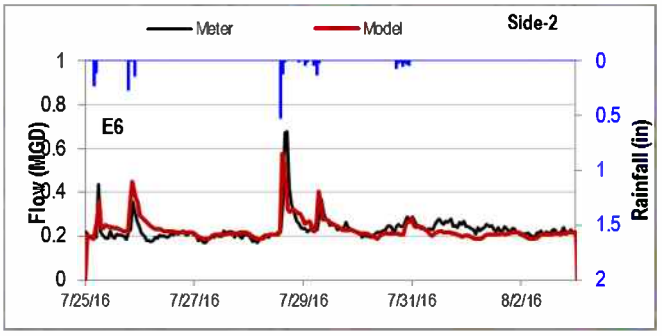
FLOW METER Side-2 MODEL CALIBRATION AND VALIDATION RESULTS

Side-2 Model Calibration Results (Metered and Modeled Flow)

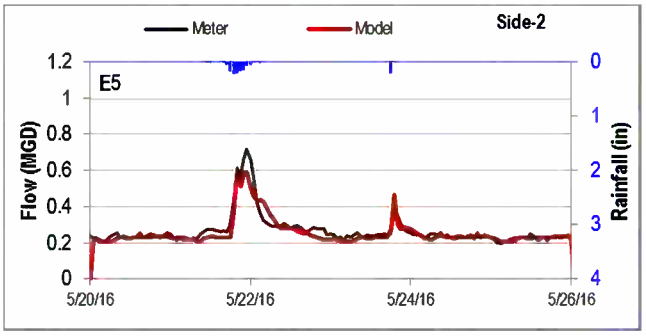




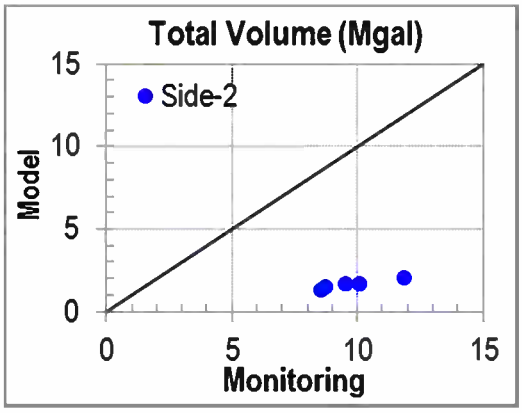


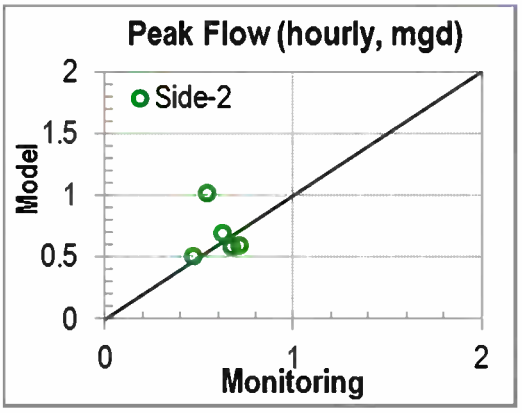


Side-2 Model Validation Results (Metered and Modeled Flow)



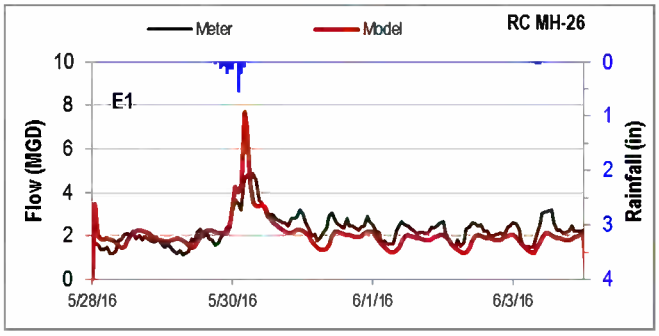
Side-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

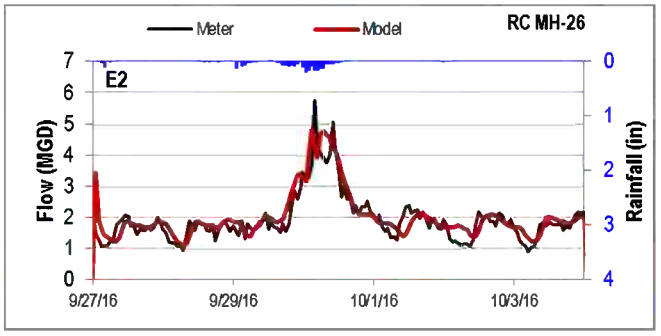


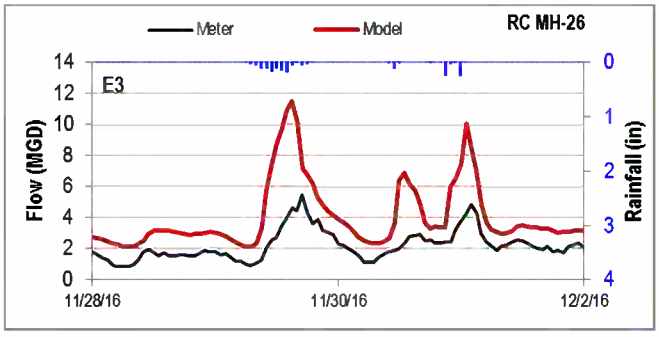


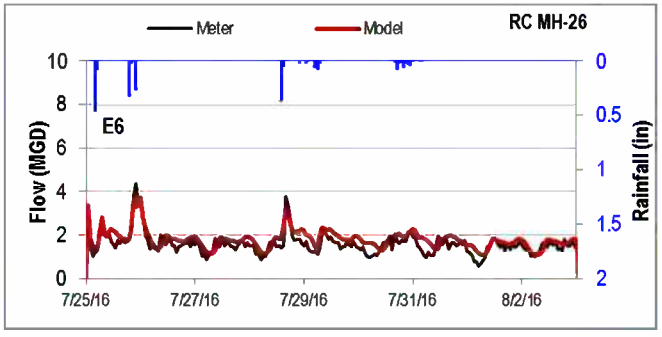
FLOW METER RC MH-26 MODEL CALIBRATION AND VALIDATION RESULTS

RC MH-26 Model Calibration Results (Metered and Modeled Flow)

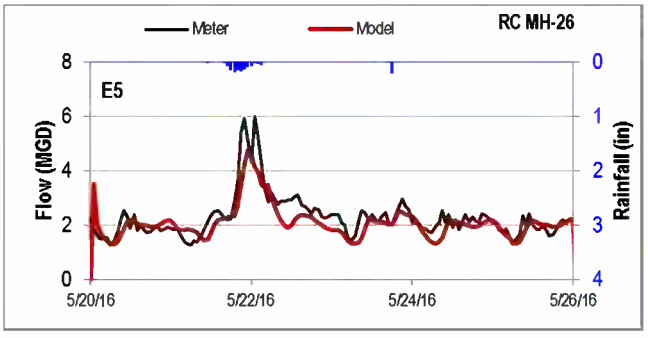




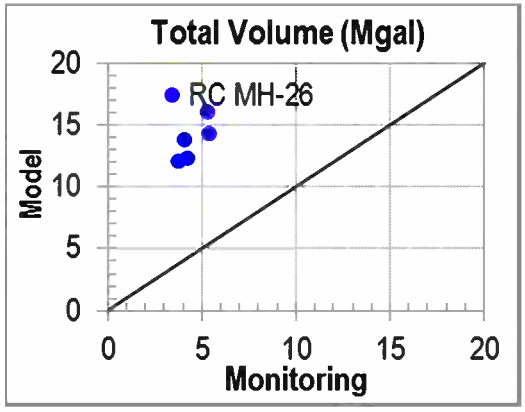


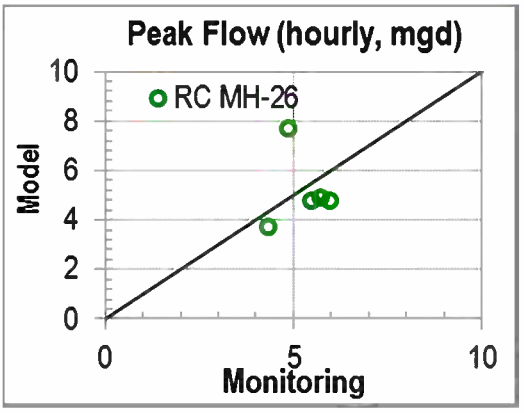


RC MH-26 Model Validation Results (Metered and Modeled Flow)



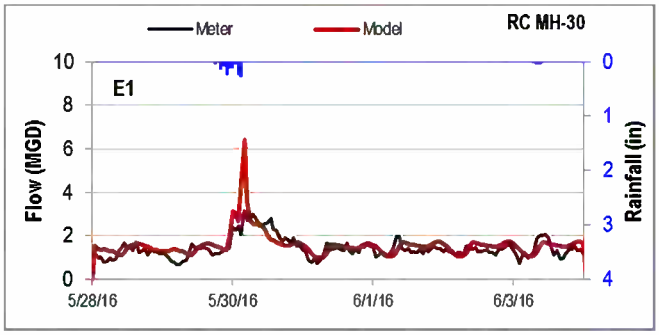
RC MH-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

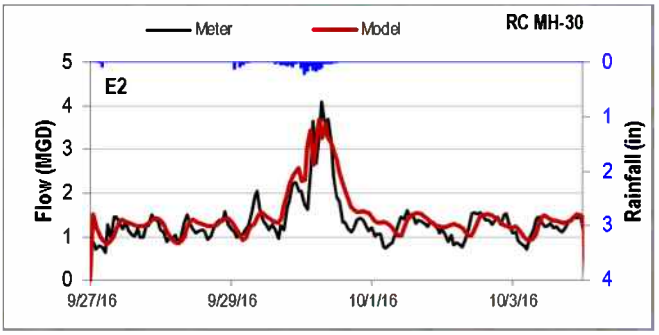


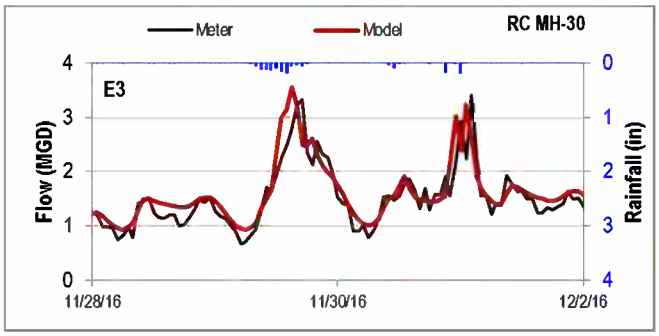


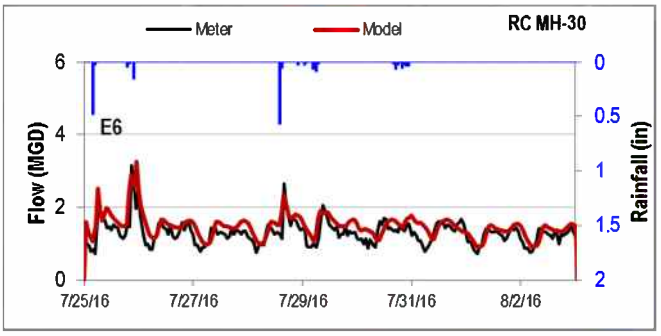
FLOW METER RC MH-30 MODEL CALIBRATION AND VALIDATION RESULTS

RC MH-30 Model Calibration Results (Metered and Modeled Flow)

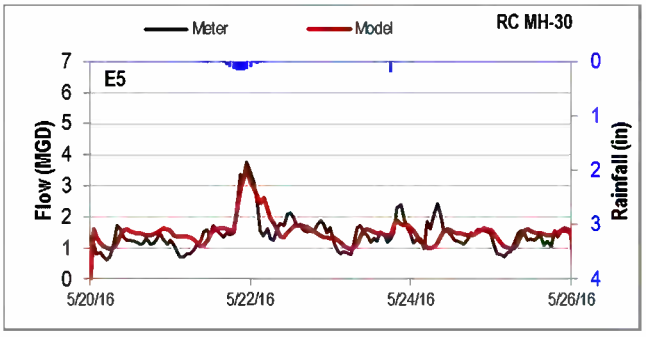




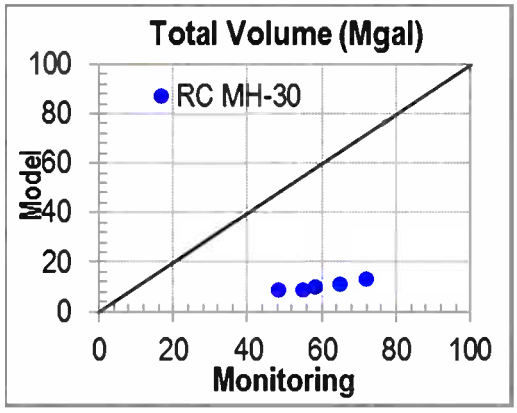


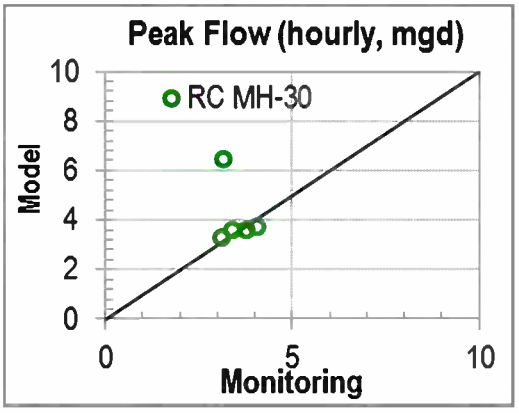


RC MH-30 Model Validation Results (Metered and Modeled Flow)



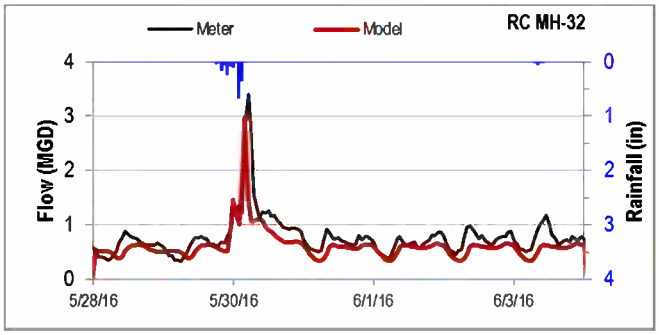
RC MH-30 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

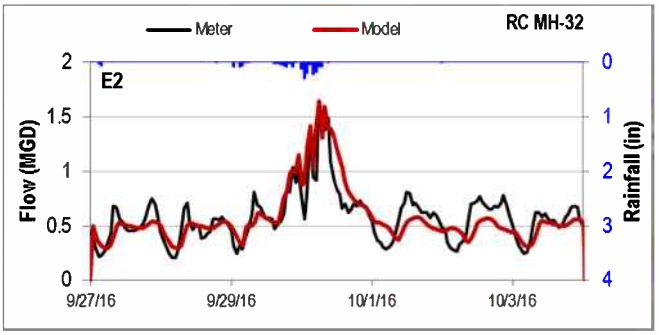


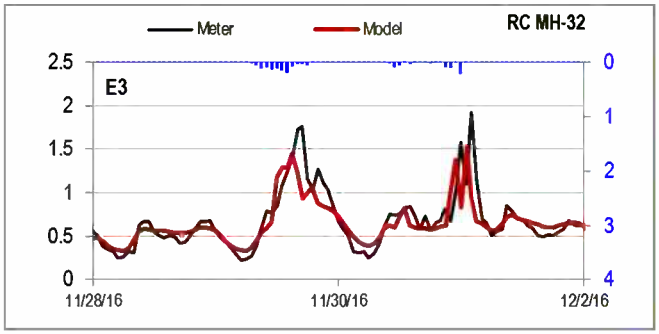


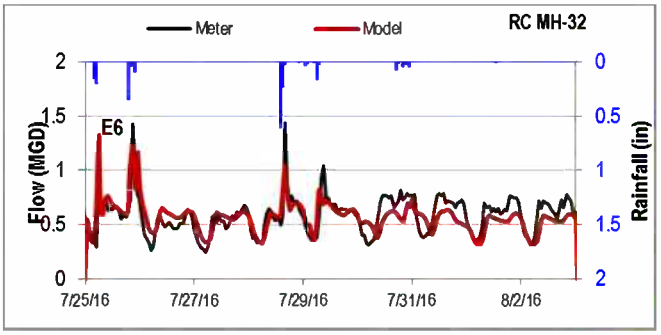
FLOW METER RC MH-32 MODEL CALIBRATION AND VALIDATION RESULTS

RC MH-32 Model Calibration Results (Metered and Modeled Flow)

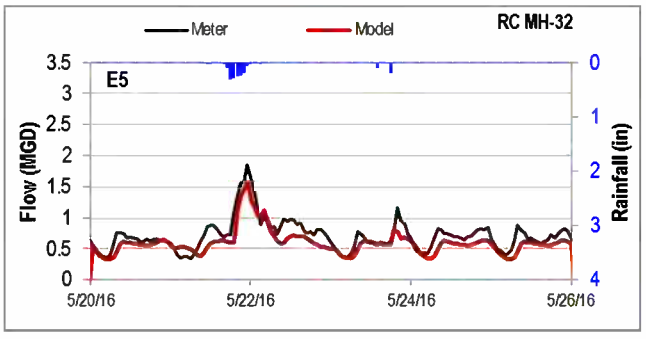




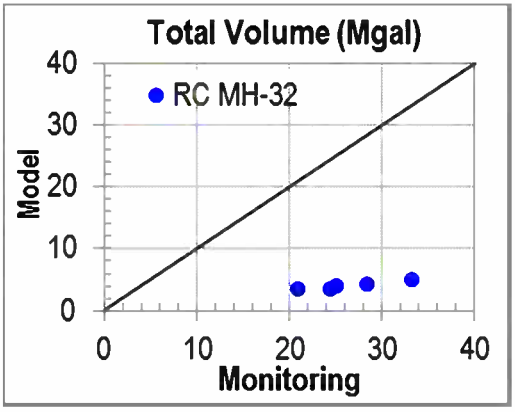


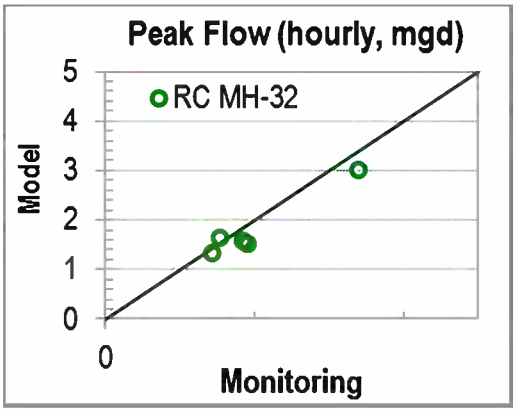


RC MH-32 Model Validation Results (Metered and Modeled Flow)



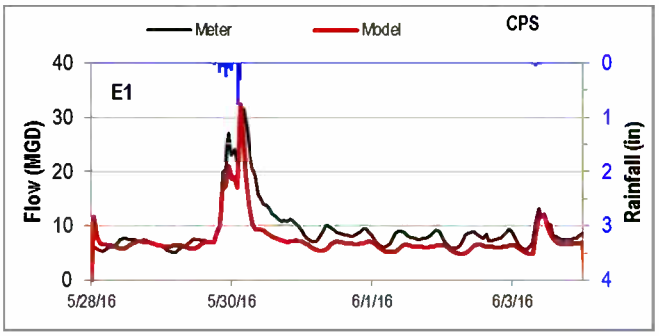
RC MH-32 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

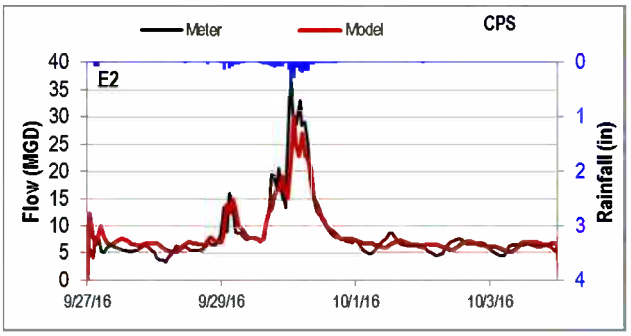


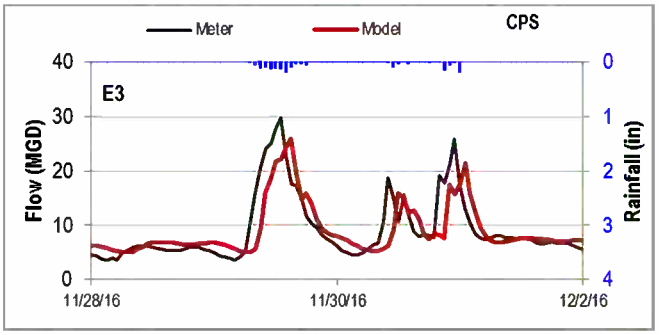


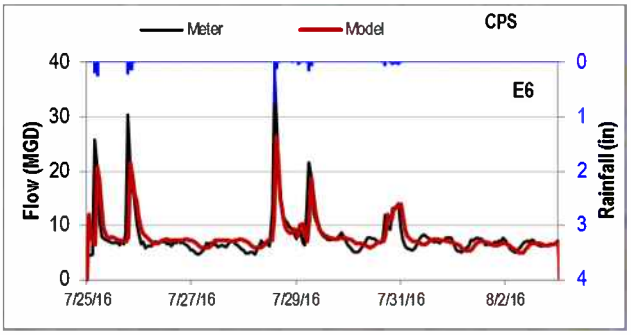
FLOW METER CPS MODEL CALIBRATION AND VALIDATION RESULTS

CPS Model Calibration Results (Metered and Modeled Flow)

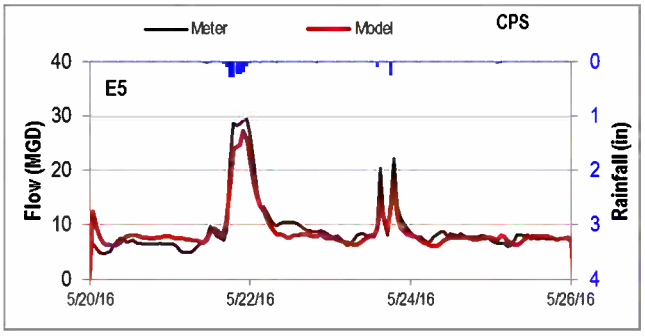




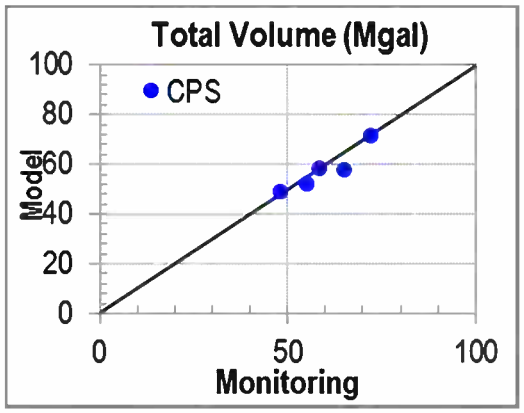


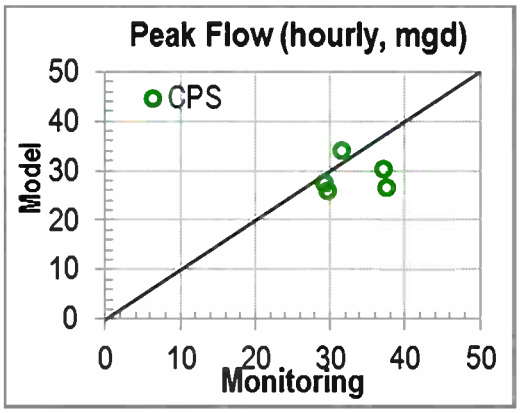


CPS Model Validation Results (Metered and Modeled Flow)



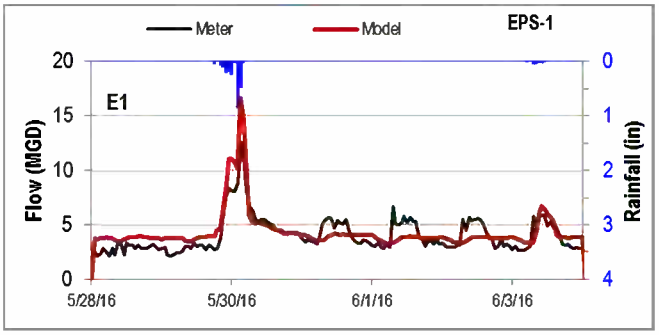
CPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

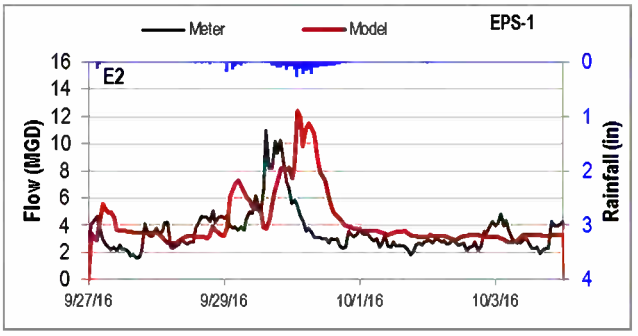


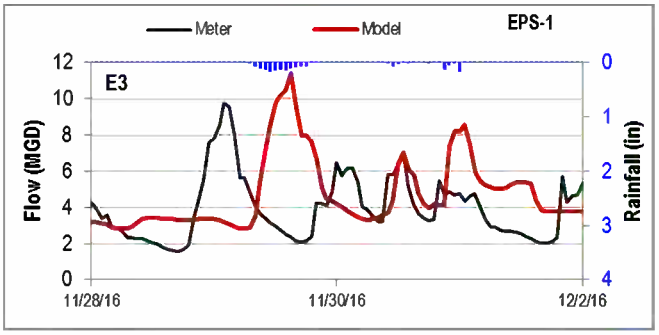


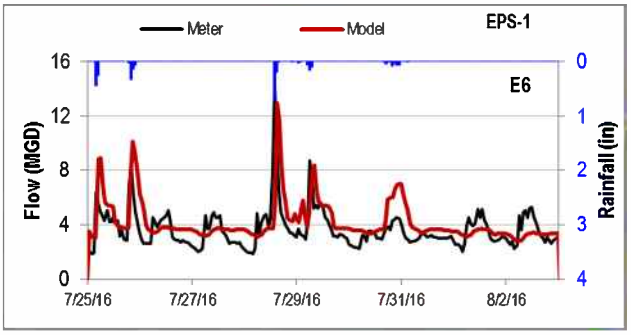
FLOW METER EPS-1 MODEL CALIBRATION AND VALIDATION RESULTS

EPS-1 Model Calibration Results (Metered and Modeled Flow)

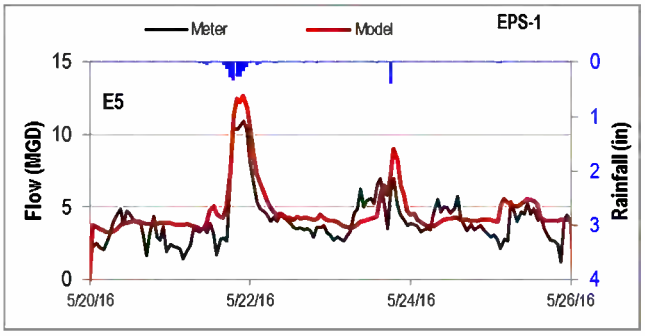




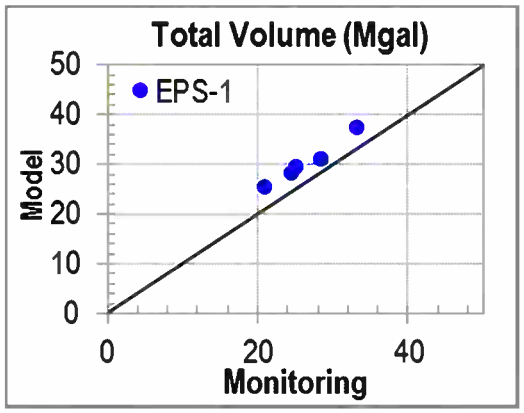


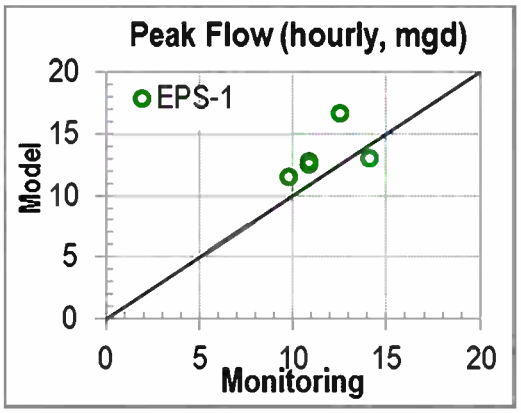


EPS-1 Model Validation Results (Metered and Modeled Flow)



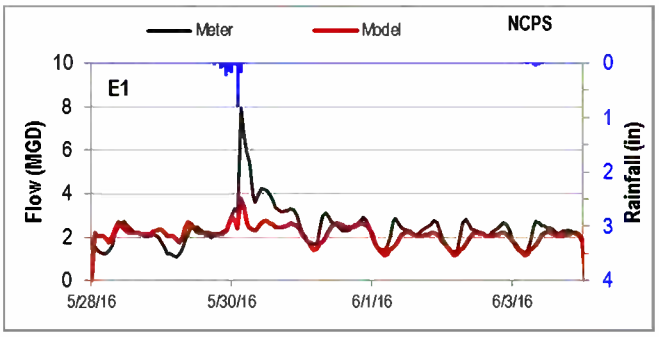
EPS-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

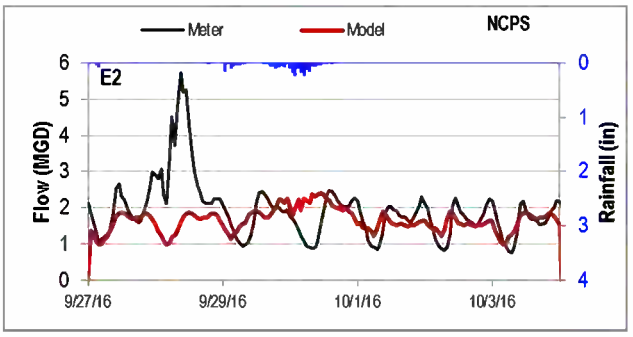


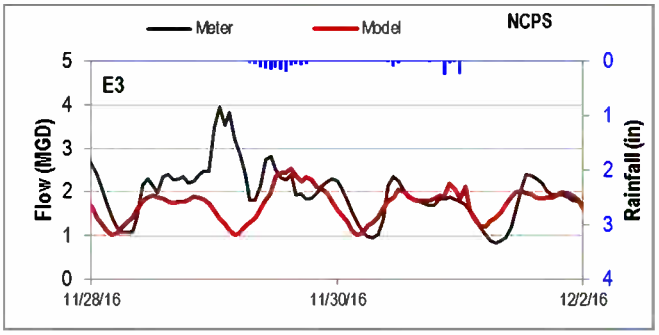


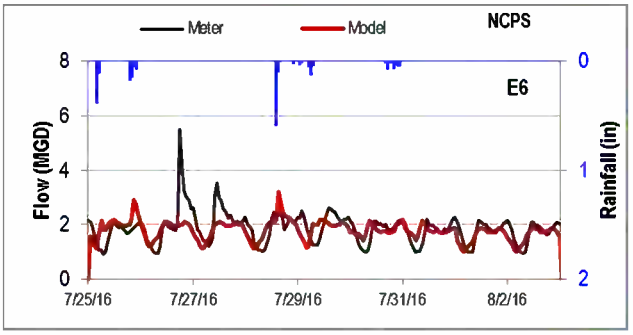
FLOW METER NCPS MODEL CALIBRATION AND VALIDATION RESULTS

NCPS Model Calibration Results (Metered and Modeled Flow)

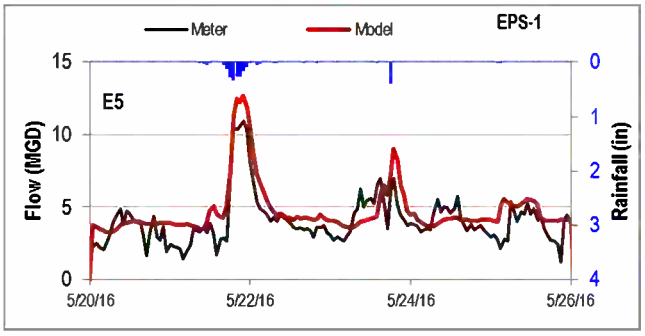




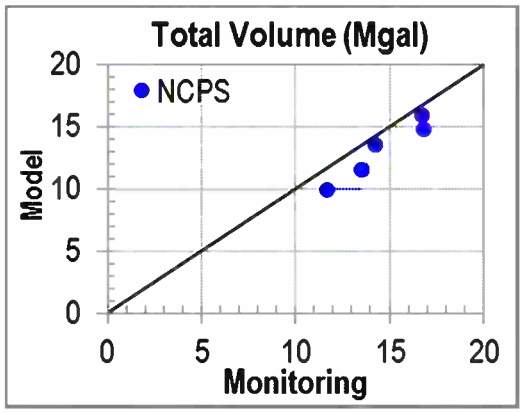


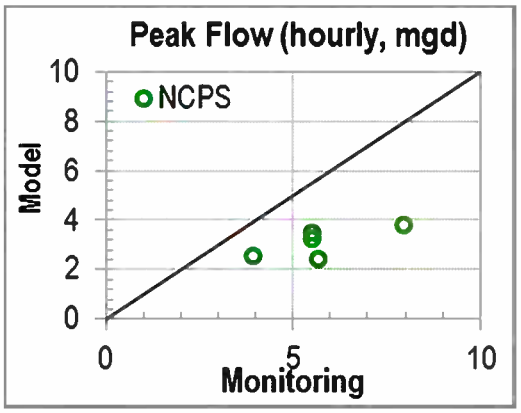


NCPS Model Validation Results (Metered and Modeled Flow)



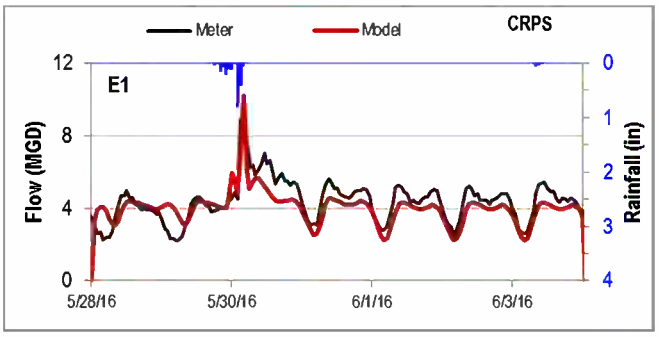
NCPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

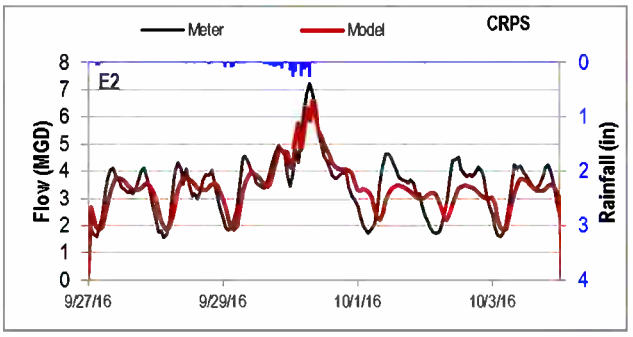


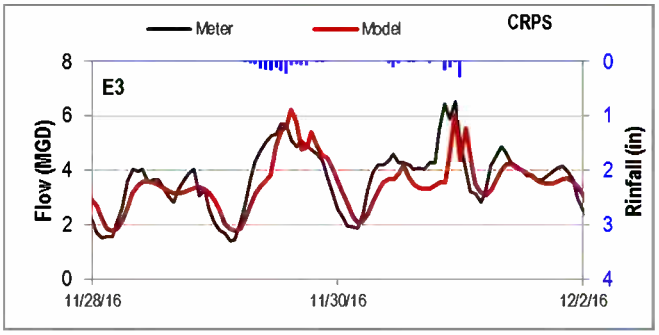


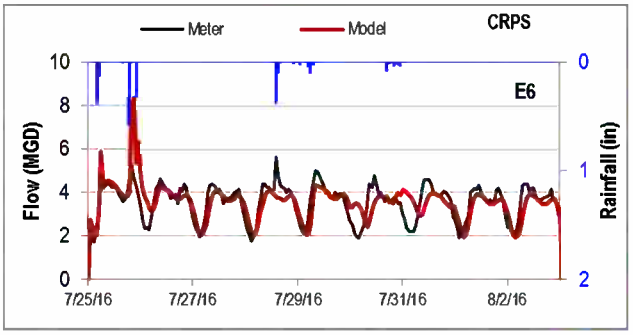
FLOW METER CRPS MODEL CALIBRATION AND VALIDATION RESULTS

CRPS Model Calibration Results (Metered and Modeled Flow)

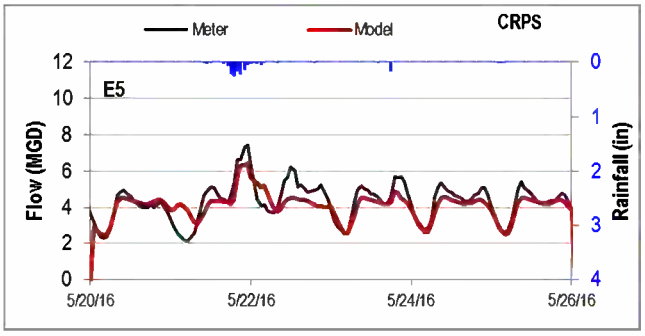




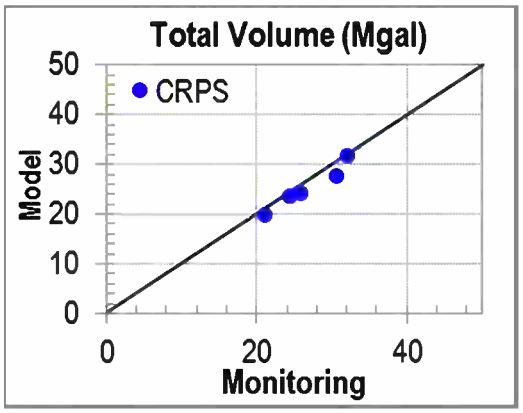


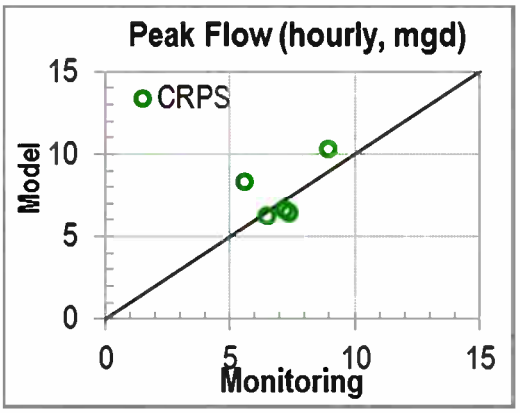


CRPS Model Validation Results (Metered and Modeled Flow)



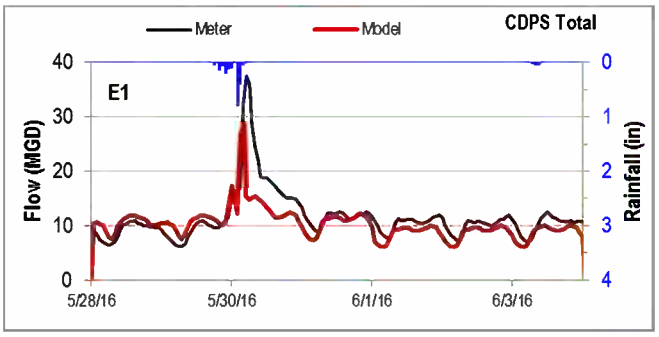
CRPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

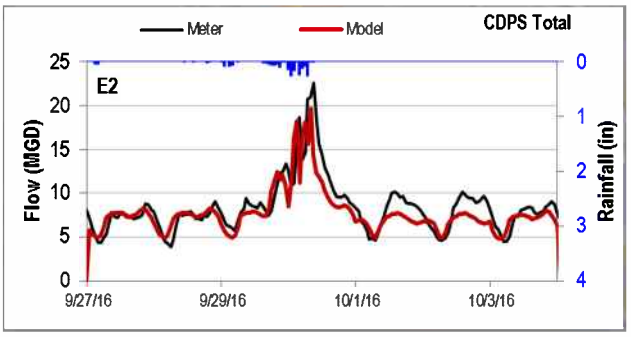


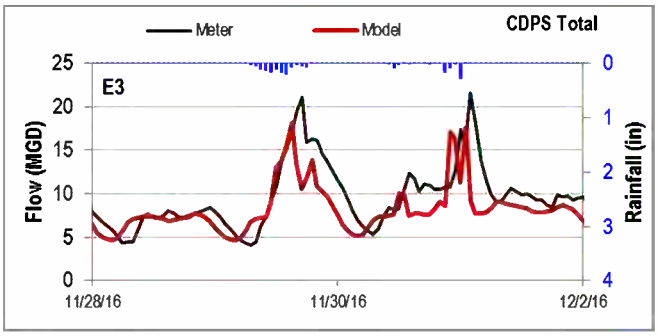


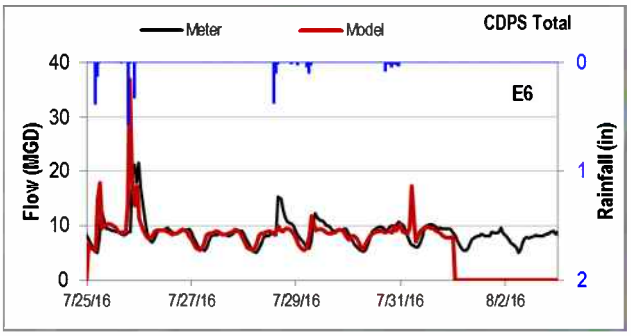
FLOW METER CDPS TOTAL MODEL CALIBRATION AND VALIDATION RESULTS

CDPS Total Model Calibration Results (Metered and Modeled Flow)

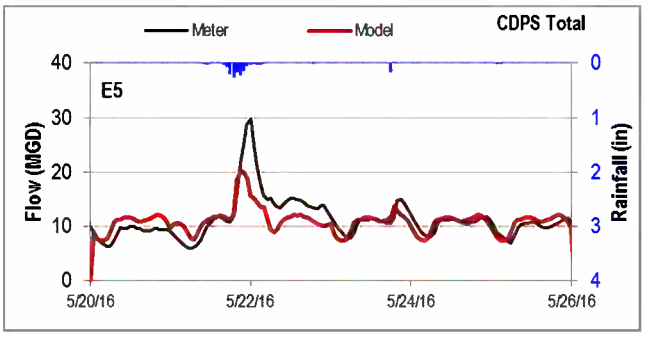




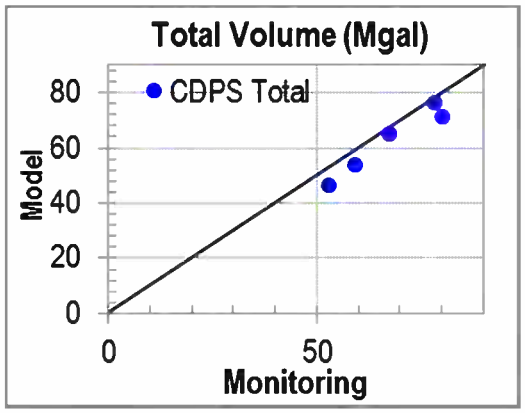


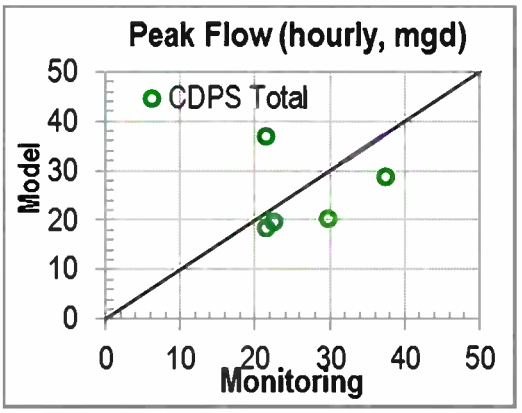


CDPS Total Model Validation Results (Metered and Modeled Flow)



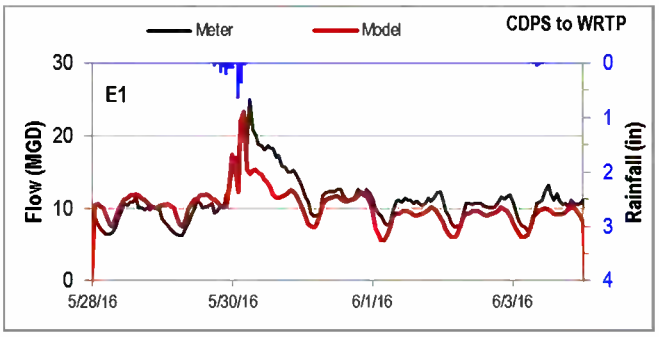
CDPS Total Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

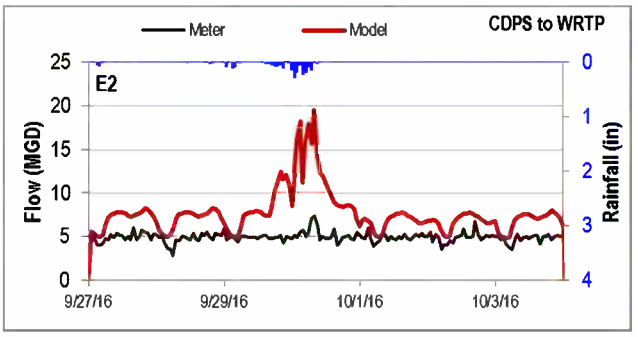


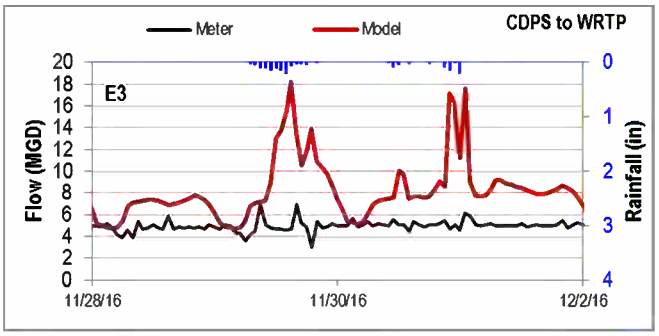


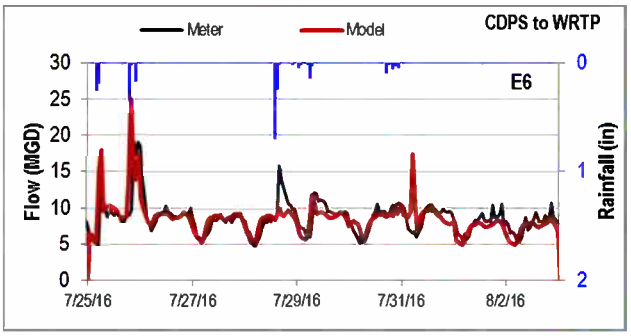
FLOW METER CDPS TO WRTP MODEL CALIBRATION AND VALIDATION RESULTS

CDPS to WRTP Model Calibration Results (Metered and Modeled Flow)

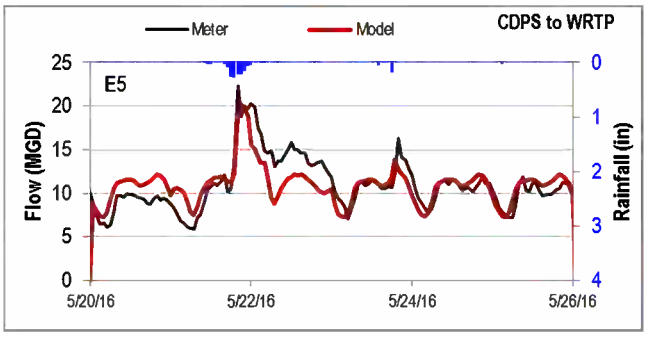




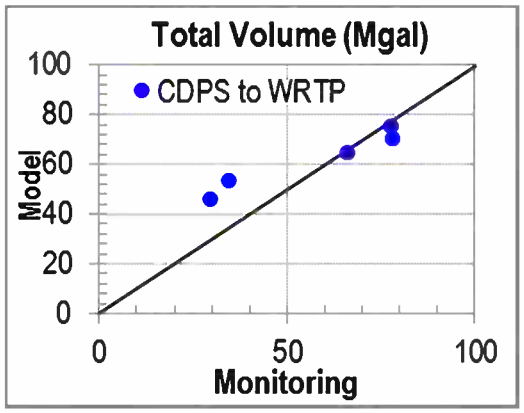


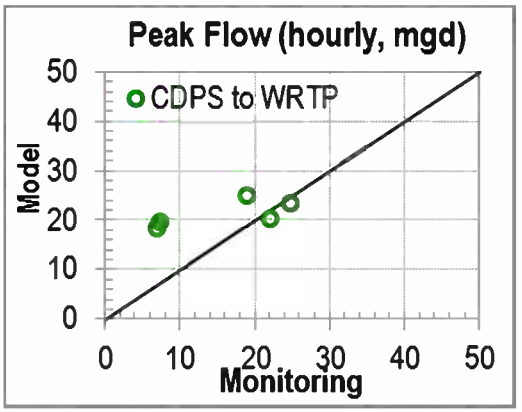


CDPS to WRTP Model Validation Results (Metered and Modeled Flow)



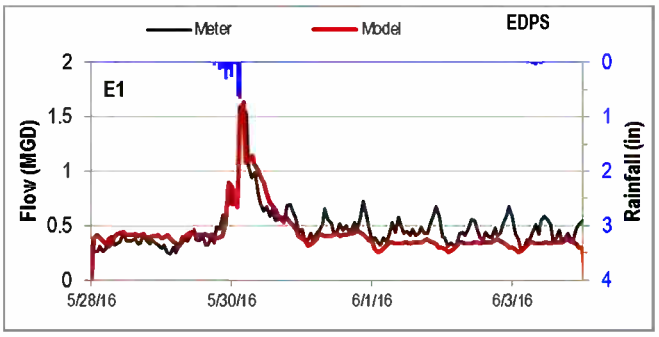
CDPS to WRTP Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

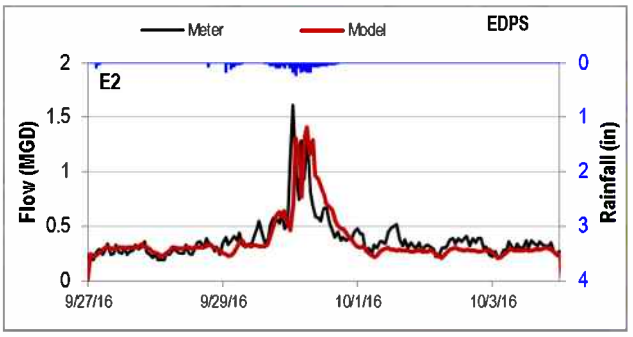


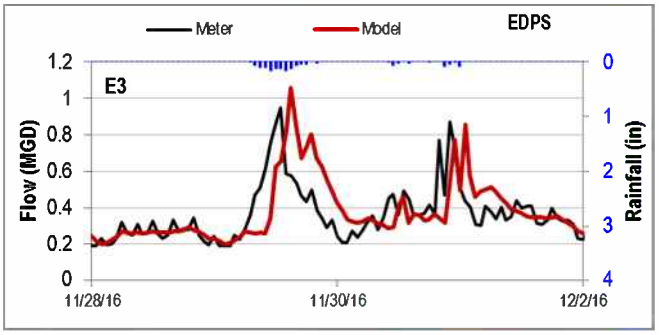


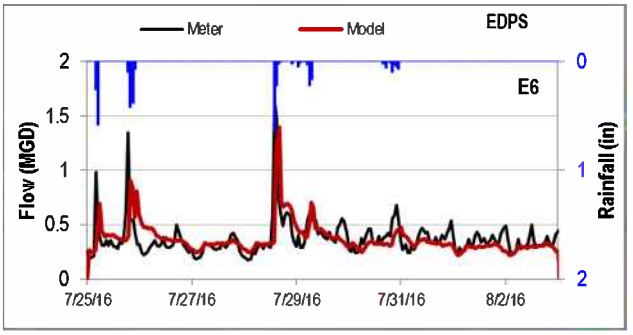
FLOW METER EDPS MODEL CALIBRATION AND VALIDATION RESULTS

EDPS Model Calibration Results (Metered and Modeled Flow)

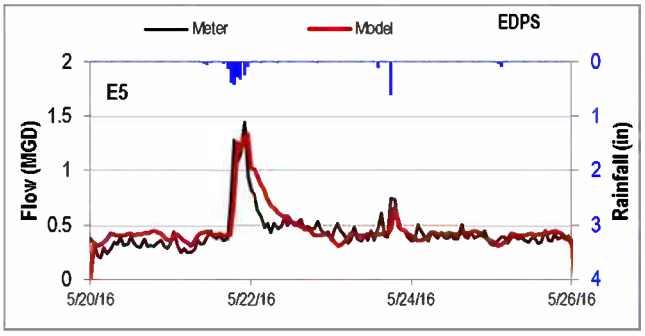




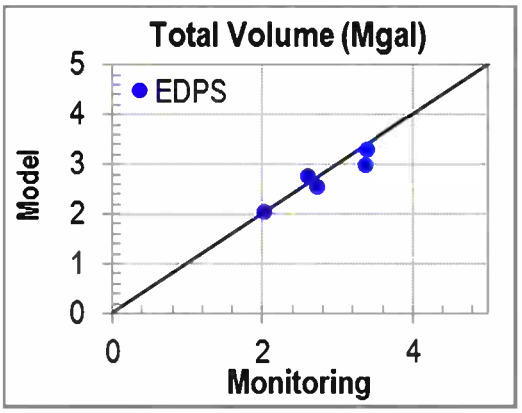


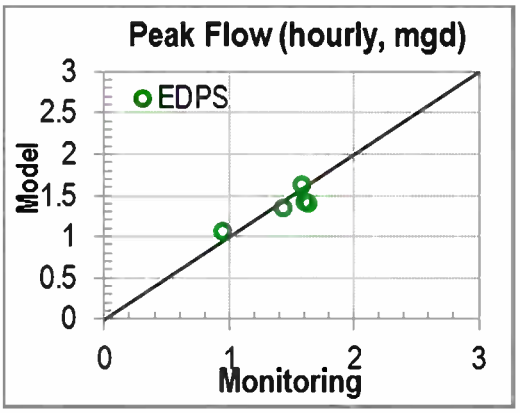


EDPS Model Validation Results (Metered and Modeled Flow)



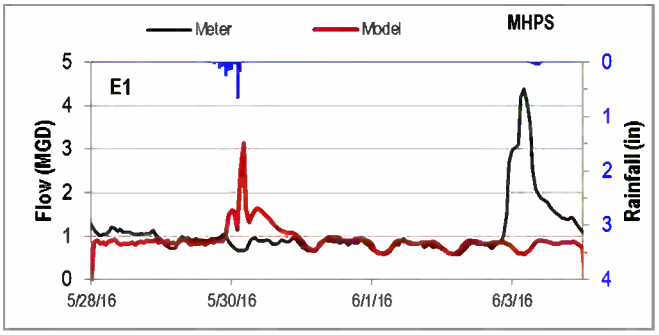
EDPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

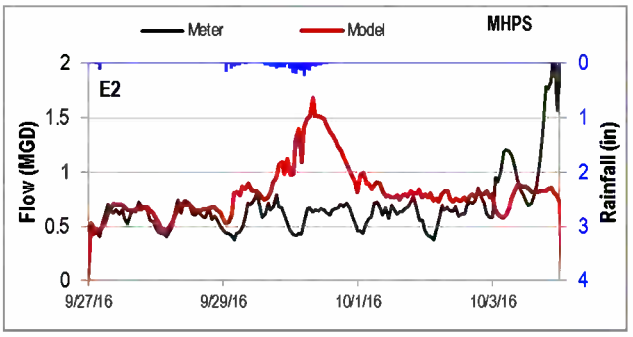


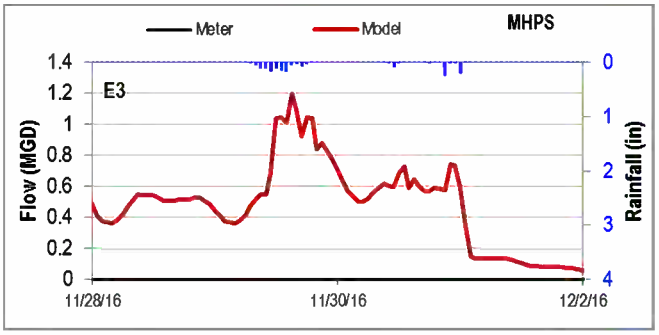


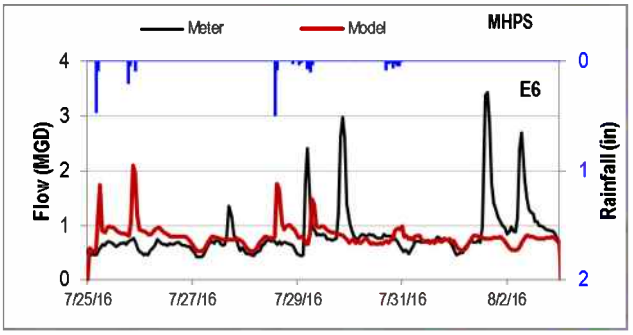
FLOW METER MHPS MODEL CALIBRATION AND VALIDATION RESULTS

MHPS Model Calibration Results (Metered and Modeled Flow)

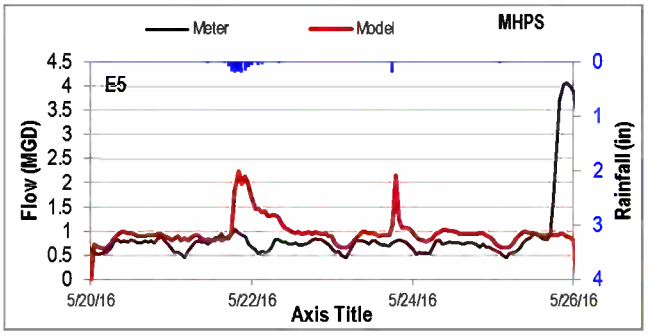




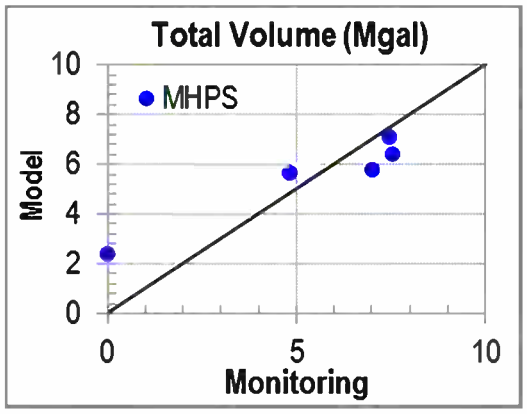


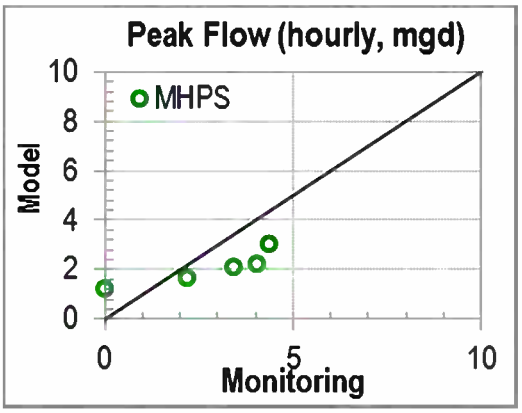


MHPS Model Validation Results (Metered and Modeled Flow)



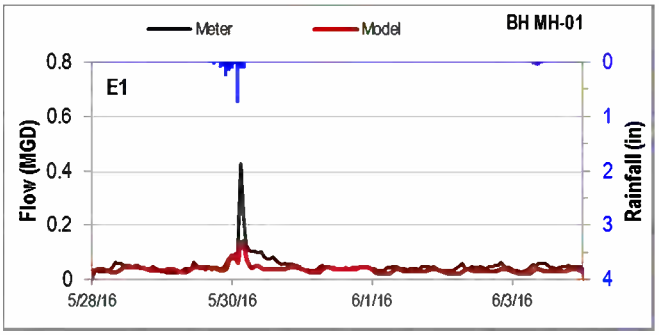
MHPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

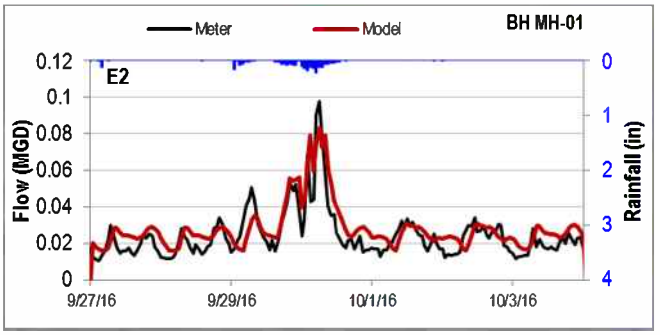


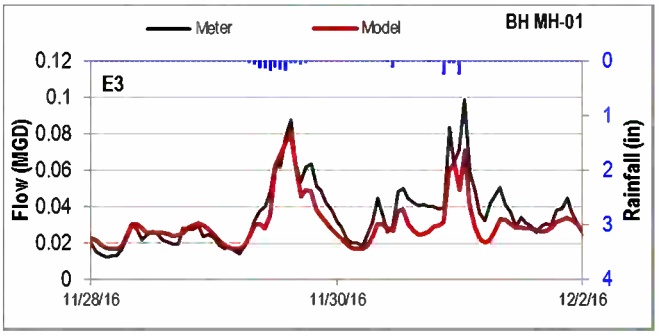


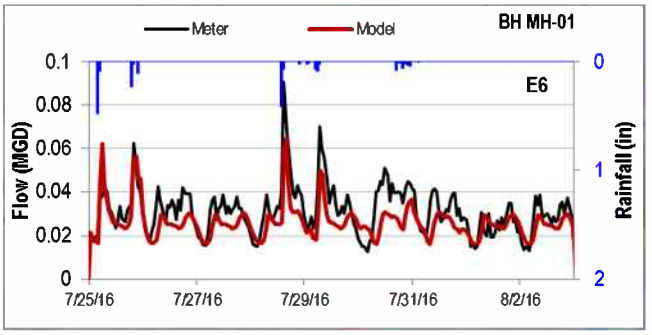
FLOW METER BH MH-01 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-01 Model Calibration Results (Metered and Modeled Flow)

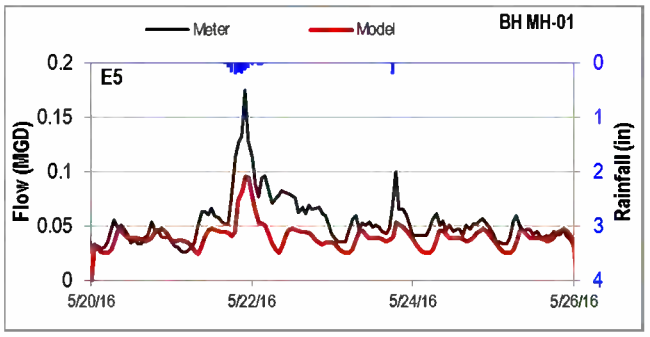




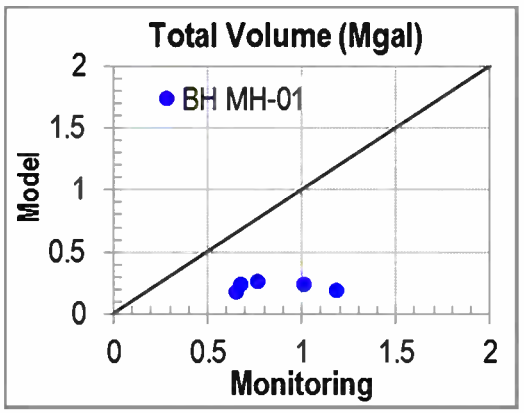


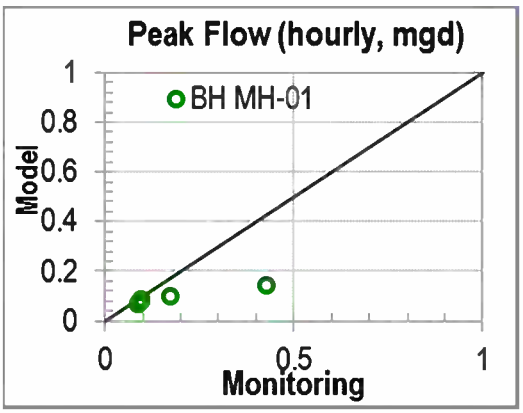


BH MH-01 Model Validation Results (Metered and Modeled Flow)



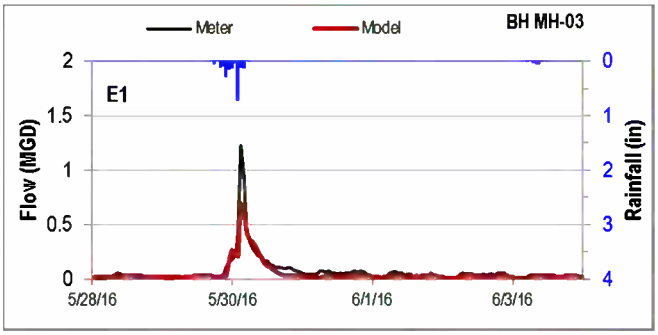
BH MH-01 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

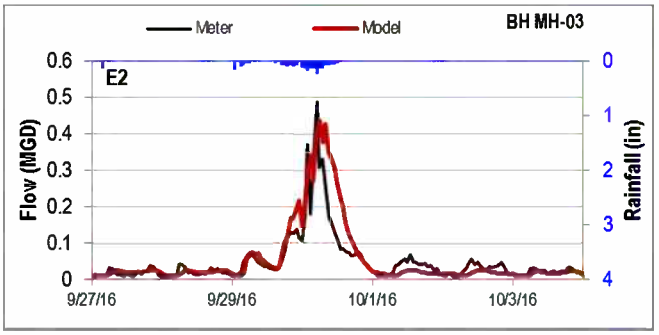


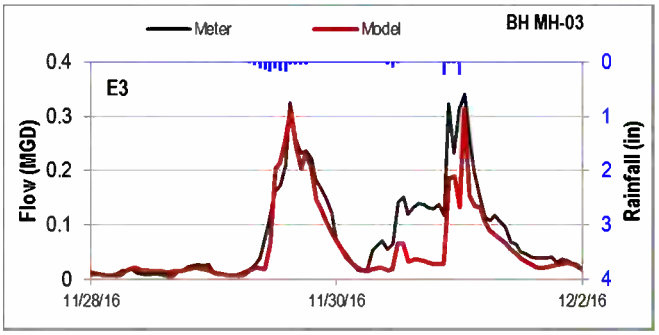


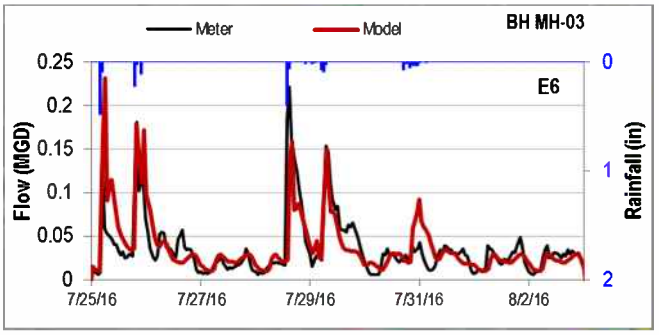
FLOW METER BH MH-03 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-03 Model Calibration Results (Metered and Modeled Flow)

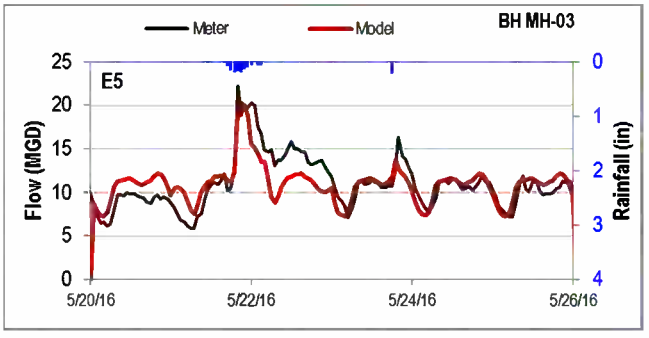




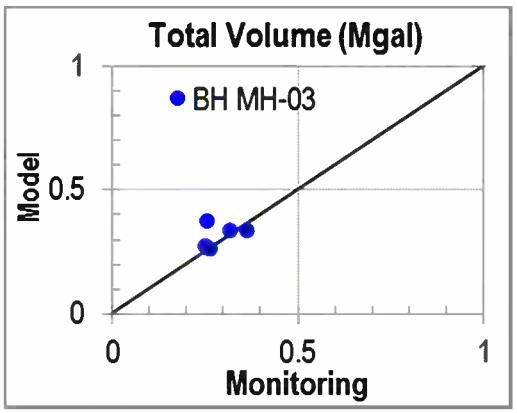


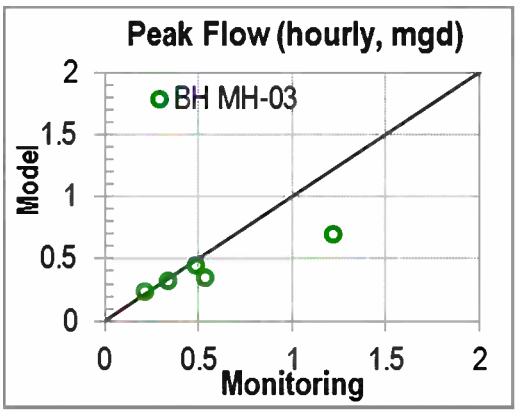


BH MH-03 Model Validation Results (Metered and Modeled Flow)



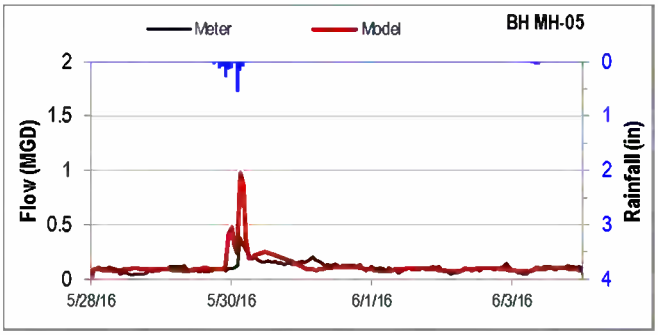
BH MH-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

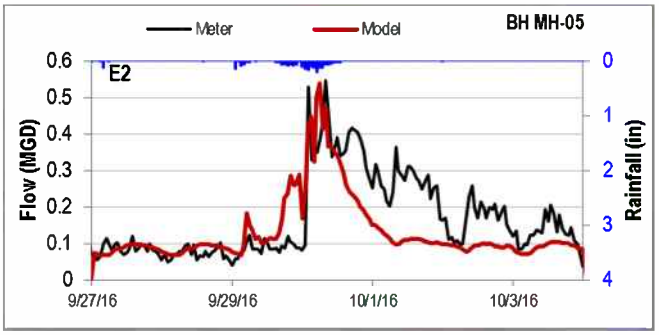


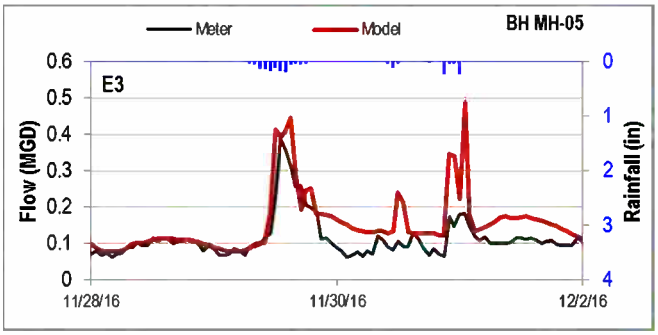


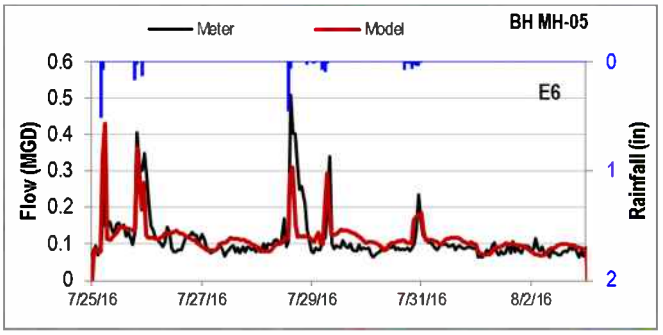
FLOW METER BH MH-05 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-05 Model Calibration Results (Metered and Modeled Flow)

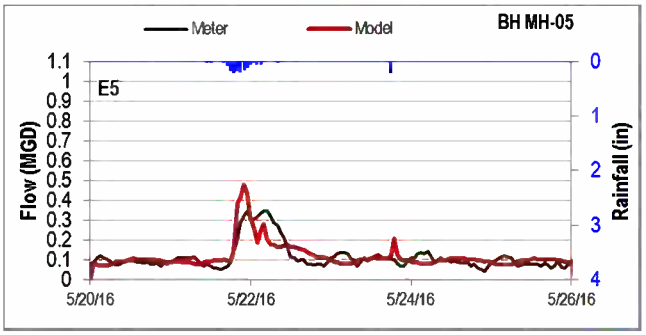




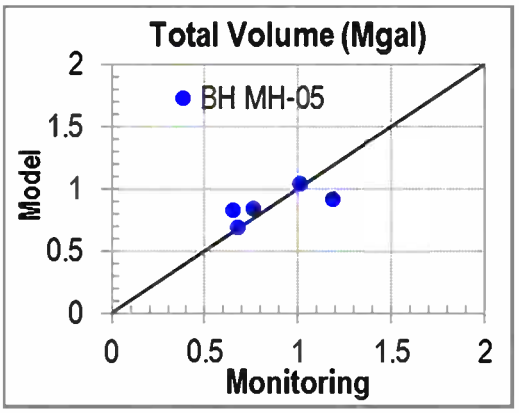


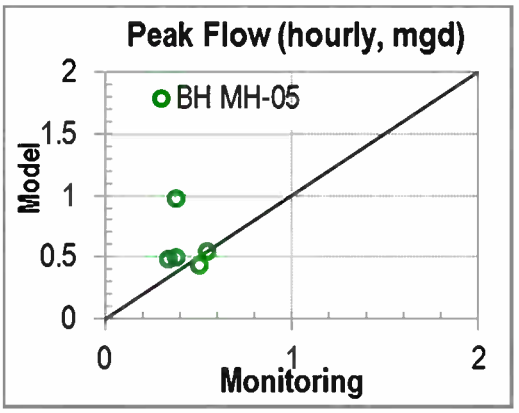


BH MH-05 Model Validation Results (Metered and Modeled Flow)



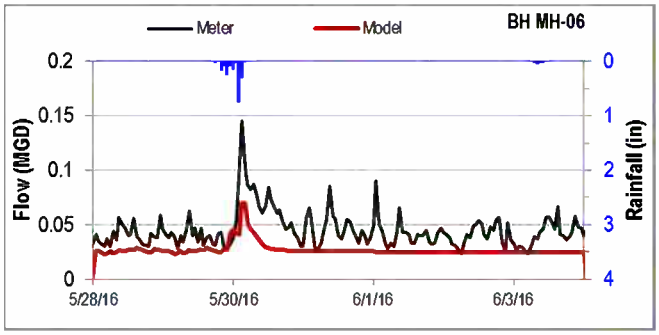
BH MH-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

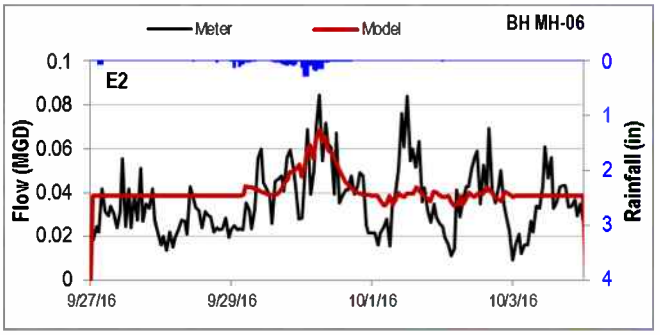


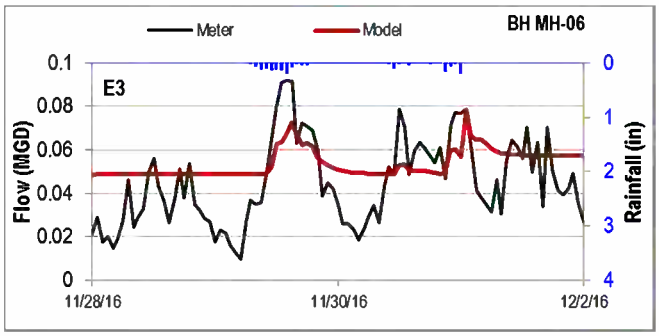


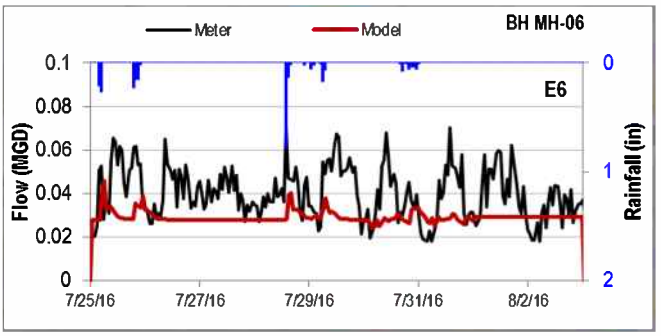
FLOW METER BH MH-06 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-06 Model Calibration Results (Metered and Modeled Flow)

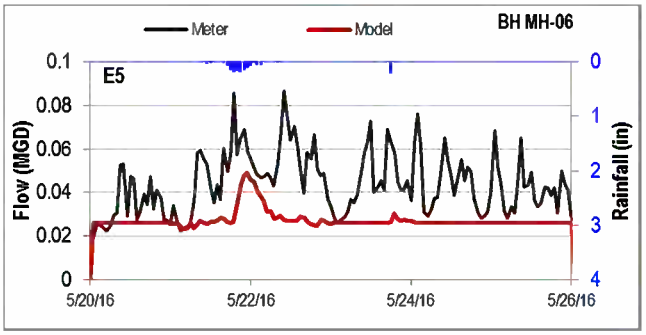




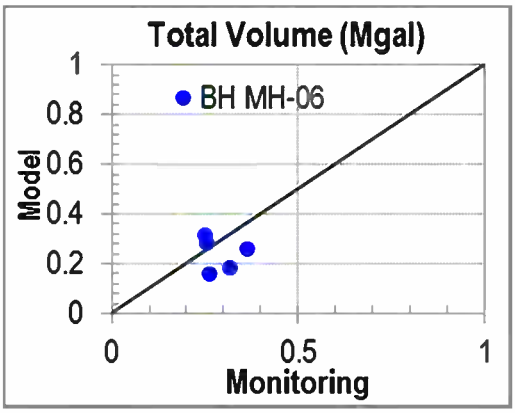


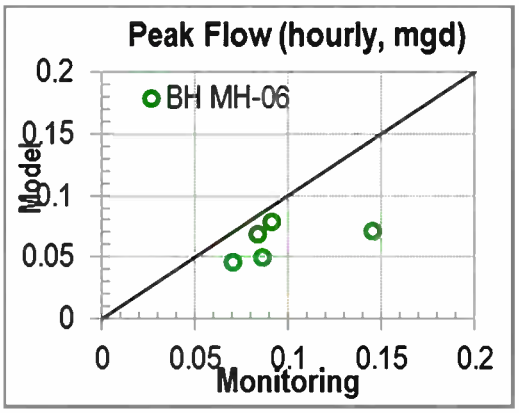


BH MH-06 Model Validation Results (Metered and Modeled Flow)



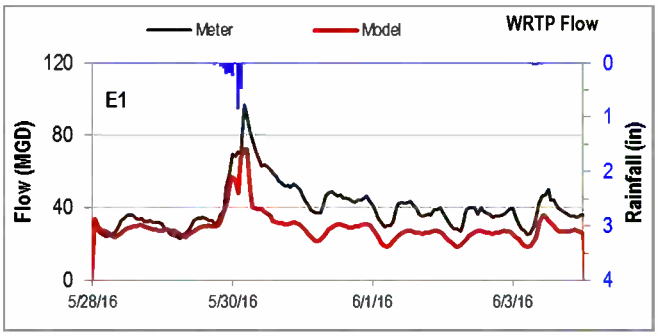
BH MH-06 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

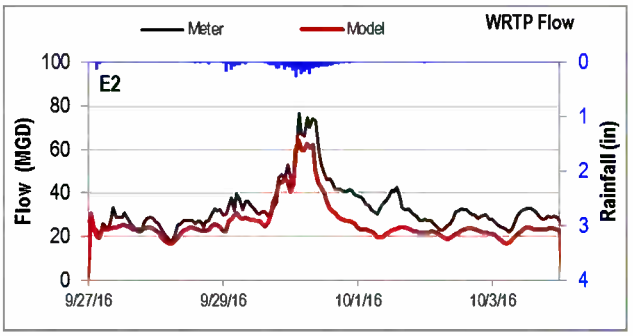


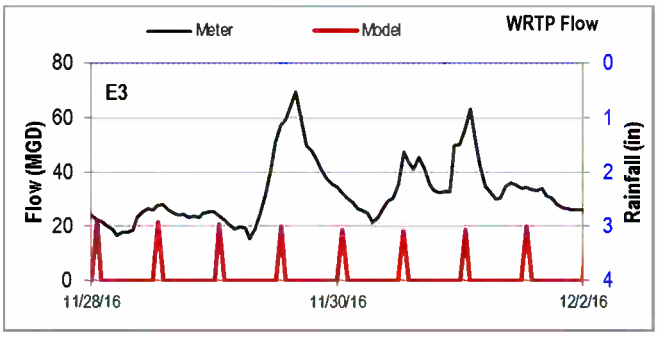


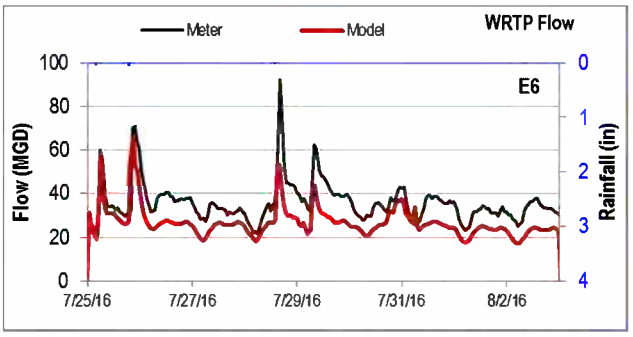
FLOW METER WRTP Flow MODEL CALIBRATION AND VALIDATION RESULTS

WRTP Flow Model Calibration Results (Metered and Modeled Flow)

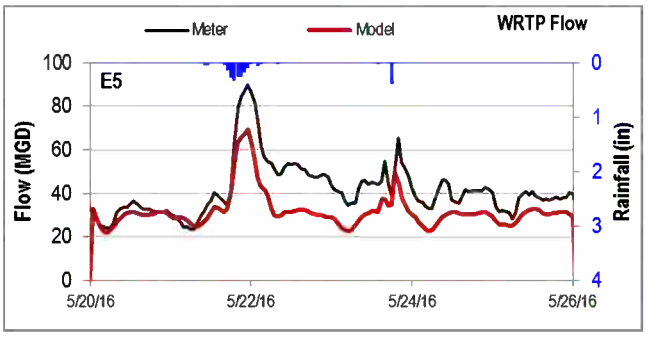




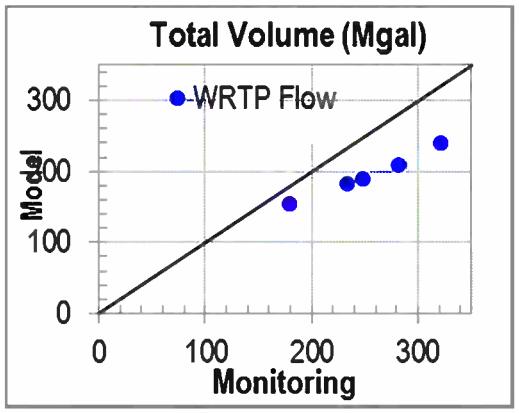


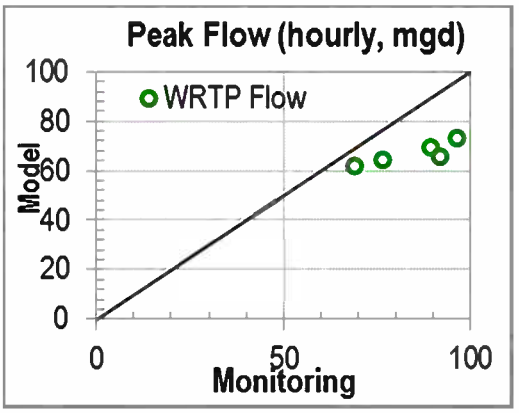


WRTP Flow Model Validation Results (Metered and Modeled Flow)



WRTP Flow Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)





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REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
1.	3/01/18	Greeley and Hansen / DELCORA	Appendix C – Revised and updated to address USEPA and PADEP comments

Appendix C Model Calibration and Validation Results (Revised and Updated March 1, 2018 to address USEPA and PADEP Comments received January 2, 2018)

H&H MODEL CALIBRATION AND VALIDATION RESULTS
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Statistical Evaluation: Nash-Sutcliffe Efficiencies

The Nash-Sutcliffe efficiency (NSE) was selected as an appropriate statistical measure of the goodness-of-fit for model calibration. It has been widely applied in hydrologic models (Moriasi et al., 2007) and thus can be used to assess the event volume predictions of the hydrologic component of the model. Although interpretation of NSE values may be subjective, model calibration is generally considered satisfactory for values greater than 0.5, with values greater than 0.75 being considered very good (Moriasi et al., 2007).

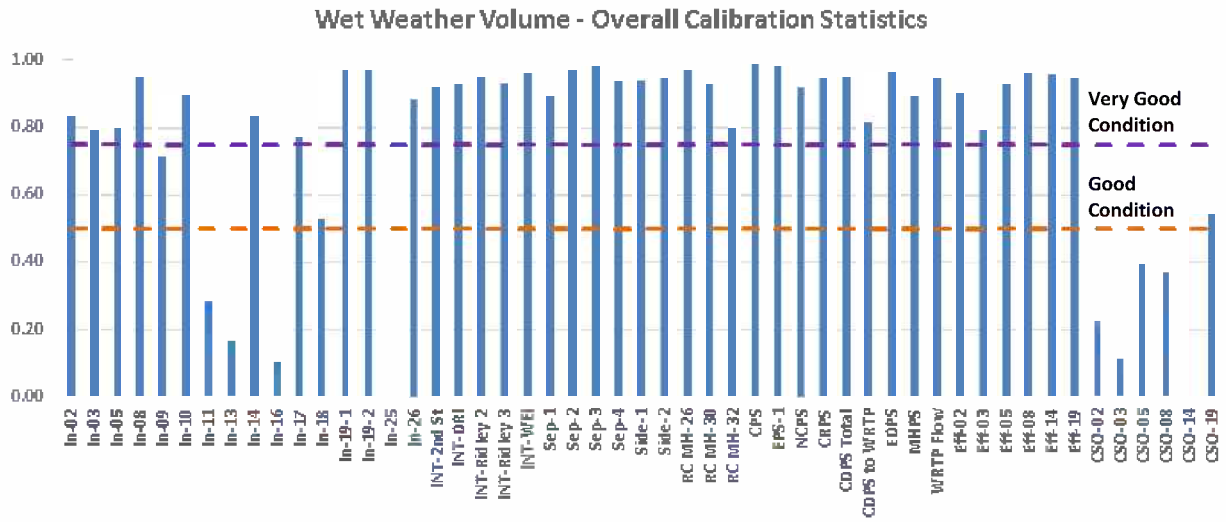
For this application the values were calculated as shown in following equation:

$$NSE = 1 - \left[\frac{\sum_{i=1}^{n}\left(Y_i^{obs} - Y_i^{sim}\right)^2}{\sum_{i=1}^{n}\left(Y_i^{obs} - Y^{mean}\right)^2}\right]$$

where,
Y_i^{obs}: the i^{th} metered event volume
Y_i^{sim}: the i^{th} modeled event volume
Y^{mean}: the mean metered volume
n: the total number of events

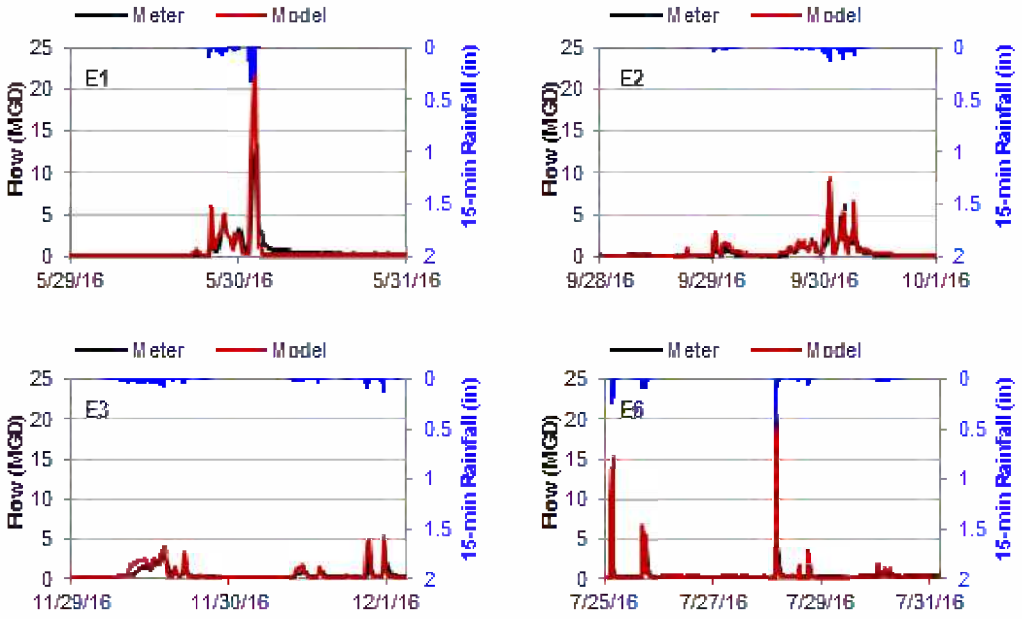
NSE values were calculated for all flow meter calibration and the results are shown in **Figure C-1** for the wet weather events**.** According to the above mentioned criteria wet weather calibration of over 82% of meters are above good condition and over 76% of the meters are above very good condition.

Figure C-1: Wet Weather Volume – Overall Calibration Statistics

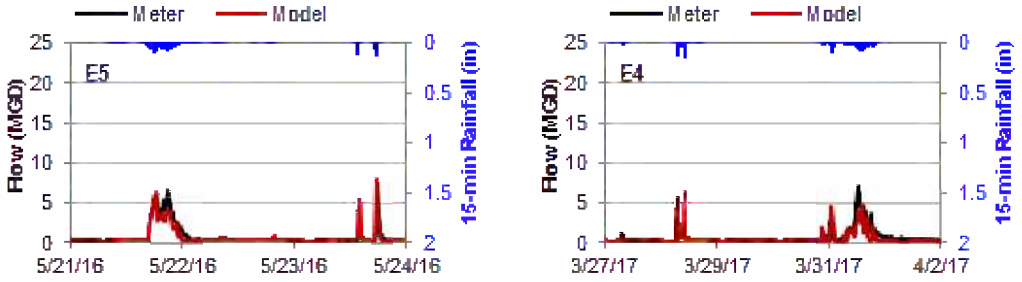


FLOW METER IN-02 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

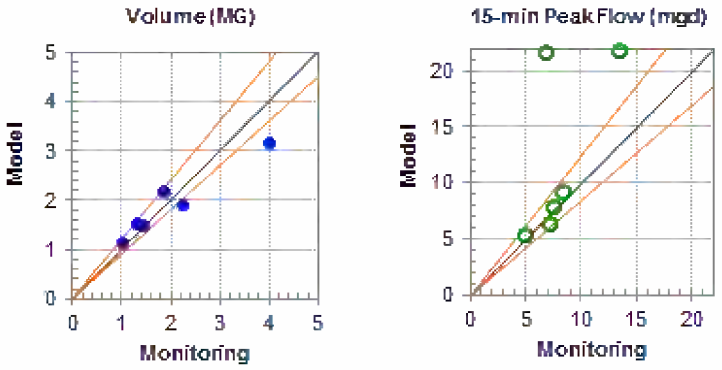
IN-02 Model Calibration Results (Metered and Modeled Flow)



IN-02 Model Validation Results (Metered and Modeled Flow)

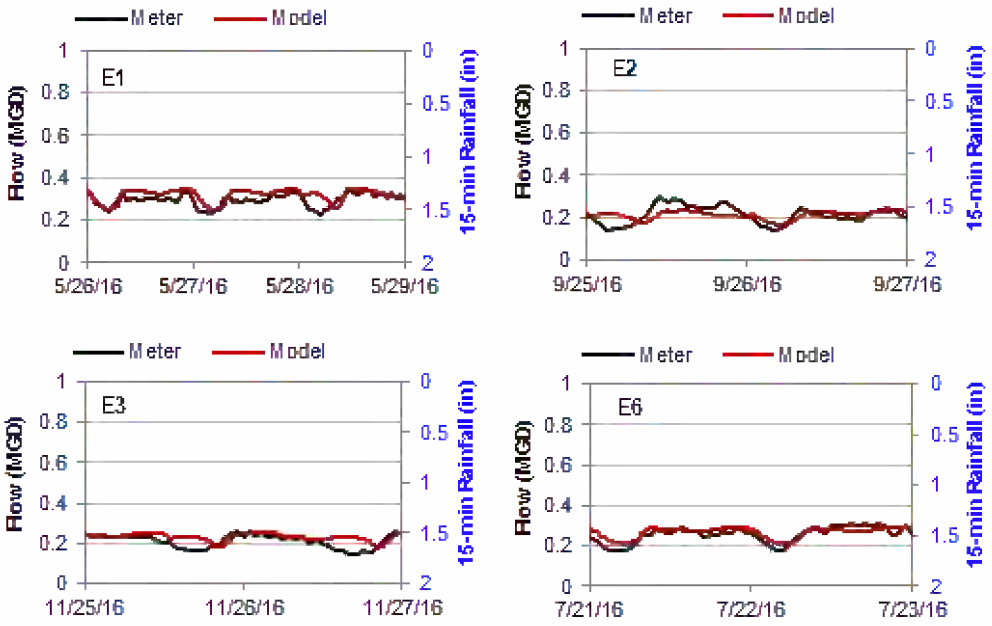


IN-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

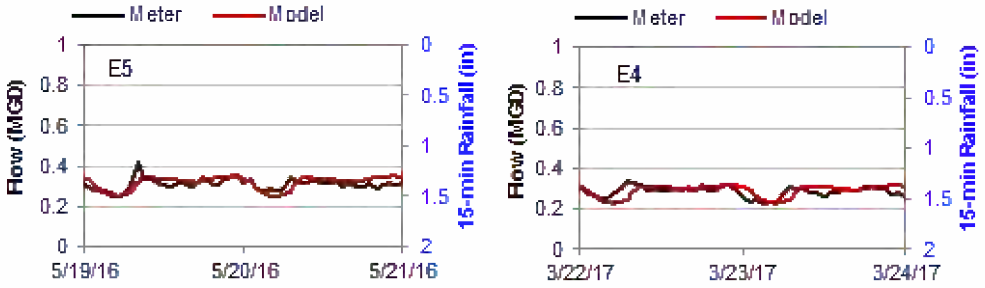


FLOW METER IN-02 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

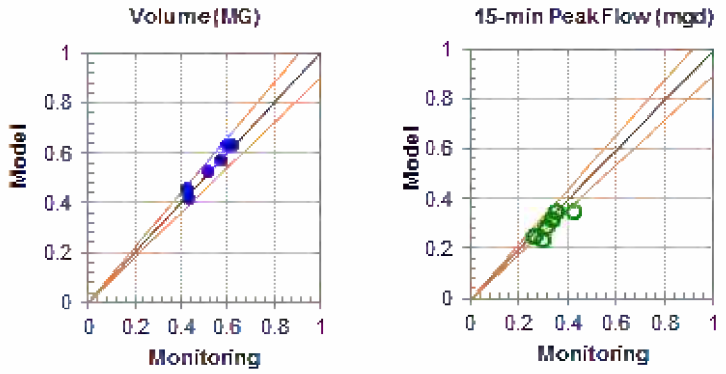
IN-02 Model Calibration Results (Metered and Modeled Flow)



IN-02 Model Validation Results (Metered and Modeled Flow)



IN-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



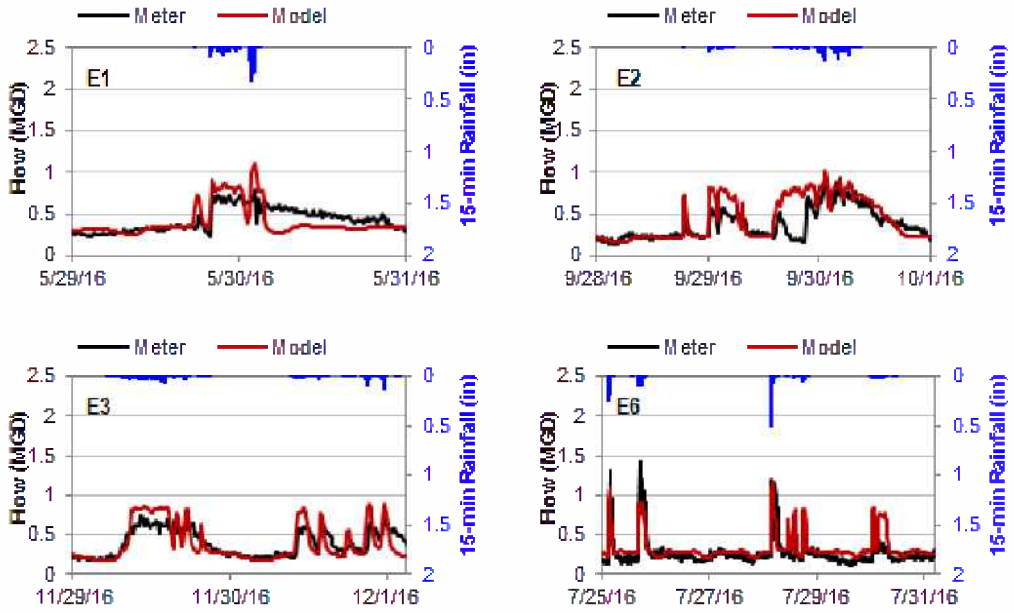
IN-02 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.35	0.35	-10% to +10%	1%	0.59	0.64	-10% to +10%	7%
E2	0.30	0.24	-10% to +10%	-20%	0.43	0.43	-10% to +10%	0%
E3	0.26	0.25	-10% to +10%	-4%	0.42	0.46	-10% to +10%	9%
E4	0.34	0.32	-10% to +10%	-5%	0.57	0.58	-10% to +10%	1%
E5	0.42	0.35	-10% to +10%	-17%	0.62	0.63	-10% to +10%	2%
E6	0.31	0.29	-10% to +10%	-5%	0.51	0.53	-10% to +10%	4%

IN-02 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	13.38	21.82	-15% to +25%	63%	1.43	1.50	-10% to +20%	5%
E2	8.31	9.29	-15% to +25%	12%	1.86	2.19	-10% to +20%	18%
E3	5.00	5.46	-15% to +25%	9%	1.32	1.53	-10% to +20%	15%
E4	7.05	6.37	-15% to +25%	-10%	4.00	3.17	-10% to +20%	-21%
E5	7.54	7.97	-15% to +25%	6%	2.25	1.91	-10% to +20%	-15%
E6	6.81	21.65	-15% to +25%	218%	1.01	1.18	-10% to +20%	17%

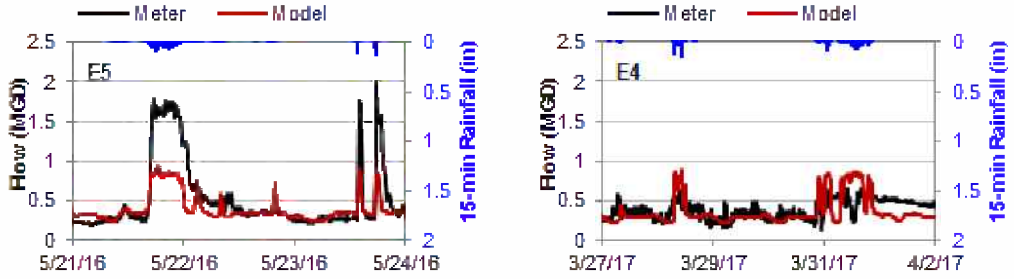
Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for Events E1 and E6 is not consistent with the recorded rainfall intensity. These events are expected to have the highest peak flow. This is most likely a result of a malfunctioning flow meter. However, based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER EFF-02 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

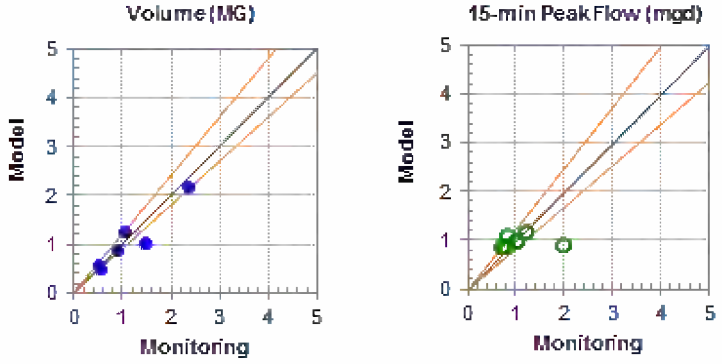
EFF-02 Model Calibration Results (Metered and Modeled Flow)



EFF-02 Model Validation Results (Metered and Modeled Flow)

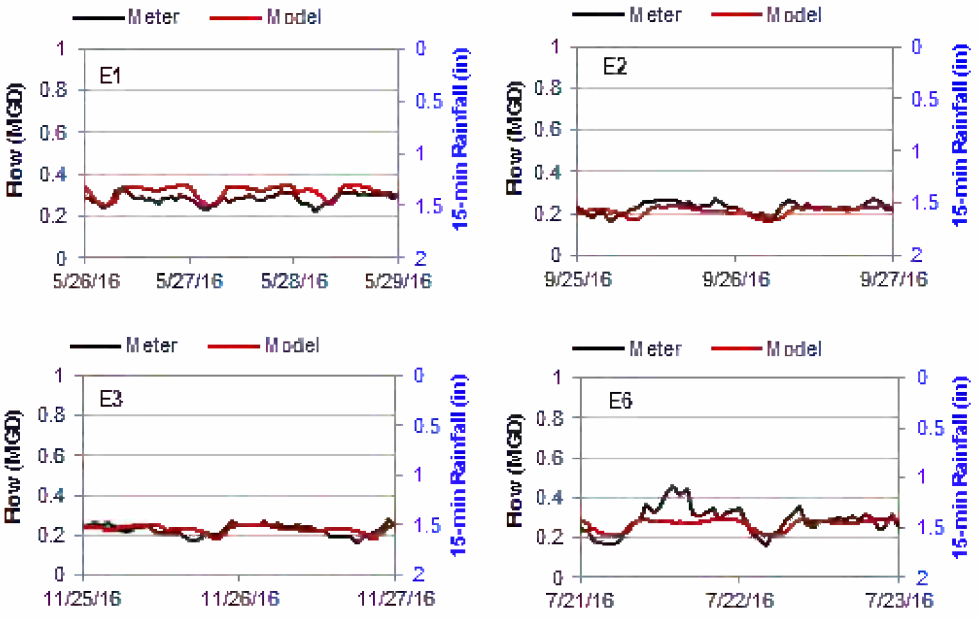


EFF-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

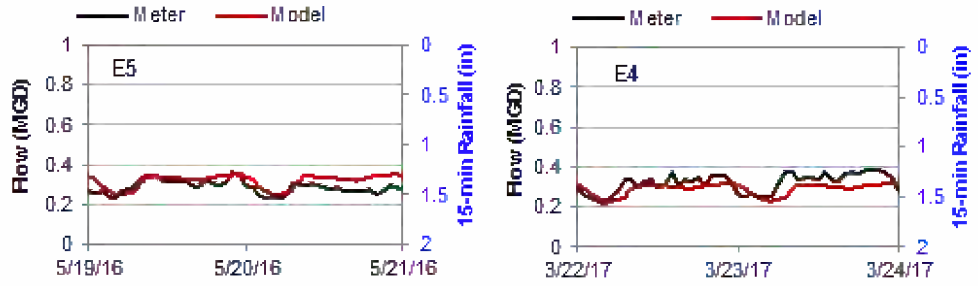


FLOW METER EFF-02 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

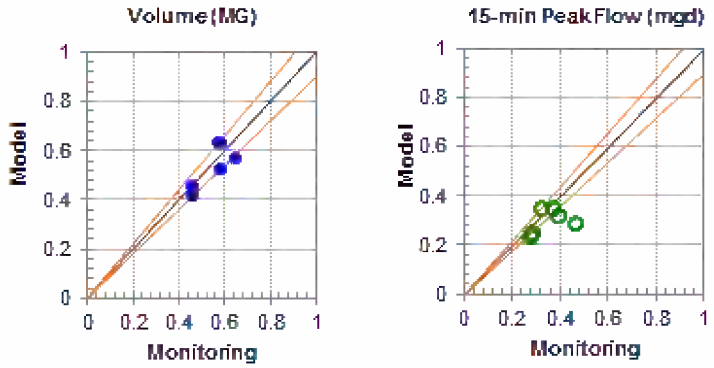
EFF-02 Model Calibration Results (Metered and Modeled Flow)



EFF-02 Model Validation Results (Metered and Modeled Flow)



EFF-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



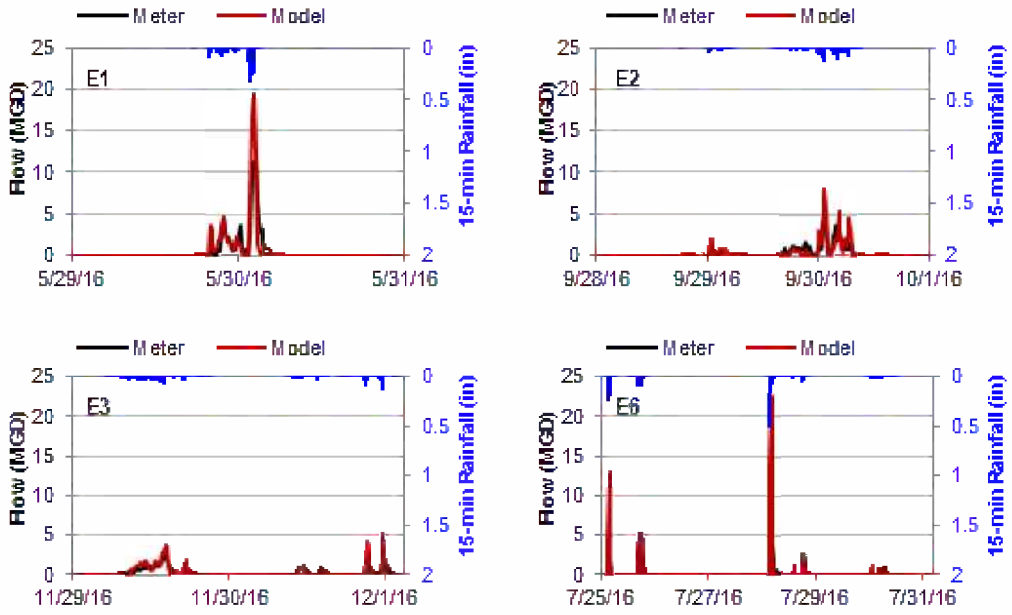
EFF-02 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.32	0.35	-10% to +10%	10%	0.57	0.64	-10% to +10%	12%
E2	0.27	0.24	-10% to +10%	-14%	0.46	0.43	-10% to +10%	-7%
E3	0.28	0.25	-10% to +10%	-10%	0.45	0.46	-10% to +10%	2%
E4	0.39	0.32	-10% to +10%	-18%	0.64	0.58	-10% to +10%	-10%
E5	0.37	0.35	-10% to +10%	-4%	0.58	0.63	-10% to +10%	10%
E6	0.46	0.29	-10% to +10%	-36%	0.58	0.53	-10% to +10%	-8%

EFF-02 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.80	1.12	-15% to +25%	39%	0.53	0.51	-10% to +20%	-3%
E2	1.01	1.01	-15% to +25%	1%	1.03	1.27	-10% to +20%	23%
E3	0.75	0.90	-15% to +25%	20%	0.90	0.88	-10% to +20%	-2%
E4	0.71	0.88	-15% to +25%	24%	2.36	2.20	-10% to +20%	-6%
E5	1.99	0.93	-15% to +25%	-53%	1.45	1.05	-10% to +20%	-27%
E6	1.20	1.17	-15% to +25%	-2%	0.49	0.57	-10% to +20%	17%

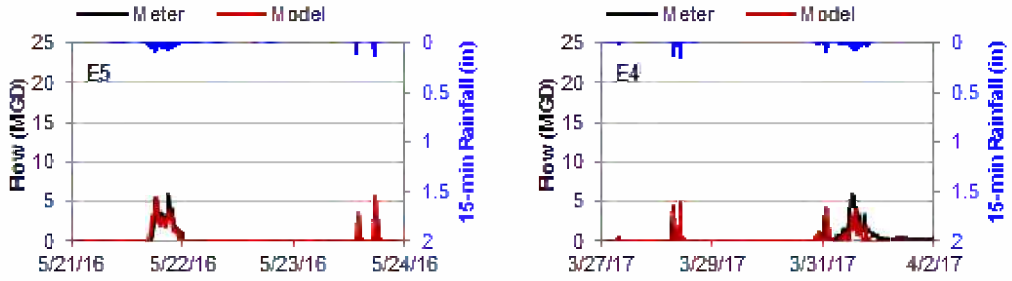
Note: Four of the six wet weather events are calibrated well within the industry criteria. The EFF-02 meter is the effluent meter from Regulator 02. The calibration of Regulator 02 meters (which include the IN-02, EFF-02 and CSO-02 meters) are more focused on the influent IN-02 meter and the overflow CSO-02 meter when the total metered influent flow (IN-02) is not balanced with the total metered effluent flow (EFF-02 plus CSO-02). Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CSO-02 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

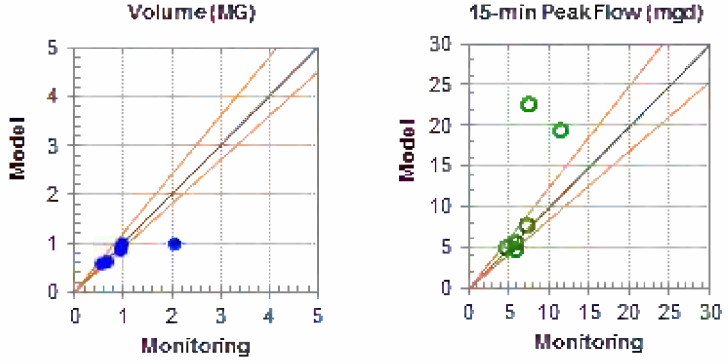
CSO-02 Model Calibration Results (Metered and Modeled Flow)



CSO-02 Model Validation Results (Metered and Modeled Flow)



CSO-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

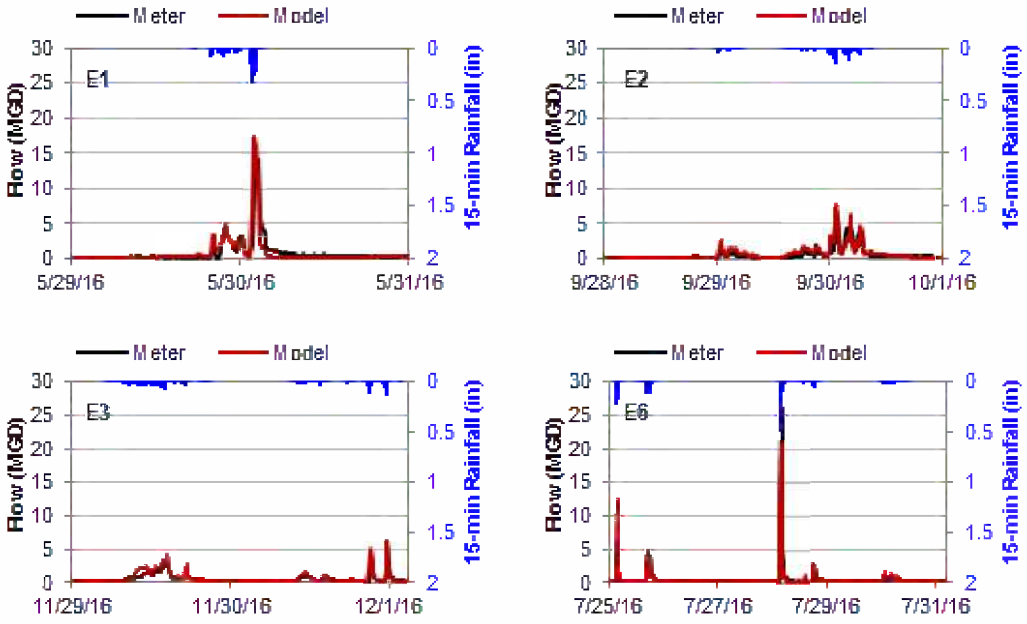


CSO-02 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	11.40	19.39	-15% to +25%	70%	0.95	0.99	-10% to +20%	4%
E2	7.16	7.90	-15% to +25%	10%	0.94	0.94	-10% to +20%	0%
E3	4.69	5.11	-15% to +25%	9%	0.64	0.66	-10% to +20%	3%
E4	5.79	4.82	-15% to +25%	-17%	2.02	0.99	-10% to +20%	-51%
E5	5.82	5.67	-15% to +25%	-3%	0.91	0.88	-10% to +20%	-3%
E6	7.49	22.64	-15% to +25%	202%	0.55	0.63	-10% to +20%	14%

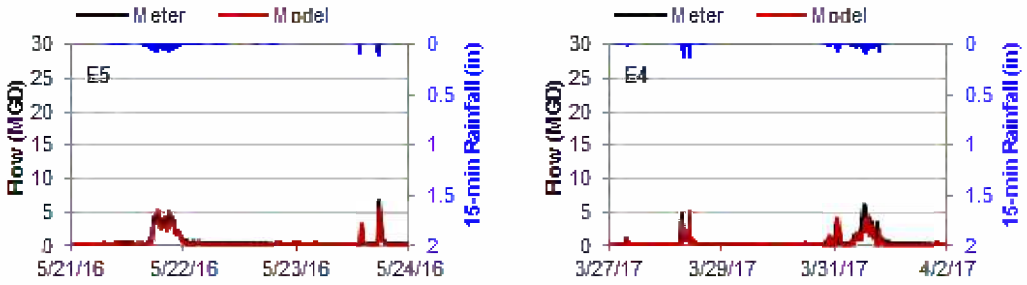
Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the Events is not consistent with the recorded rainfall intensity. For instance, it is expected that Event E6 would have a high peak flow due to high rainfall intensity. This is most likely a result of a malfunctioning flow meter. However, based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-03 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

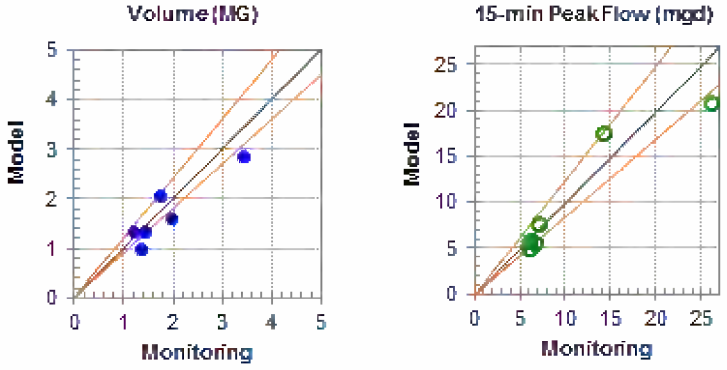
IN-03 Model Calibration Results (Metered and Modeled Flow)



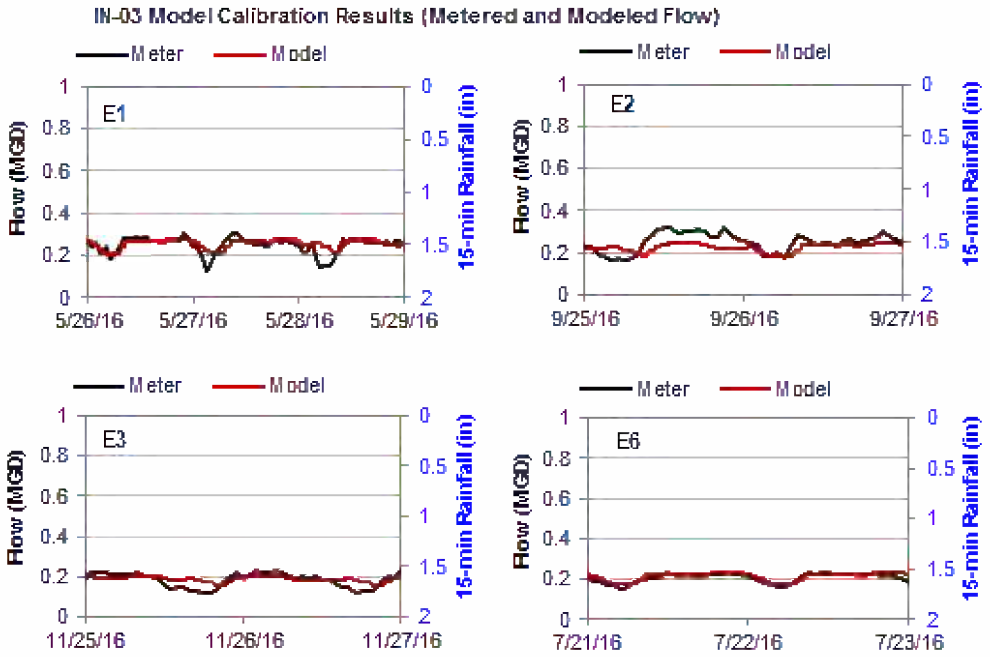
IN-03 Model Validation Results (Metered and Modeled Flow)

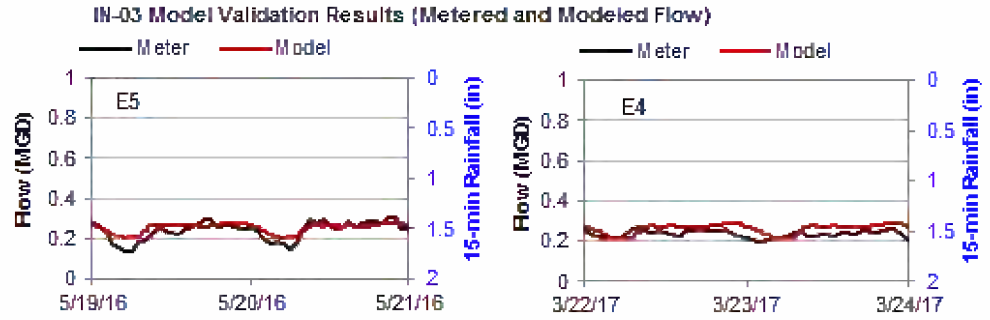


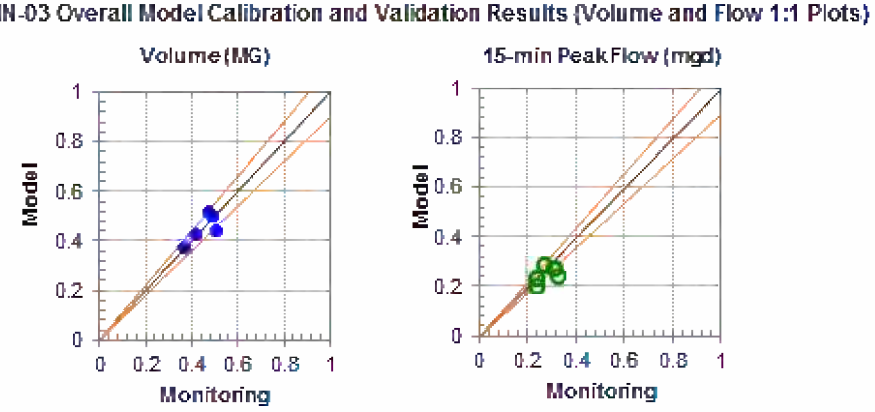
IN-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-03 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







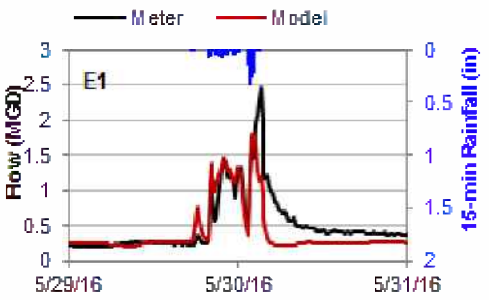
IN-03 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.31	0.28	-10% to +10%	-9%	0.48	0.51	-10% to +10%	5%
E2	0.32	0.25	-10% to +10%	-23%	0.50	0.45	-10% to +10%	-10%
E3	0.23	0.21	-10% to +10%	-12%	0.37	0.38	-10% to +10%	3%
E4	0.27	0.29	-10% to +10%	8%	0.47	0.52	-10% to +10%	11%
E5	0.31	0.28	-10% to +10%	-9%	0.48	0.51	-10% to +10%	5%
E6	0.24	0.24	-10% to +10%	-1%	0.41	0.43	-10% to +10%	4%

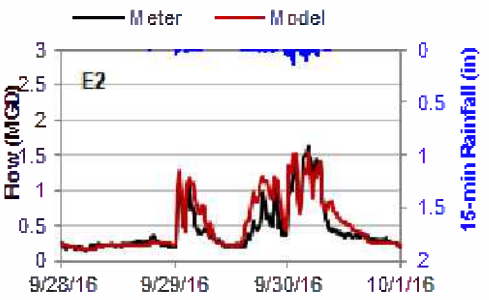
IN-03 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	14.09	17.46	-15% to +25%	24%	1.41	1.34	-10% to +20%	-6%
E2	7.06	7.69	-15% to +25%	9%	1.73	2.07	-10% to +20%	20%
E3	6.06	5.79	-15% to +25%	-4%	1.20	1.36	-10% to +20%	13%
E4	6.01	5.07	-15% to +25%	-16%	3.43	2.87	-10% to +20%	-16%
E5	6.71	5.50	-15% to +25%	-18%	1.96	1.60	-10% to +20%	-18%
E6	26.00	20.94	-15% to +25%	-19%	1.36	1.02	-10% to +20%	-25%

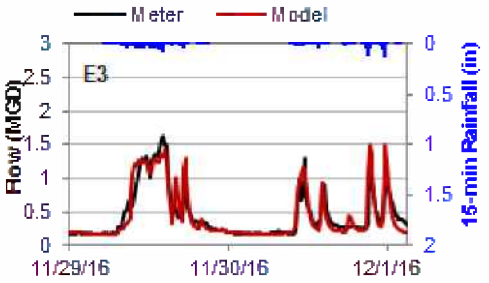
Note: All the six wet weather events are calibrated well within or close to the industry criteria.

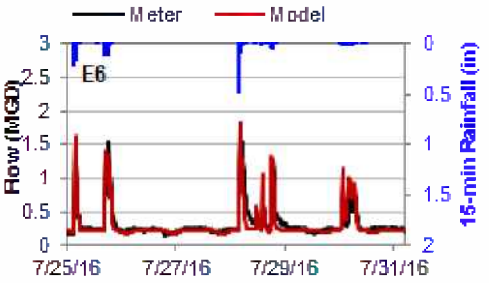
FLOW METER EFF-03 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

EFF-03 Model Calibration Results (Metered and Modeled Flow)

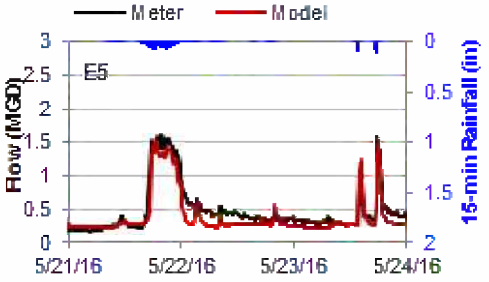


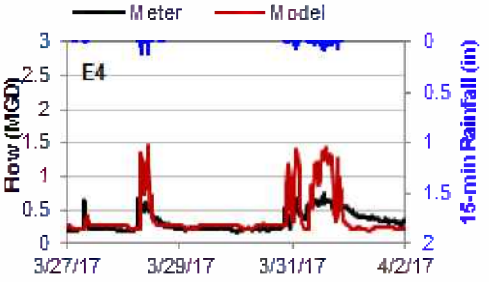




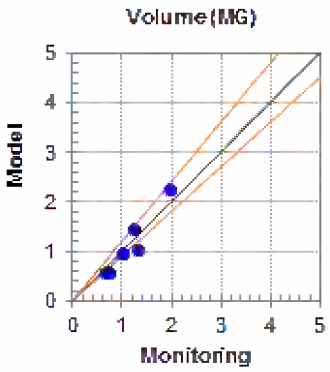


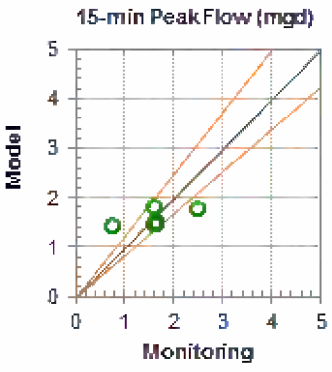
EFF-03 Model Validation Results (Metered and Modeled Flow)





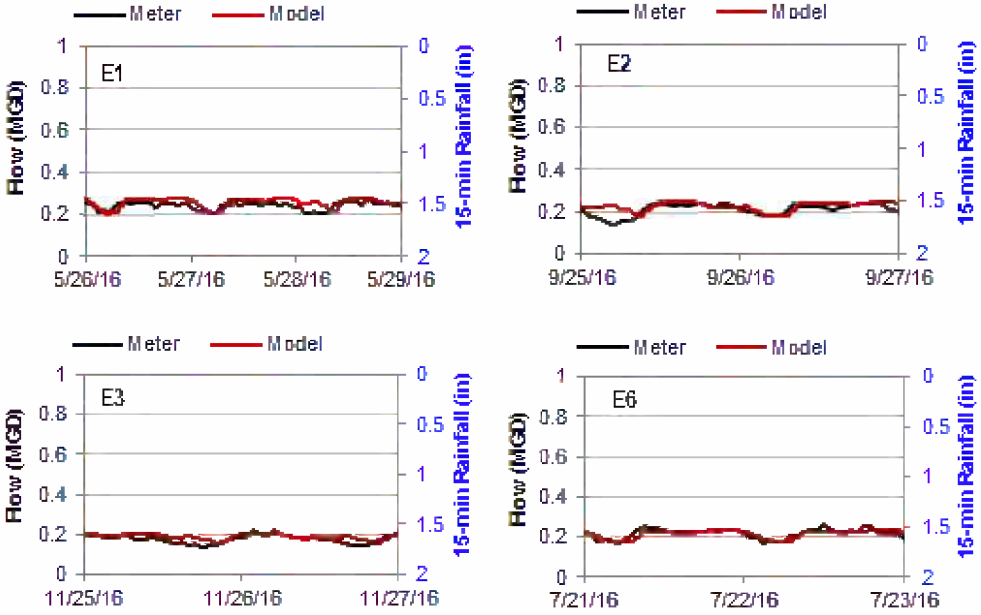
EFF-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



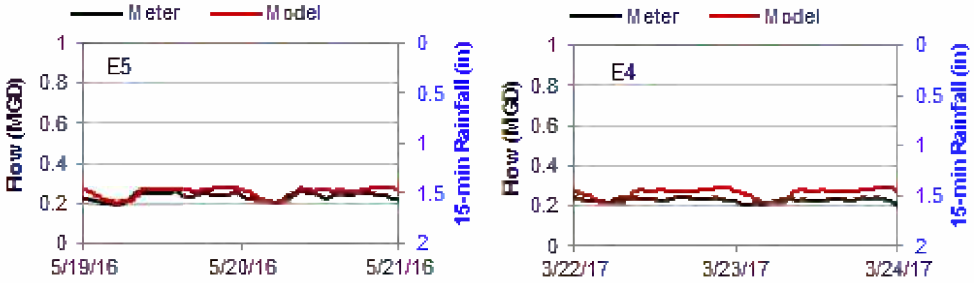


FLOW METER EFF-03 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

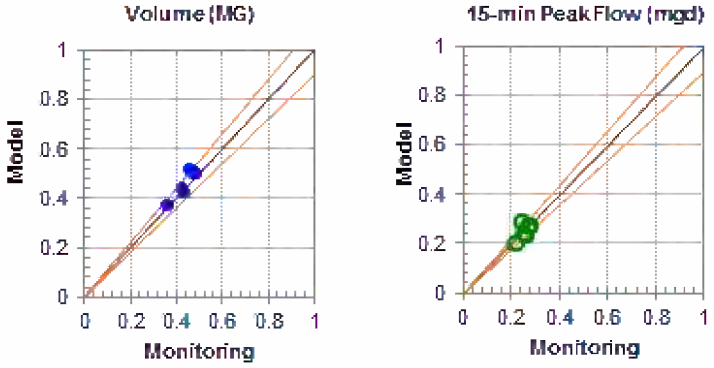
EFF-03 Model Calibration Results (Metered and Modeled Flow)



EFF-03 Model Validation Results (Metered and Modeled Flow)



EFF-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



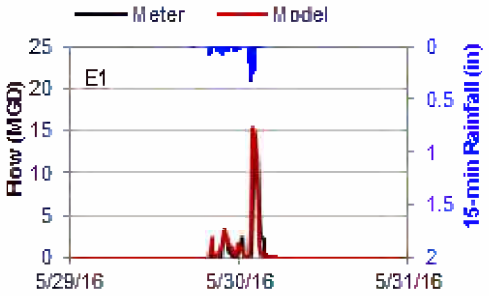
EFF-03 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.27	0.28	-10% to +10%	5%	0.48	0.51	-10% to +10%	6%
E2	0.25	0.25	-10% to +10%	-1%	0.42	0.45	-10% to +10%	6%
E3	0.22	0.21	-10% to +10%	-7%	0.36	0.38	-10% to +10%	6%
E4	0.24	0.29	-10% to +10%	18%	0.46	0.52	-10% to +10%	15%
E5	0.28	0.28	-10% to +10%	1%	0.47	0.51	-10% to +10%	8%
E6	0.26	0.24	-10% to +10%	-9%	0.43	0.43	-10% to +10%	-1%

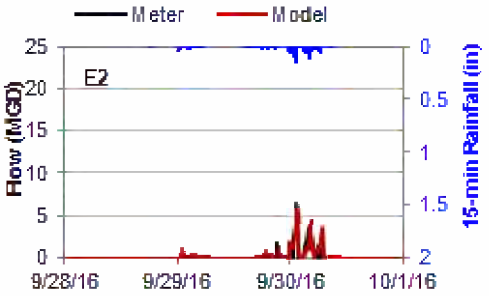
EFF-03 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	2.47	1.80	-15% to +25%	-27%	0.73	0.59	-10% to +20%	-19%
E2	1.63	1.54	-15% to +25%	-6%	1.24	1.47	-10% to +20%	19%
E3	1.63	1.49	-15% to +25%	-9%	0.99	0.96	-10% to +20%	-3%
E4	0.75	1.47	-15% to +25%	96%	1.98	2.28	-10% to +20%	15%
E5	1.60	1.51	-15% to +25%	-6%	1.31	1.06	-10% to +20%	-19%
E6	1.57	1.84	-15% to +25%	17%	0.67	0.57	-10% to +20%	-15%

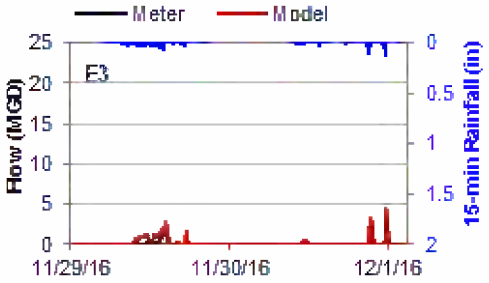
Note: Four of the six wet weather events are calibrated well within the industry criteria. The EFF-03 meter is the effluent meter from Regulator 03. The calibration of Regulator 03 meters (which include the IN-03, EFF-03 and CSO-03 meters) are more focused on the influent IN-03 meter and the overflow CSO-03 meter when the total metered influent flow (IN-03) is not balanced with the total metered effluent flow (EFF-03 plus CSO-03). Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

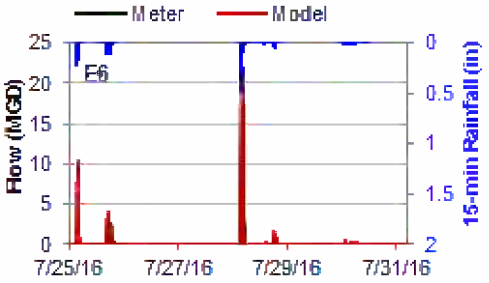
FLOW METER CSO-03 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

CSO-03 Model Calibration Results (Metered and Modeled Flow)

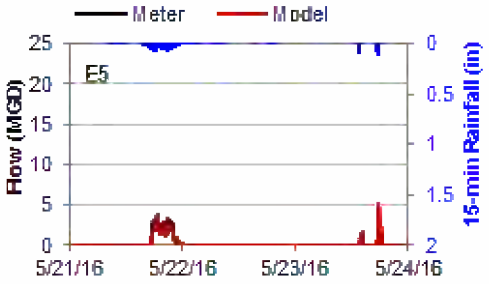


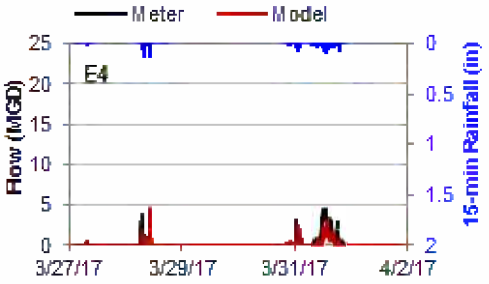




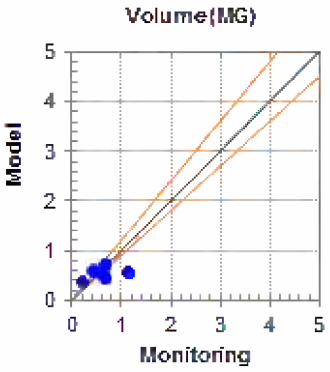


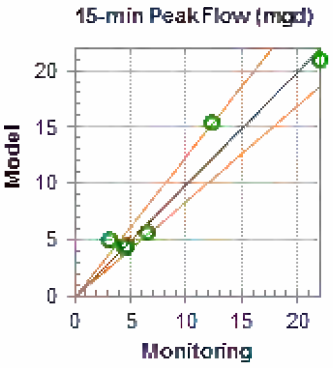
CSO-03 Model Validation Results (Metered and Modeled Flow)





CSO-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



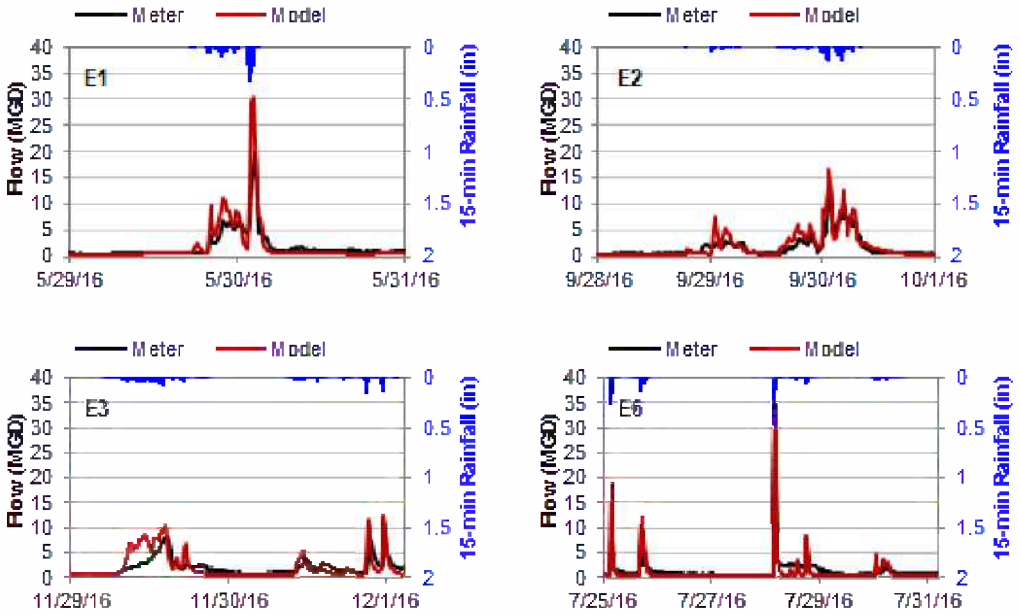


CSO-03 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	12.30	15.47	-15% to +25%	26%	0.64	0.75	-10% to +20%	17%
E2	6.41	5.80	-15% to +25%	-9%	0.42	0.61	-10% to +20%	44%
E3	4.48	4.39	-15% to +25%	-2%	0.19	0.39	-10% to +20%	112%
E4	4.52	4.56	-15% to +25%	1%	1.13	0.58	-10% to +20%	-48%
E5	3.13	5.03	-15% to +25%	61%	0.61	0.54	-10% to +20%	-11%
E6	21.93	21.00	-15% to +25%	-4%	0.66	0.45	-10% to +20%	-31%

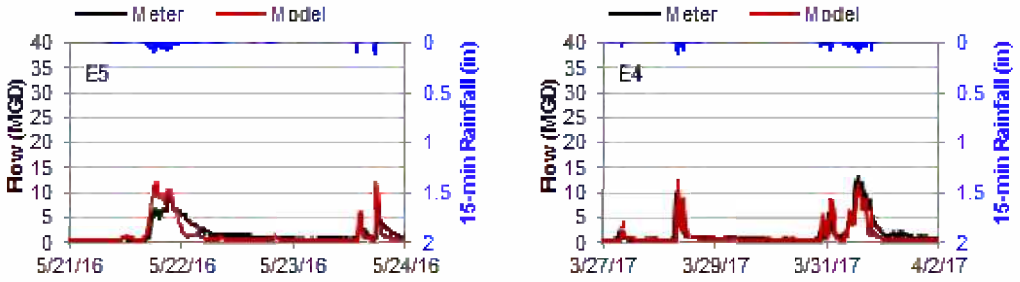
Note: Four of the six wet weather event peak flows are calibrated well within the industry criteria. The overflow volume is more challenging to match, especially for the small overflow event like E3. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-05 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

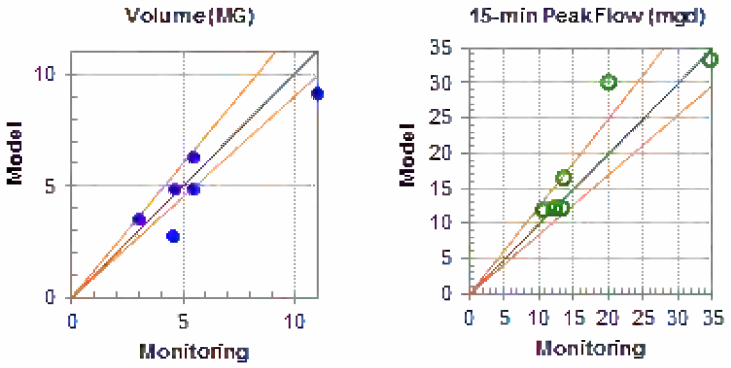
IN-05 Model Calibration Results (Metered and Modeled Flow)



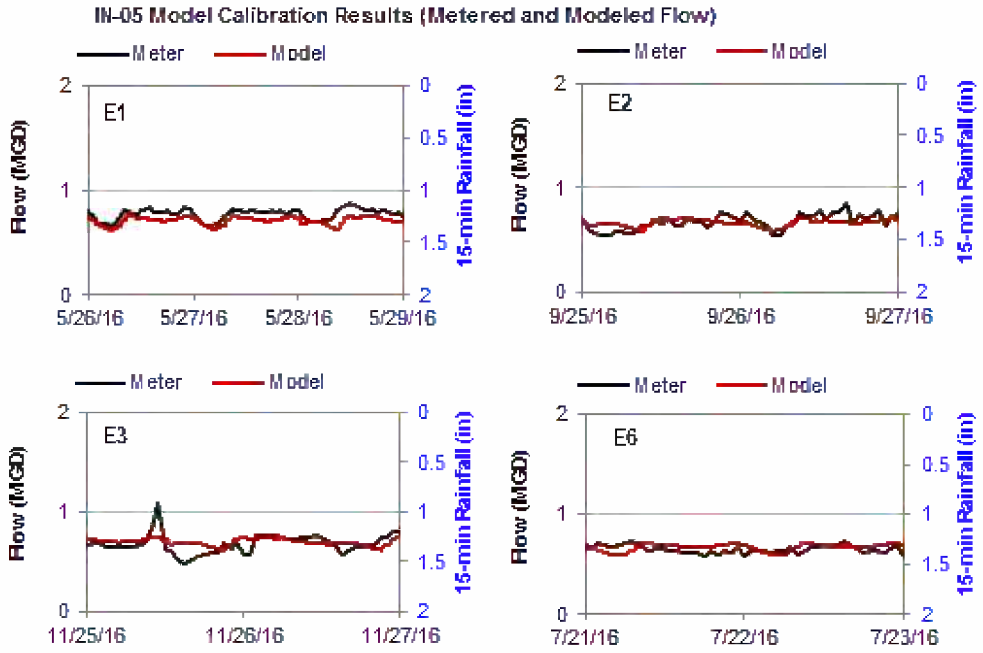
IN-05 Model Validation Results (Metered and Modeled Flow)

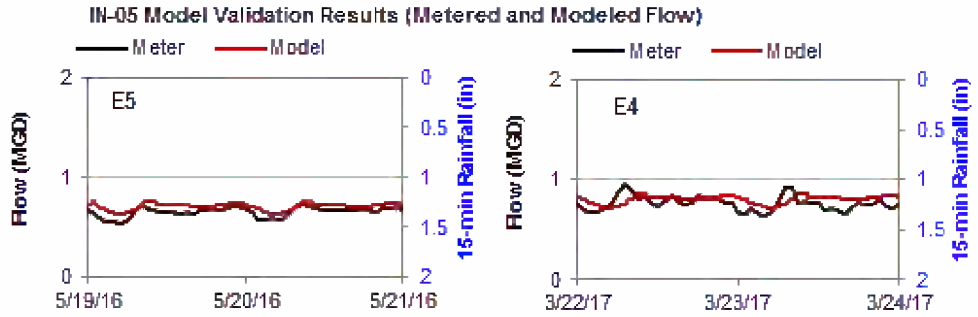


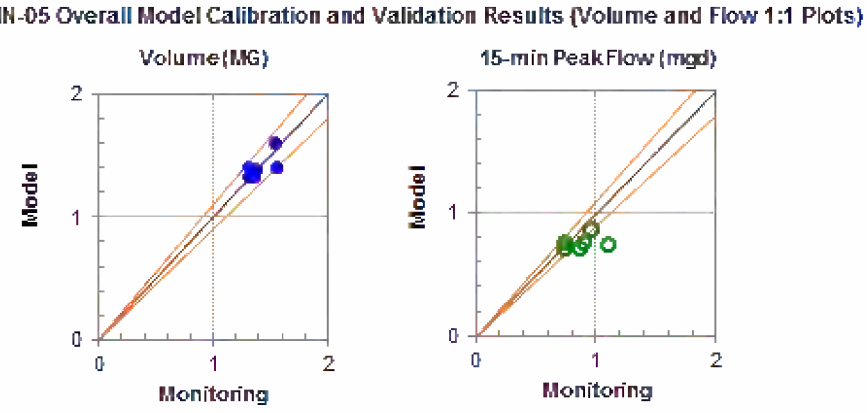
IN-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-05 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







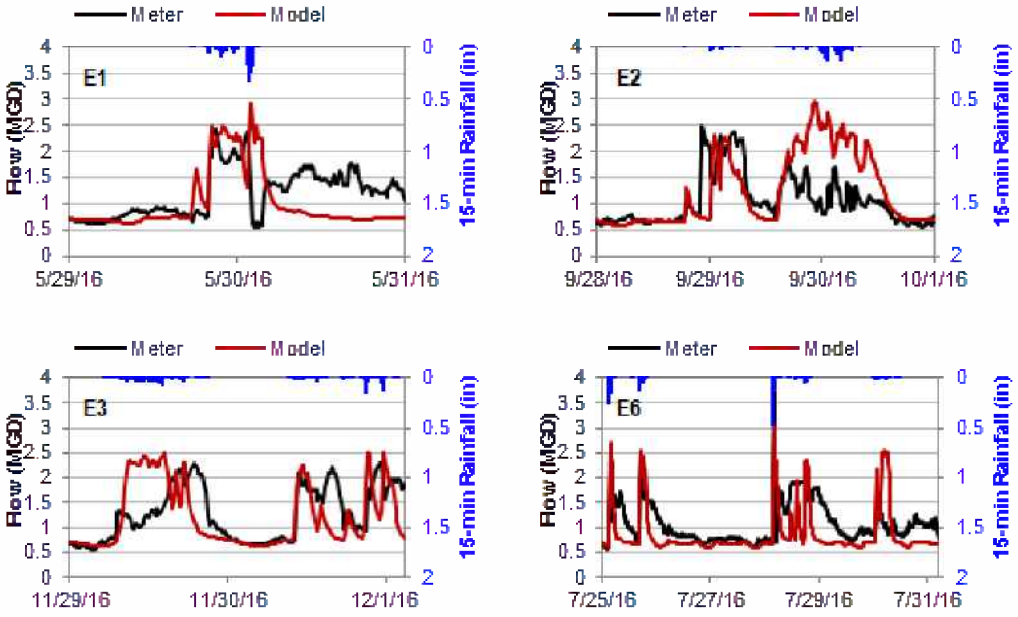
IN-05 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.88	0.76	-10% to +10%	-14%	1.54	1.41	-10% to +10%	-8%
E2	0.86	0.72	-10% to +10%	-16%	1.35	1.33	-10% to +10%	-2%
E3	1.09	0.75	-10% to +10%	-31%	1.36	1.40	-10% to +10%	3%
E4	0.95	0.87	-10% to +10%	-9%	1.53	1.61	-10% to +10%	5%
E5	0.73	0.76	-10% to +10%	4%	1.31	1.42	-10% to +10%	8%
E6	0.73	0.72	-10% to +10%	-1%	1.31	1.34	-10% to +10%	2%

IN-05 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	19.90	30.28	-15% to +25%	52%	3.00	3.57	-10% to +20%	19%
E2	13.38	16.57	-15% to +25%	24%	5.39	6.32	-10% to +20%	17%
E3	12.07	12.28	-15% to +25%	2%	4.57	4.93	-10% to +20%	8%
E4	13.17	12.43	-15% to +25%	-6%	10.98	9.18	-10% to +20%	-16%
E5	10.58	12.02	-15% to +25%	14%	5.42	4.89	-10% to +20%	-10%
E6	34.58	33.54	-15% to +25%	-3%	4.50	2.79	-10% to +20%	-38%

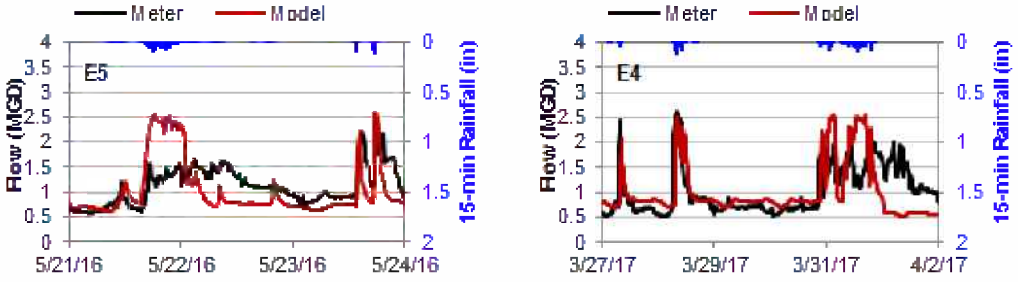
Note: Four of the six wet weather event peak flows are calibrated well within the industry criteria. Flow meter data recorded for some of the events is not consistent with the recorded rainfall intensity. For instance, it is expected that Event E1 would have a high peak flow due to high rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER EFF-05 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

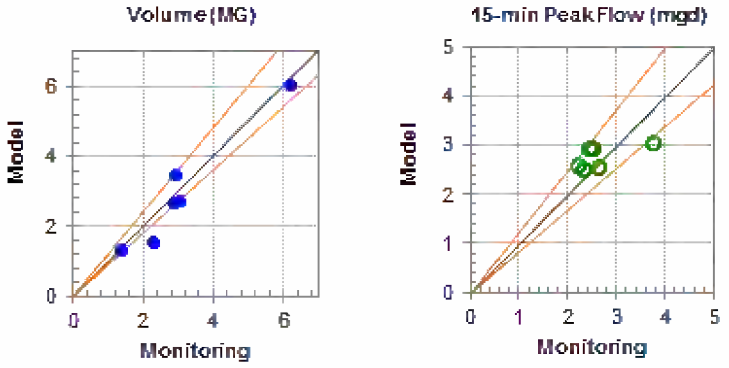
EFF-05 Model Calibration Results (Metered and Modeled Flow)



EFF-05 Model Validation Results (Metered and Modeled Flow)

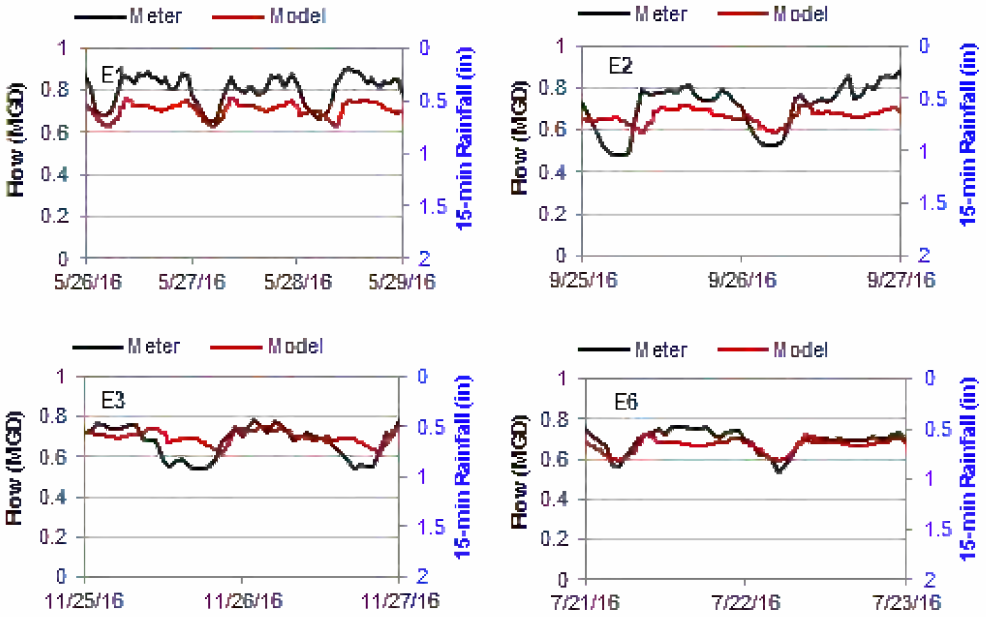


EFF-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

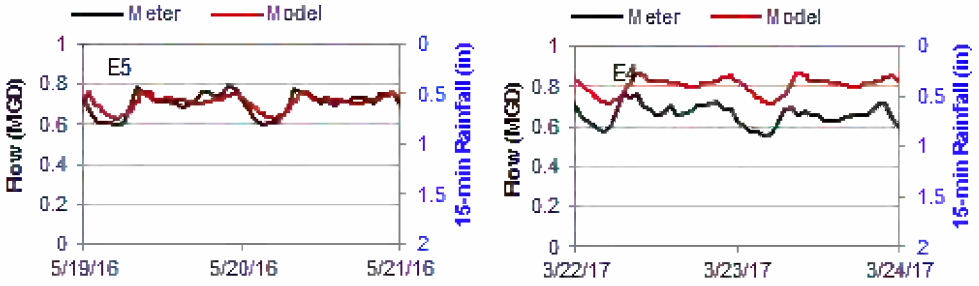


FLOW METER EFF-05 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

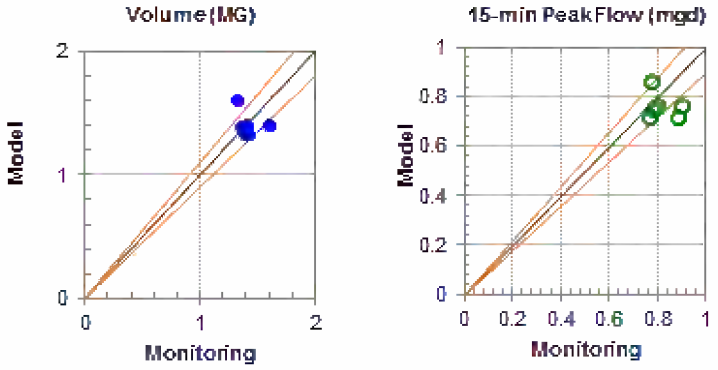
EFF-05 Model Calibration Results (Metered and Modeled Flow)



EFF-05 Model Validation Results (Metered and Modeled Flow)



EFF-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



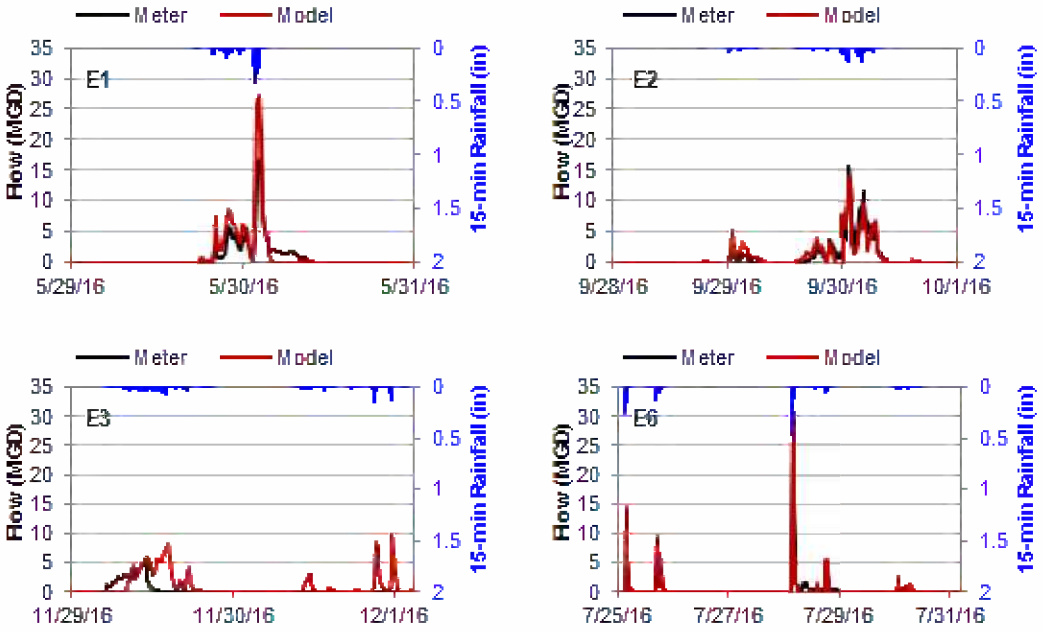
EFF-05 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.90	0.76	-10% to +10%	-16%	1.59	1.41	-10% to +10%	-11%
E2	0.88	0.72	-10% to +10%	-19%	1.42	1.33	-10% to +10%	-6%
E3	0.78	0.75	-10% to +10%	-5%	1.35	1.40	-10% to +10%	4%
E4	0.77	0.87	-10% to +10%	12%	1.32	1.61	-10% to +10%	22%
E5	0.80	0.76	-10% to +10%	-4%	1.41	1.42	-10% to +10%	1%
E6	0.77	0.72	-10% to +10%	-6%	1.38	1.34	-10% to +10%	-3%

EFF-05 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	2.44	2.93	-15% to +25%	20%	1.37	1.35	-10% to +20%	-1%
E2	2.49	2.96	-15% to +25%	19%	2.89	3.49	-10% to +20%	21%
E3	2.30	2.53	-15% to +25%	10%	2.88	2.72	-10% to +20%	-6%
E4	2.61	2.55	-15% to +25%	-3%	6.20	6.07	-10% to +20%	-2%
E5	2.20	2.58	-15% to +25%	18%	3.00	2.73	-10% to +20%	-9%
E6	3.73	3.06	-15% to +25%	-18%	2.28	1.56	-10% to +20%	-32%

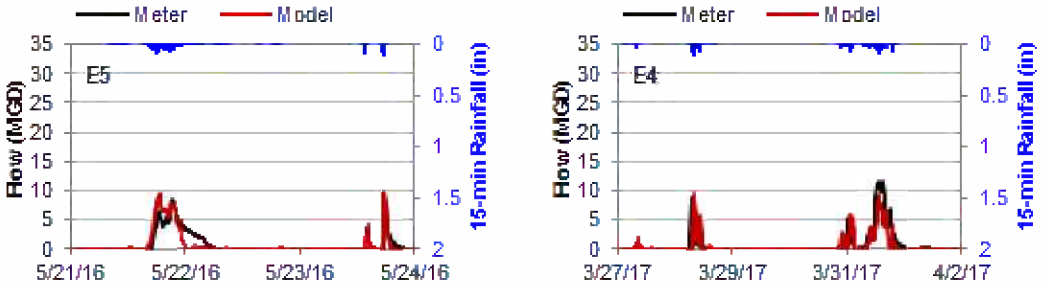
Note: Five of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E2, E3) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CSO-05 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

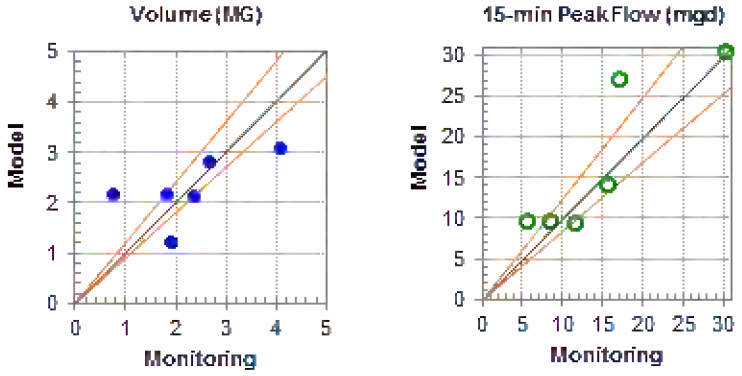
CSO-05 Model Calibration Results (Metered and Modeled Flow)



CSO-05 Model Validation Results (Metered and Modeled Flow)



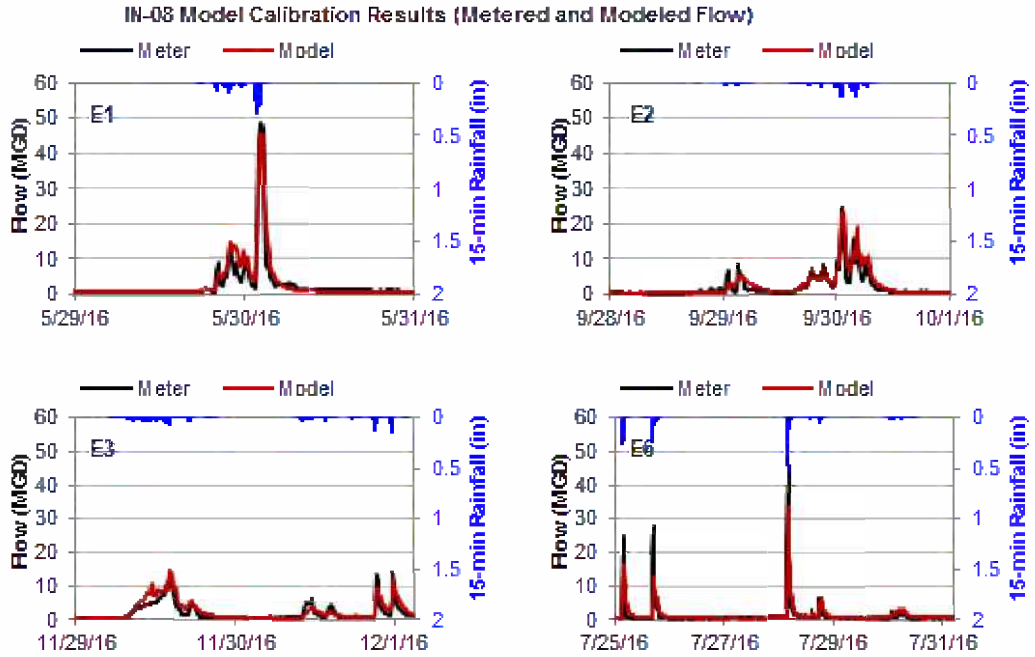
CSO-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

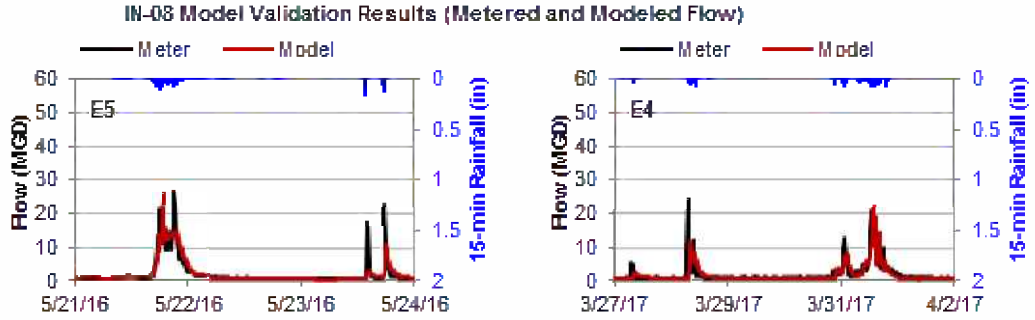


CSO-05 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	16.91	27.24	-15% to +25%	61%	1.79	2.19	-10% to +20%	22%
E2	15.44	14.14	-15% to +25%	-8%	2.64	2.84	-10% to +20%	8%
E3	5.39	9.83	-15% to +25%	82%	0.72	2.18	-10% to +20%	202%
E4	11.39	9.58	-15% to +25%	-16%	4.05	3.09	-10% to +20%	-24%
E5	8.46	9.65	-15% to +25%	14%	2.35	2.15	-10% to +20%	-9%
E6	30.25	30.66	-15% to +25%	1%	1.88	1.24	-10% to +20%	-34%

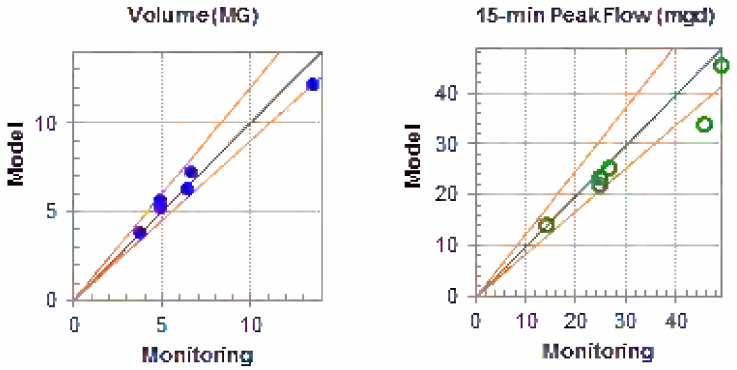
Note: Four of the six wet weather event peak flows are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1, E2, E3) is not consistent with the recorded rainfall intensity. The overflow volume calibration is more challenging, especially for the small overflow event like E3. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-08 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

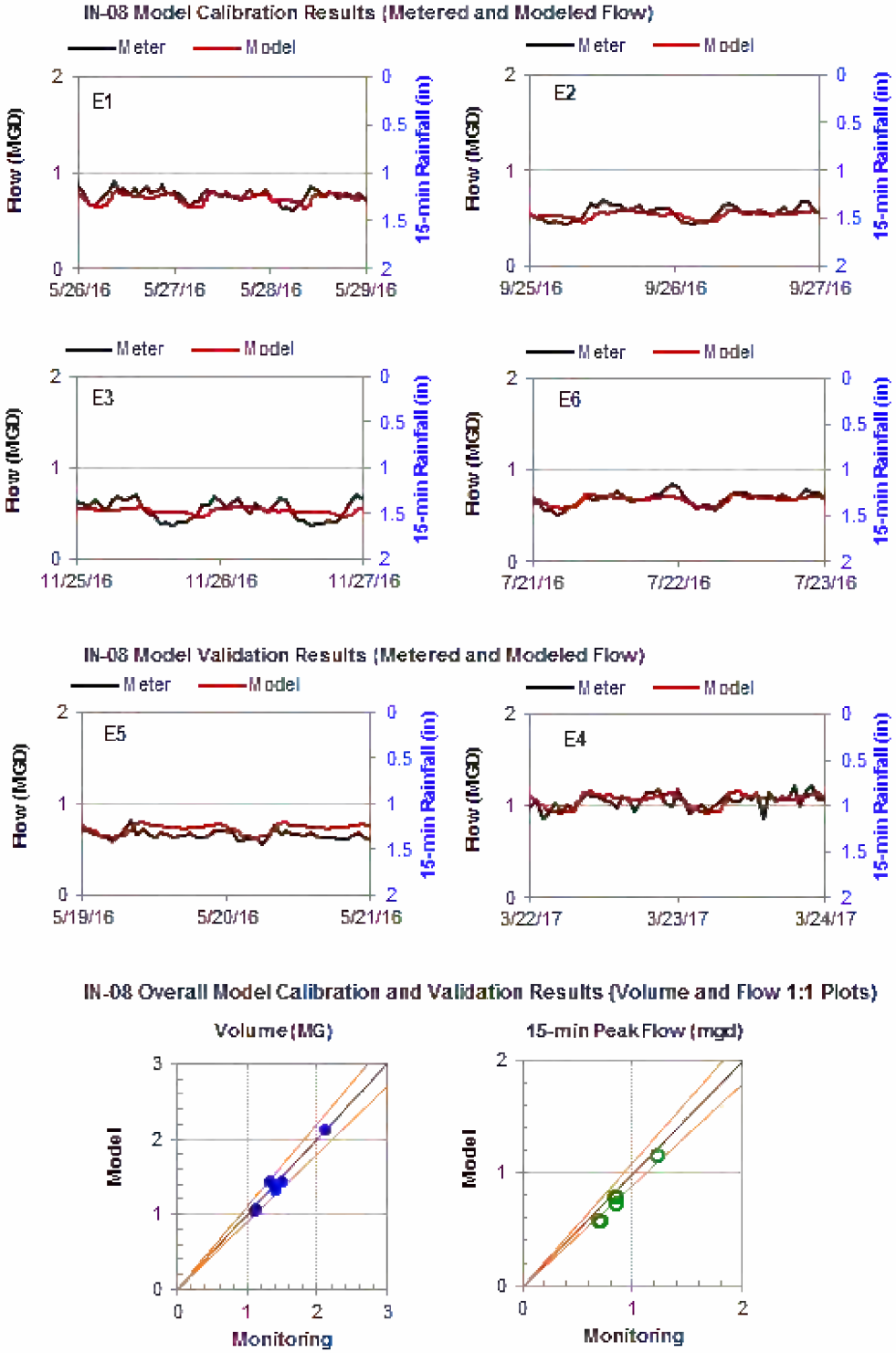




IN-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-08 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events



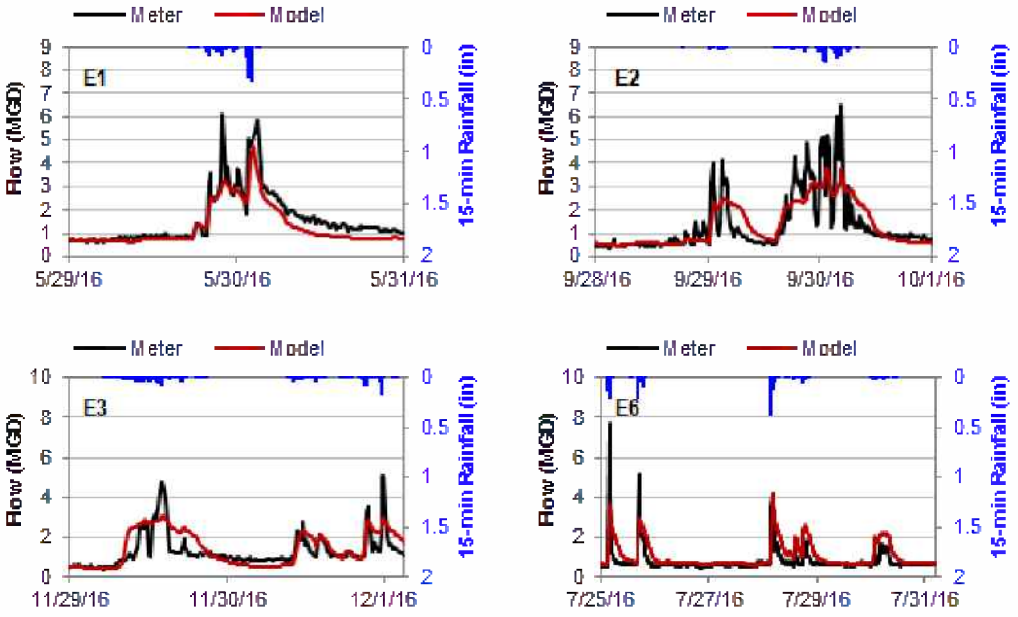
IN-08 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.85	0.80	-10% to +10%	-6%	1.49	1.46	-10% to +10%	-2%
E2	0.69	0.59	-10% to +10%	-15%	1.12	1.08	-10% to +10%	-4%
E3	0.70	0.58	-10% to +10%	-17%	1.09	1.06	-10% to +10%	-3%
E4	1.22	1.16	-10% to +10%	-5%	2.11	2.13	-10% to +10%	1%
E5	0.82	0.80	-10% to +10%	-3%	1.32	1.46	-10% to +10%	11%
E6	0.84	0.73	-10% to +10%	-13%	1.38	1.35	-10% to +10%	-2%

IN-08 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	48.94	45.65	-15% to +25%	-7%	4.81	5.25	-10% to +20%	9%
E2	24.74	23.68	-15% to +25%	-4%	6.55	7.29	-10% to +20%	11%
E3	14.08	14.45	-15% to +25%	3%	4.84	5.73	-10% to +20%	18%
E4	24.42	22.15	-15% to +25%	-9%	13.46	12.23	-10% to +20%	-9%
E5	26.44	25.62	-15% to +25%	-3%	6.39	6.34	-10% to +20%	-1%
E6	45.55	33.93	-15% to +25%	-26%	3.65	3.91	-10% to +20%	7%

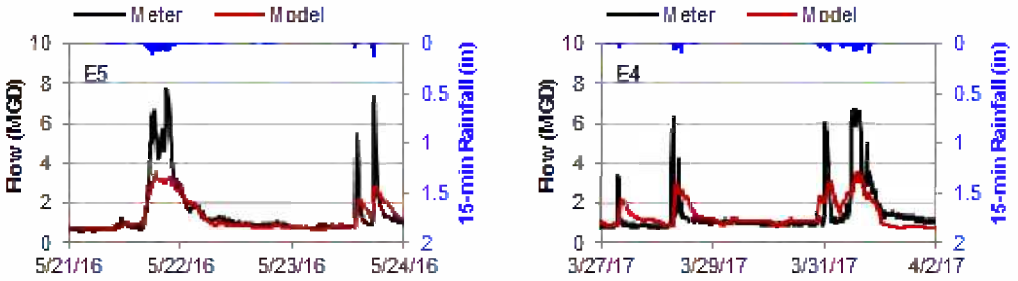
Note: All of the six wet weather events are calibrated well within the industry criteria except for the peak flow of E6. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER EFF-08 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

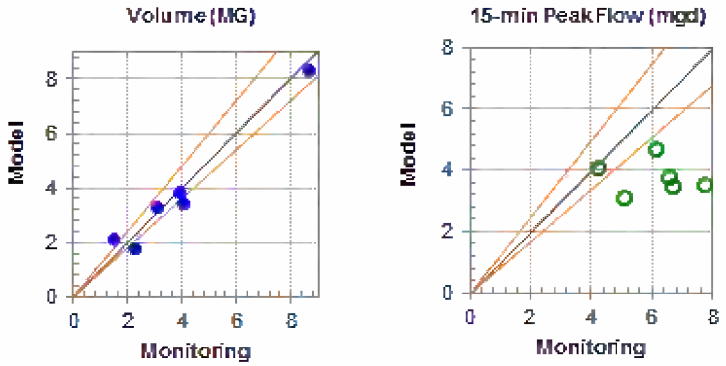
EFF-08 Model Calibration Results (Metered and Modeled Flow)



EFF-08 Model Validation Results (Metered and Modeled Flow)

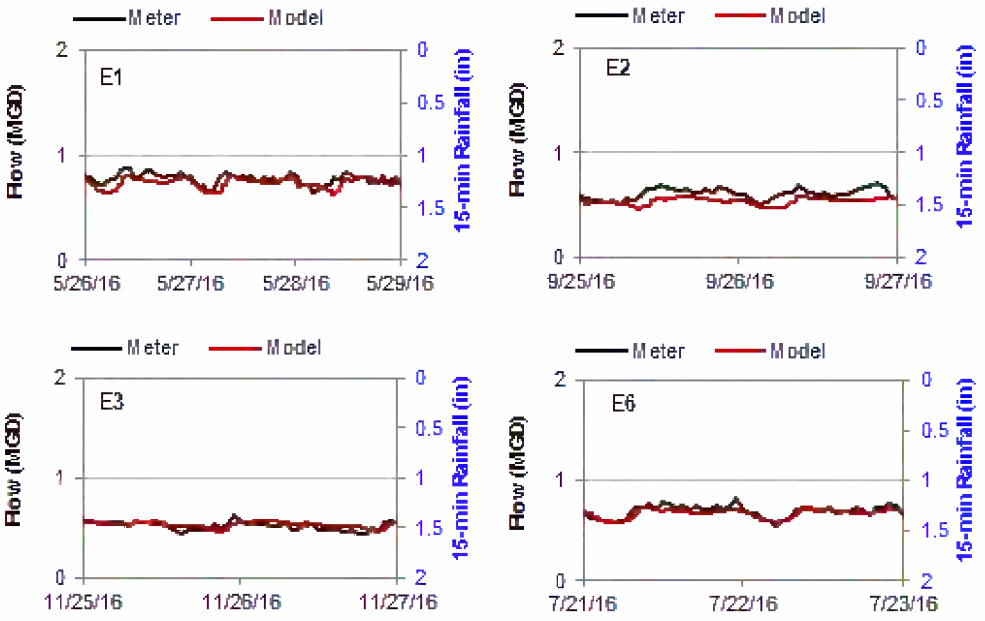


EFF-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

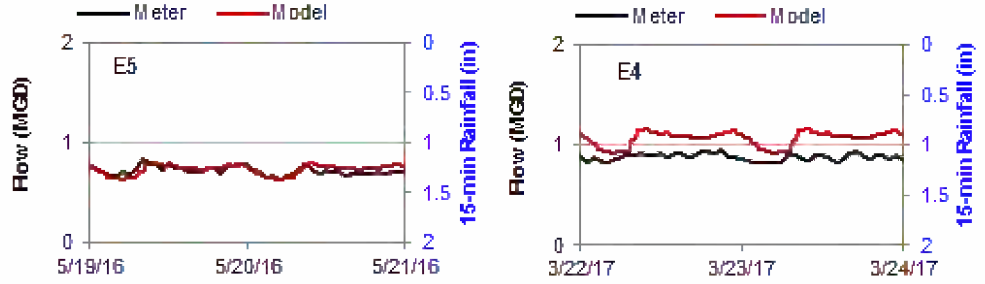


FLOW METER EFF-08 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

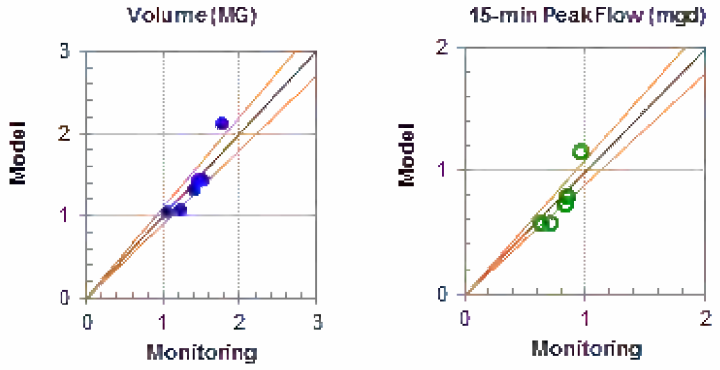
EFF-08 Model Calibration Results (Metered and Modeled Flow)



EFF-08 Model Validation Results (Metered and Modeled Flow)



EFF-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



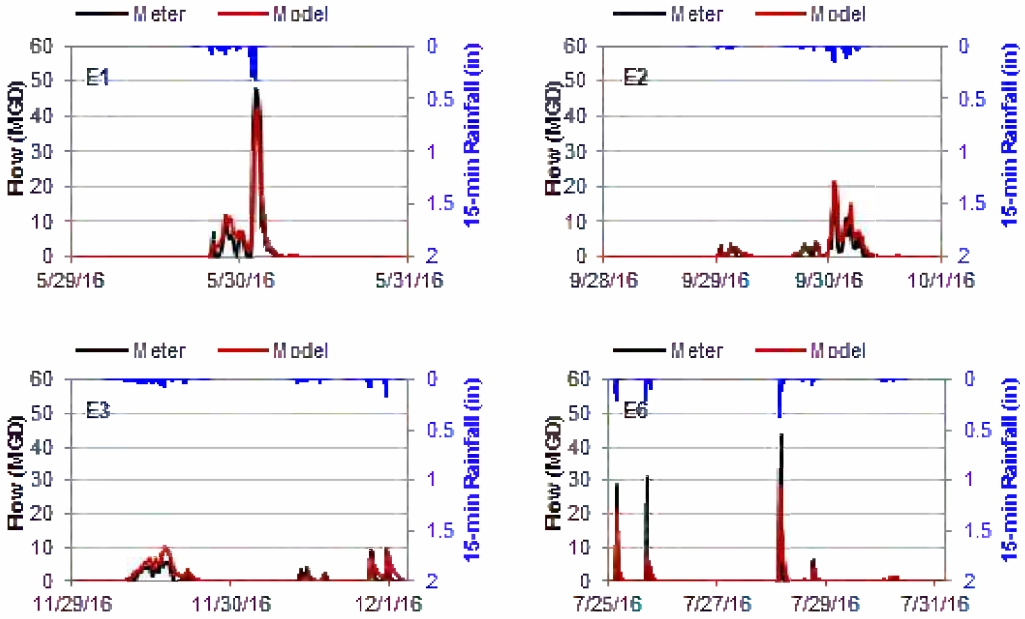
EFF-08 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.85	0.80	-10% to +10%	-6%	1.52	1.46	-10% to +10%	-4%
E2	0.70	0.59	-10% to +10%	-16%	1.22	1.08	-10% to +10%	-12%
E3	0.63	0.58	-10% to +10%	-8%	1.05	1.06	-10% to +10%	2%
E4	0.95	1.16	-10% to +10%	22%	1.76	2.13	-10% to +10%	21%
E5	0.84	0.80	-10% to +10%	-6%	1.44	1.46	-10% to +10%	1%
E6	0.83	0.73	-10% to +10%	-11%	1.39	1.35	-10% to +10%	-3%

EFF-08 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	6.09	4.57	-15% to +25%	-25%	2.23	1.80	-10% to +20%	-19%
E2	6.53	3.67	-15% to +25%	-44%	3.86	3.80	-10% to +20%	-2%
E3	5.08	3.02	-15% to +25%	-40%	3.02	3.25	-10% to +20%	8%
E4	6.65	3.35	-15% to +25%	-50%	8.66	8.25	-10% to +20%	-5%
E5	7.71	3.20	-15% to +25%	-58%	3.99	3.41	-10% to +20%	-15%
E6	4.18	4.39	-15% to +25%	5%	1.44	2.15	-10% to +20%	49%

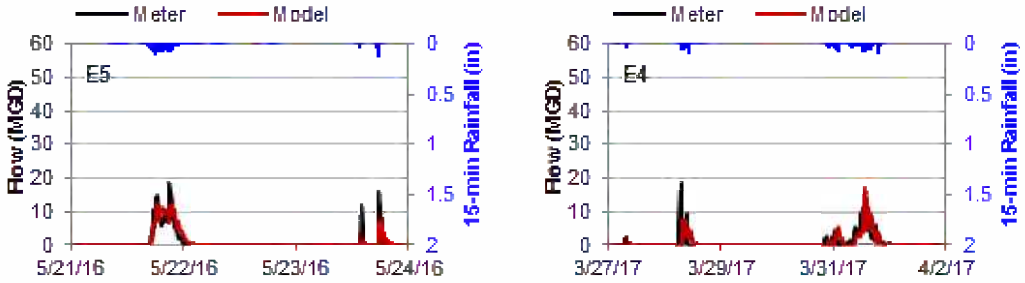
Note: Four of the six wet weather events are calibrated well within the industry criteria. The EFF-08 meter is the effluent meter from Regulator 08. The calibration of Regulator 08 meters (which include the IN-08, EFF-08 and CSO-08 meters) are more focused on the influent IN-08 meter and the overflow CSO-08 meter when the total metered influent flow (IN-08) is not balanced with the total metered effluent flow (EFF-08 plus CSO-08). Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CSO-08 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

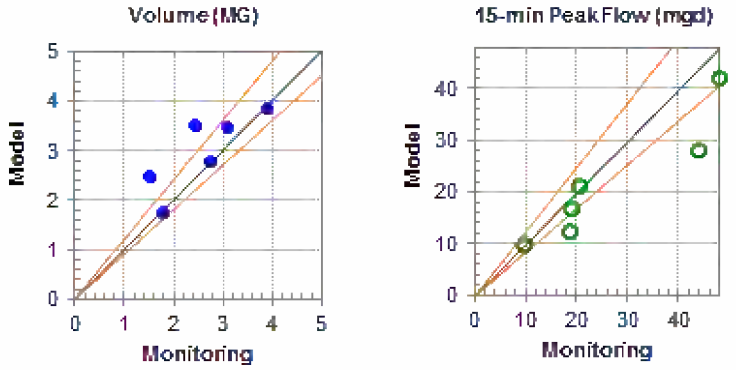
CSO-08 Model Calibration Results (Metered and Modeled Flow)



CSO-08 Model Validation Results (Metered and Modeled Flow)



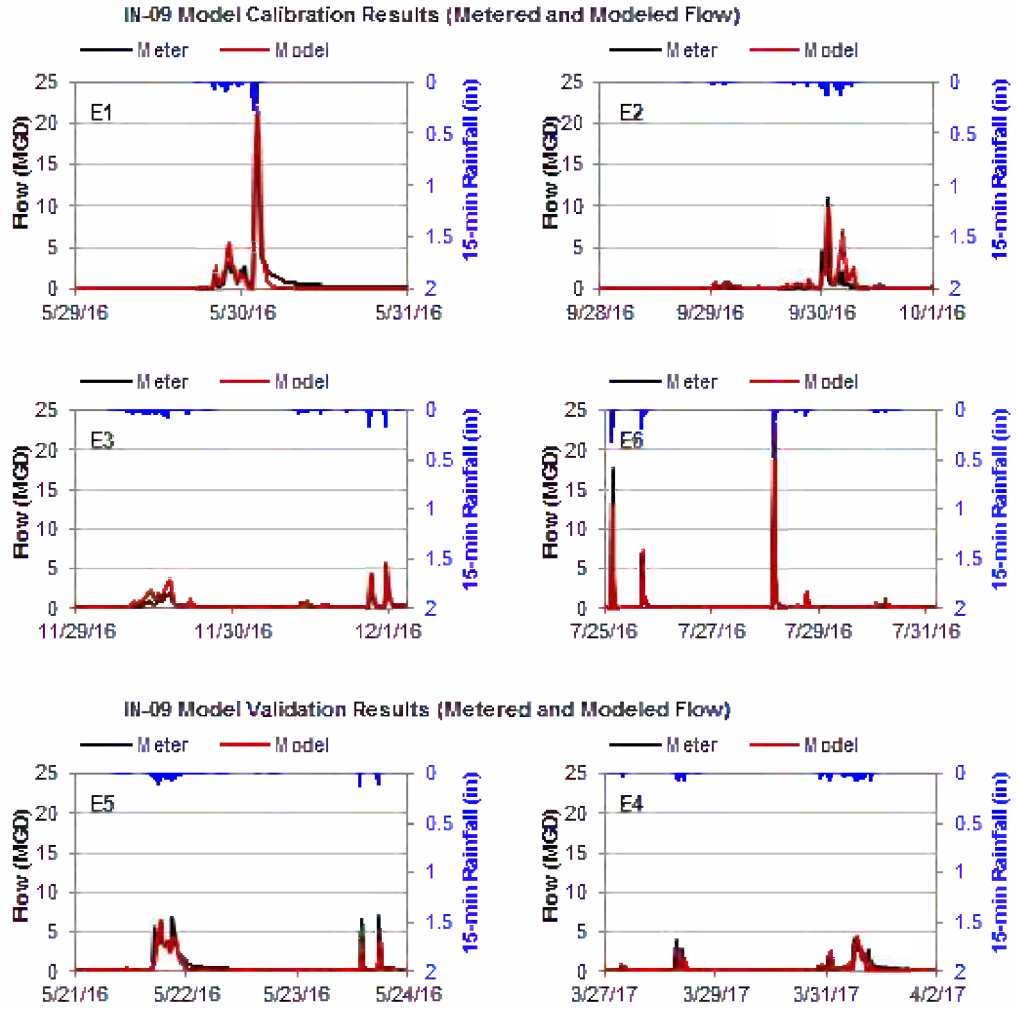
CSO-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



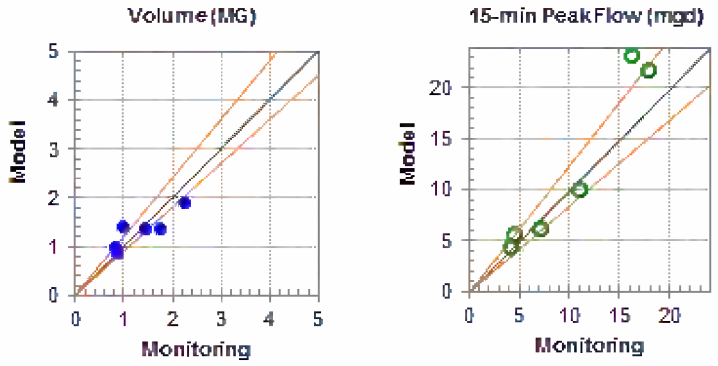
CSO-08 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	47.82	42.26	-15% to +25%	-12%	3.08	3.47	-10% to +20%	13%
E2	20.55	21.32	-15% to +25%	4%	2.42	3.54	-10% to +20%	46%
E3	9.50	9.79	-15% to +25%	3%	1.52	2.48	-10% to +20%	63%
E4	18.72	16.78	-15% to +25%	-10%	3.87	3.87	-10% to +20%	0%
E5	18.35	12.44	-15% to +25%	-32%	2.73	2.81	-10% to +20%	3%
E6	43.63	28.23	-15% to +25%	-35%	1.78	1.77	-10% to +20%	0%

Note: Four of the six wet weather events are calibrated well within the industry criteria. This is the CSO meter from Regulator 08, the calibration of Regulator 08 meters (including Influent meter, effluent meter and CSO meter) are more focused on matching the peak flow and flow volume of the influent and CSO meter. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

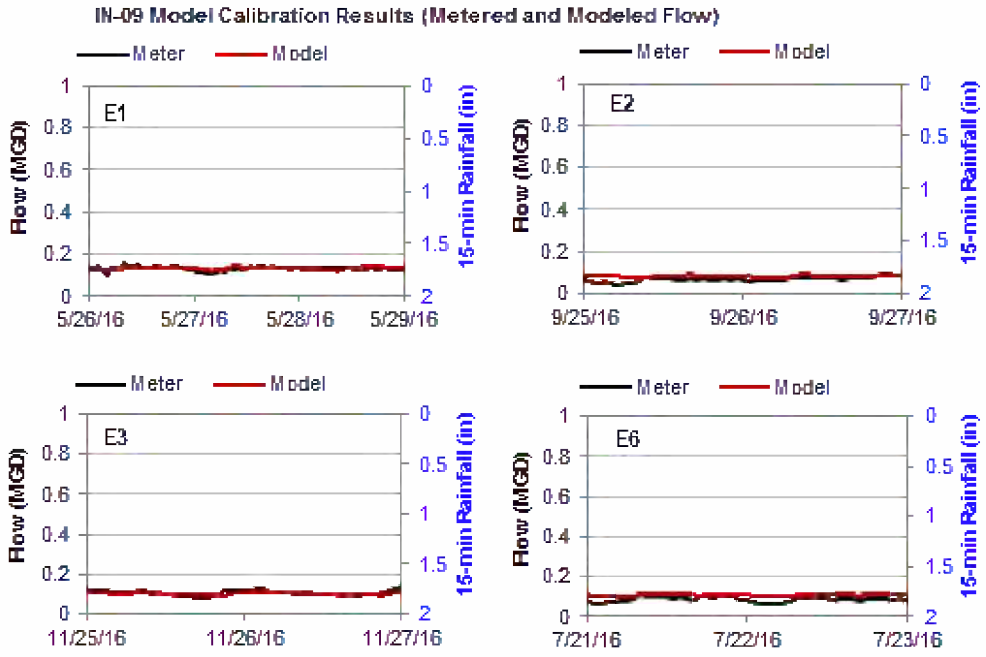
FLOW METER IN-09 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

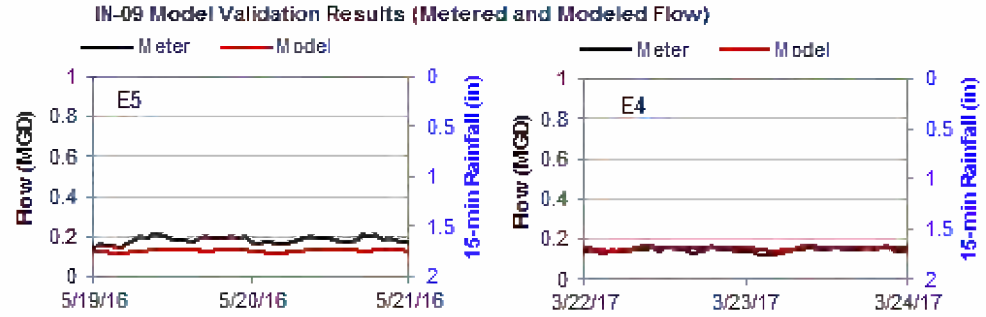


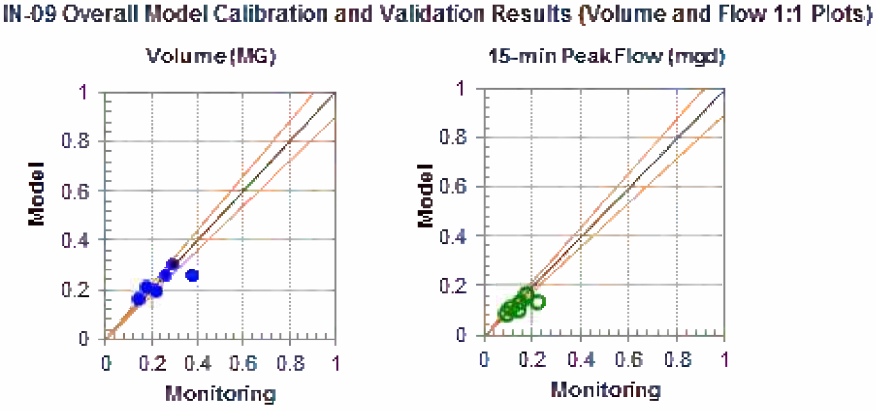
IN-09 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-09 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





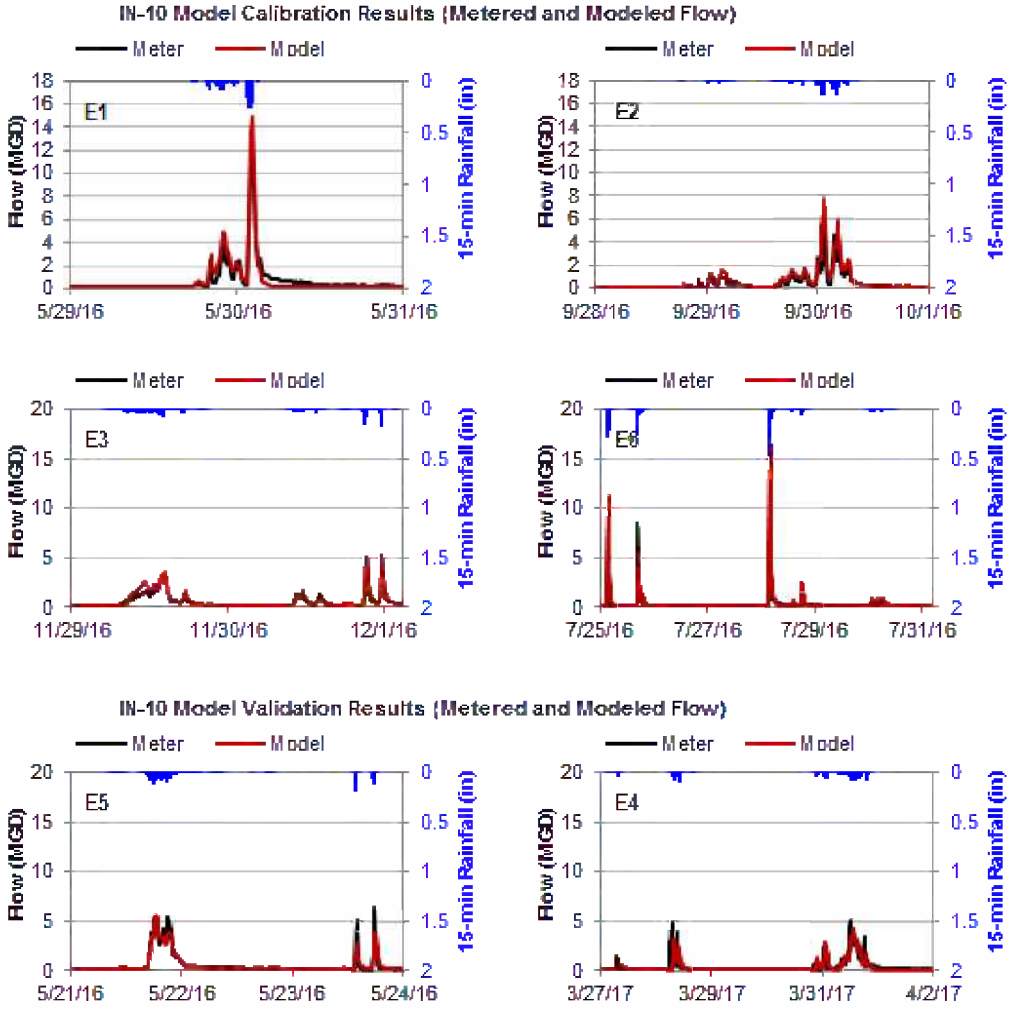


IN-09 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.15	0.14	-10% to +10%	-3%	0.26	0.26	-10% to +10%	2%
E2	0.09	0.09	-10% to +10%	-4%	0.14	0.17	-10% to +10%	19%
E3	0.14	0.11	-10% to +10%	-20%	0.21	0.20	-10% to +10%	-4%
E4	0.17	0.17	-10% to +10%	-2%	0.29	0.31	-10% to +10%	6%
E5	0.21	0.14	-10% to +10%	-35%	0.37	0.26	-10% to +10%	-29%
E6	0.11	0.11	-10% to +10%	6%	0.17	0.21	-10% to +10%	22%

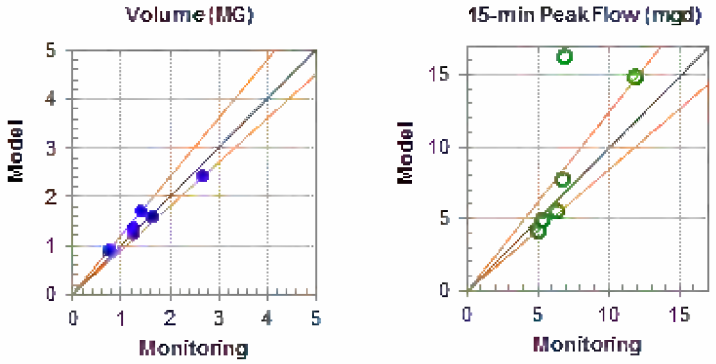
IN-09 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	17.88	21.83	-15% to +25%	22%	1.42	1.39	-10% to +20%	-2%
E2	10.87	10.06	-15% to +25%	-7%	0.96	1.41	-10% to +20%	47%
E3	4.41	5.62	-15% to +25%	28%	0.79	1.01	-10% to +20%	27%
E4	4.10	4.49	-15% to +25%	10%	2.24	1.91	-10% to +20%	-15%
E5	7.10	6.25	-15% to +25%	-12%	1.74	1.41	-10% to +20%	-19%
E6	16.13	23.34	-15% to +25%	45%	0.85	0.88	-10% to +20%	3%

Note: Four of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E3, E5, and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

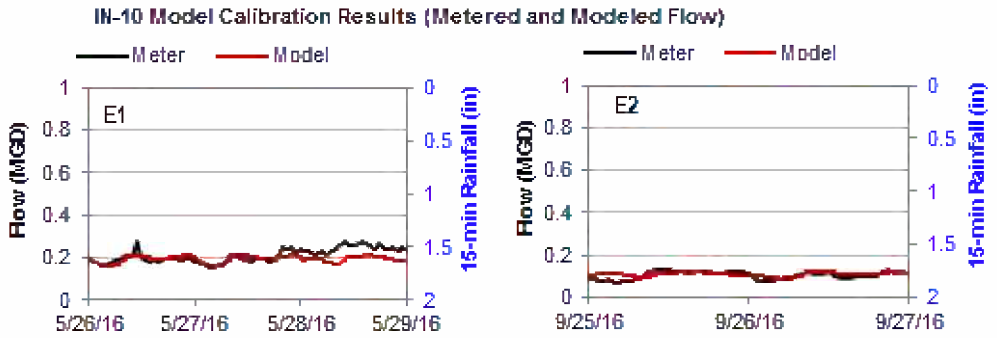
FLOW METER IN-10 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

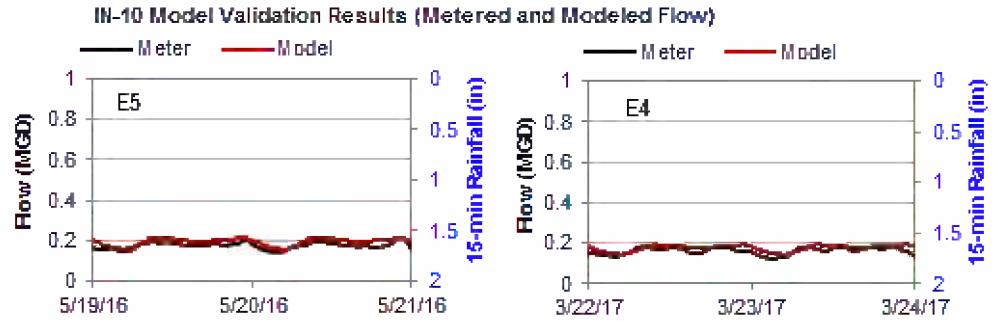


IN-10 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

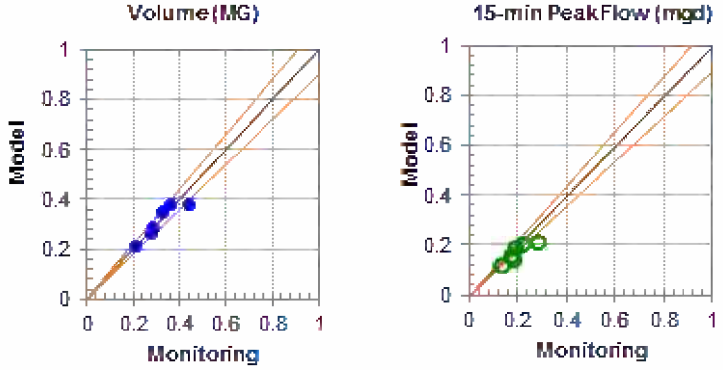


FLOW METER IN-10 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





IN-10 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

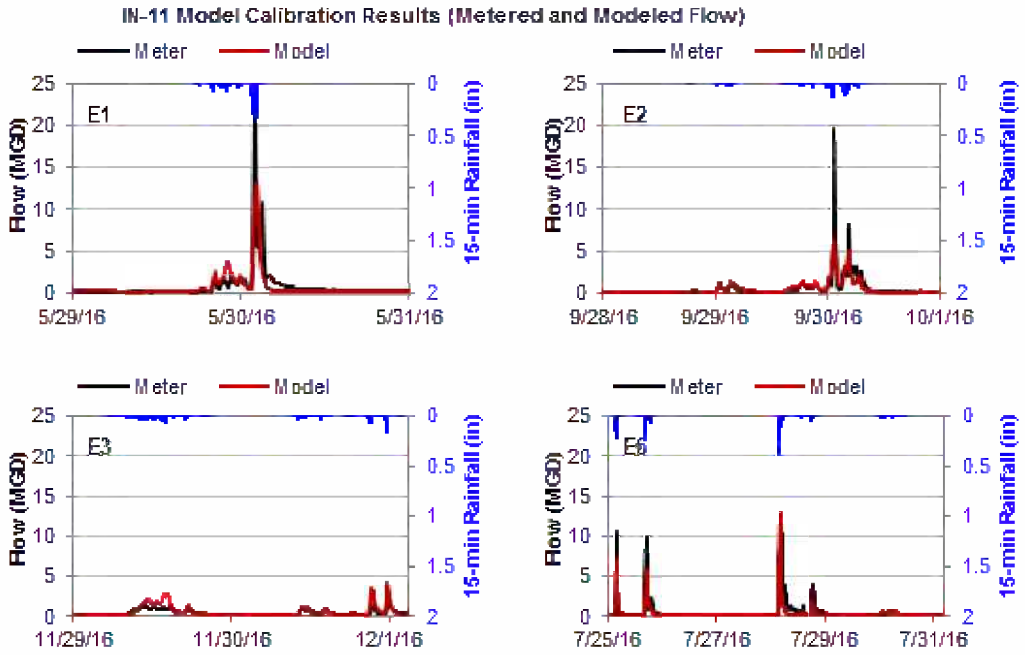


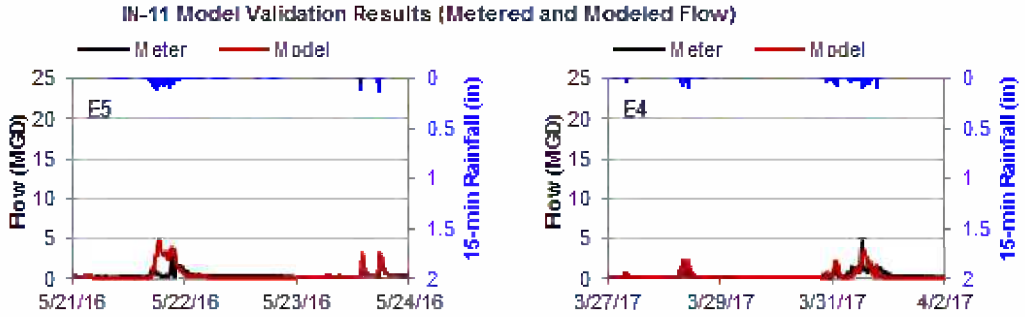
IN-10 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.28	0.21	-10% to +10%	-24%	0.44	0.39	-10% to +10%	-12%
E2	0.13	0.12	-10% to +10%	-10%	0.21	0.22	-10% to +10%	3%
E3	0.18	0.15	-10% to +10%	-16%	0.27	0.27	-10% to +10%	-1%
E4	0.19	0.19	-10% to +10%	1%	0.32	0.35	-10% to +10%	8%
E5	0.22	0.21	-10% to +10%	-2%	0.35	0.39	-10% to +10%	10%
E6	0.17	0.16	-10% to +10%	-6%	0.28	0.29	-10% to +10%	5%

IN-10 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	11.83	14.96	-15% to +25%	26%	1.25	1.28	-10% to +20%	3%
E2	6.70	7.85	-15% to +25%	17%	1.38	1.72	-10% to +20%	24%
E3	5.31	4.99	-15% to +25%	-6%	1.23	1.37	-10% to +20%	11%
E4	5.04	4.22	-15% to +25%	-16%	2.67	2.46	-10% to +20%	-8%
E5	6.31	5.56	-15% to +25%	-12%	1.61	1.60	-10% to +20%	-1%
E6	6.82	16.42	-15% to +25%	141%	0.72	0.94	-10% to +20%	30%

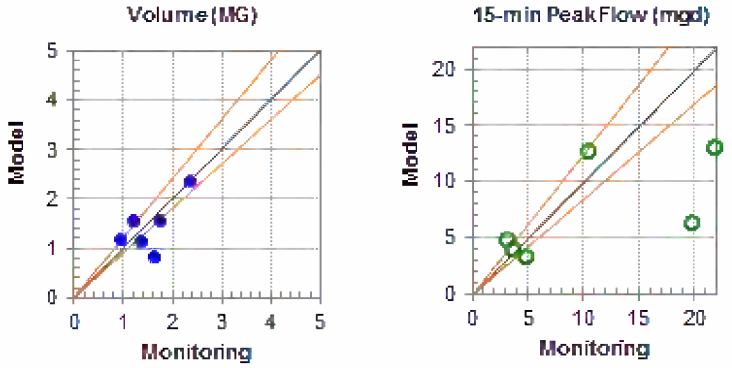
Note: Five of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-11 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

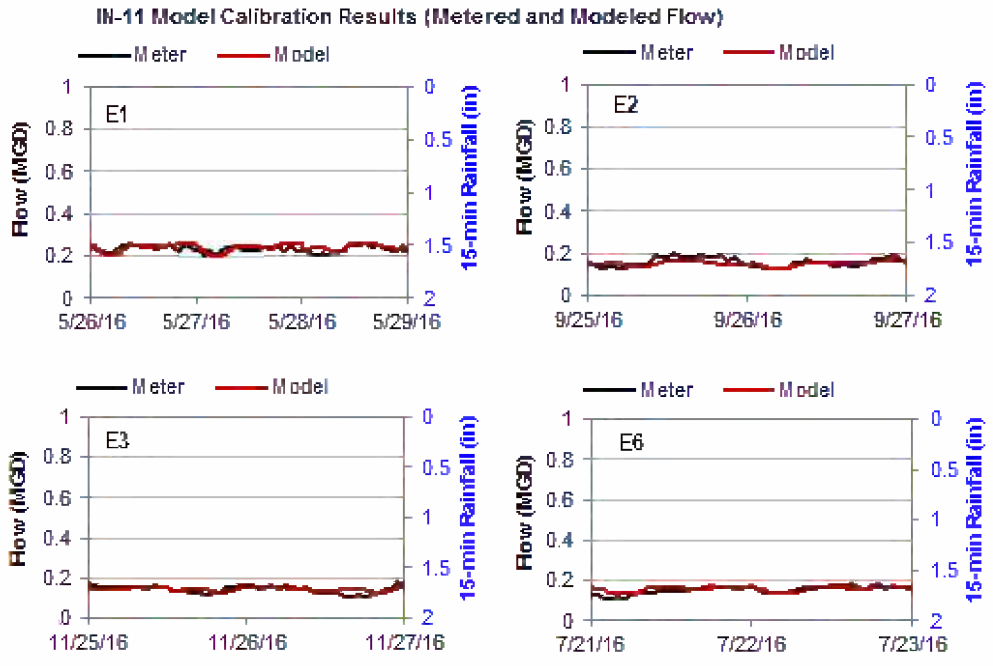


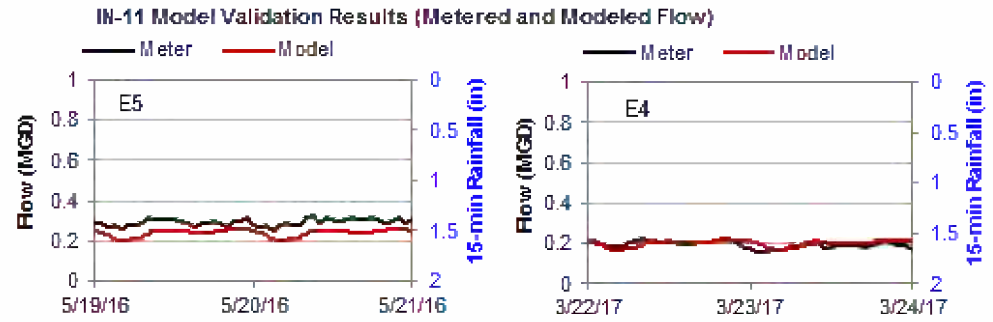


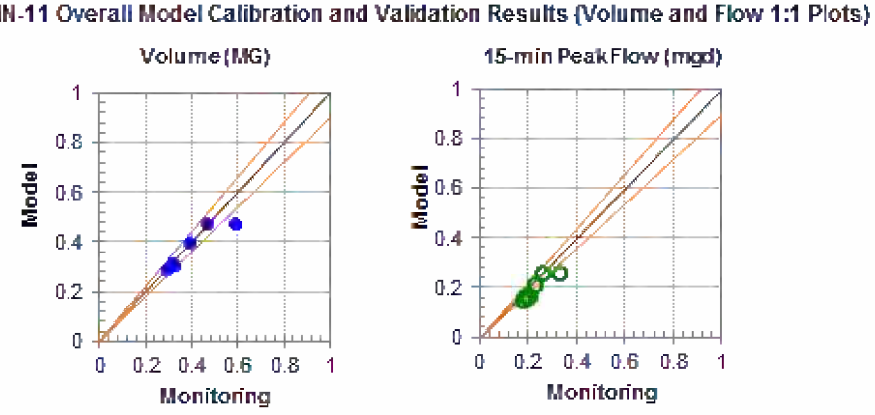
IN-11 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-11 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







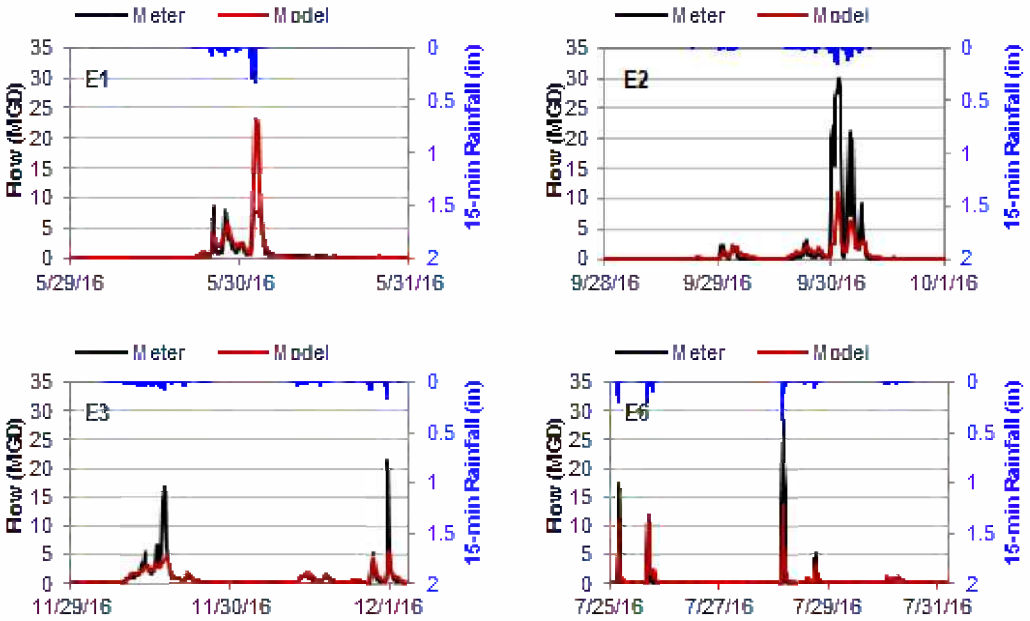
IN-11 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.26	0.26	-10% to +10%	1%	0.46	0.48	-10% to +10%	3%
E2	0.20	0.17	-10% to +10%	-17%	0.32	0.31	-10% to +10%	-4%
E3	0.18	0.16	-10% to +10%	-13%	0.29	0.29	-10% to +10%	1%
E4	0.23	0.22	-10% to +10%	-5%	0.39	0.40	-10% to +10%	2%
E5	0.32	0.26	-10% to +10%	-20%	0.59	0.48	-10% to +10%	-18%
E6	0.19	0.17	-10% to +10%	-8%	0.31	0.32	-10% to +10%	2%

IN-11 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	21.79	13.12	-15% to +25%	-40%	1.34	1.14	-10% to +20%	-15%
E2	19.64	6.48	-15% to +25%	-67%	1.71	1.56	-10% to +20%	-9%
E3	3.59	4.11	-15% to +25%	14%	0.94	1.19	-10% to +20%	27%
E4	4.74	3.44	-15% to +25%	-27%	2.34	2.37	-10% to +20%	1%
E5	3.06	4.84	-15% to +25%	58%	1.19	1.58	-10% to +20%	33%
E6	10.30	12.79	-15% to +25%	24%	1.62	0.86	-10% to +20%	-47%

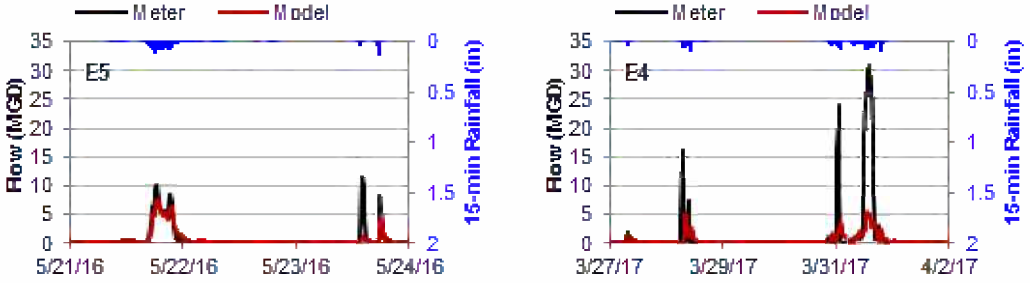
Note: Only two of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1, E2, E5) is not consistent with the recorded rainfall intensity. The calibration goal is to balance the over-prediction and under-prediction event numbers cross all the events. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-13 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

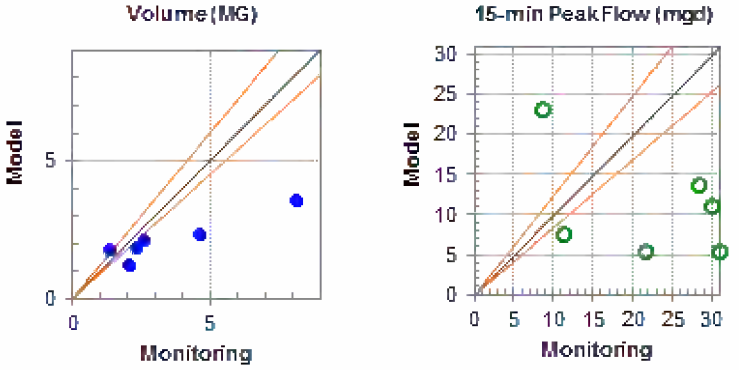
IN-13 Model Calibration Results (Metered and Modeled Flow)



IN-13 Model Validation Results (Metered and Modeled Flow)

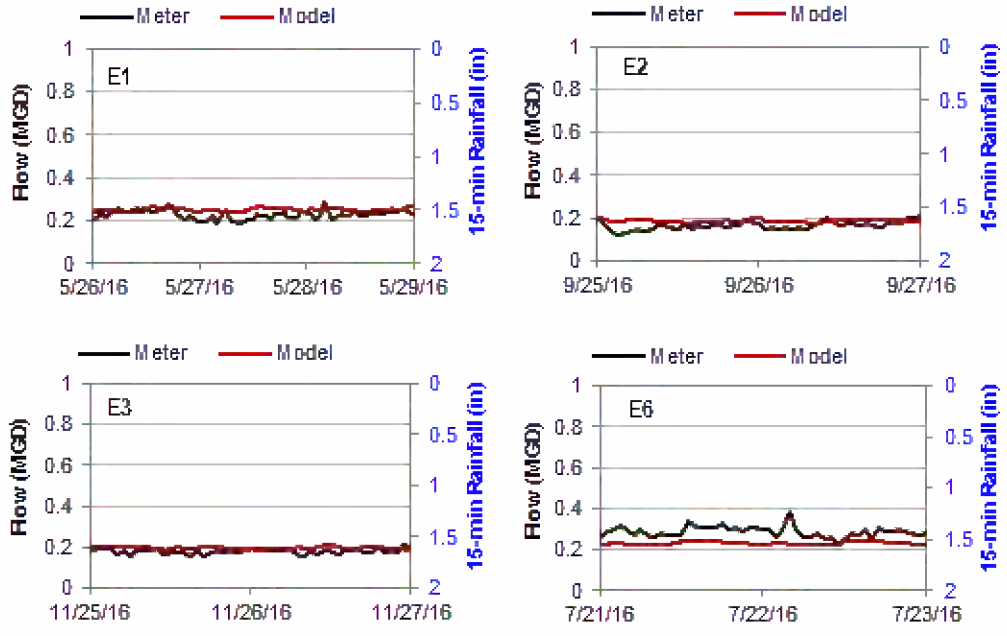


IN-13 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

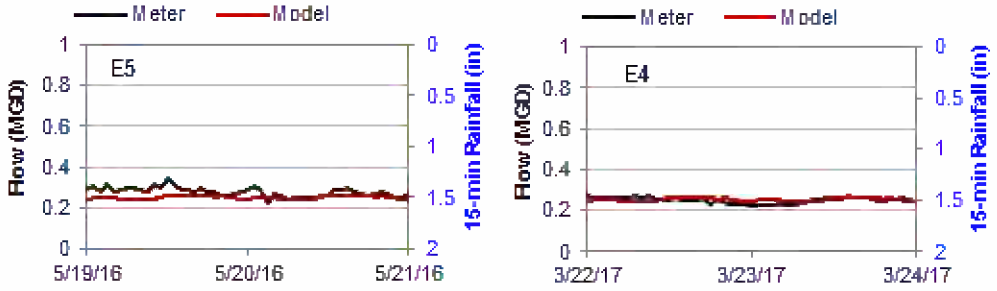


FLOW METER IN-13 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

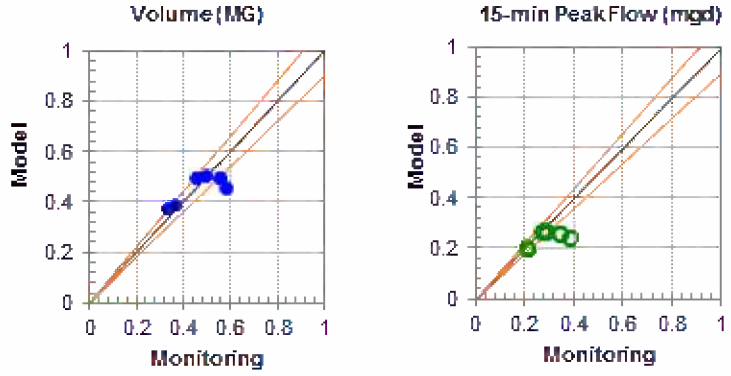
IN-13 Model Calibration Results (Metered and Modeled Flow)



IN-13 Model Validation Results (Metered and Modeled Flow)



IN-13 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

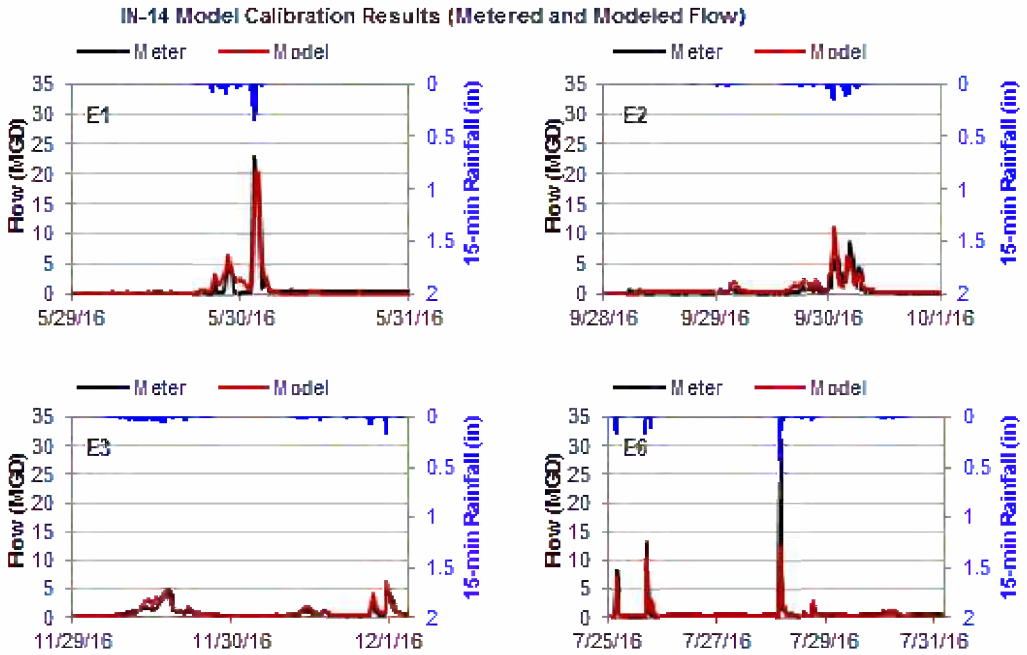


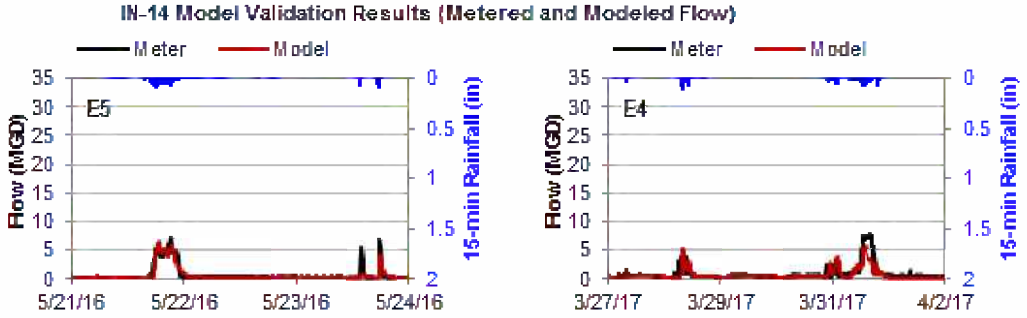
IN-13 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.29	0.27	-10% to +10%	-5%	0.45	0.50	-10% to +10%	11%
E2	0.21	0.20	-10% to +10%	-5%	0.33	0.37	-10% to +10%	13%
E3	0.21	0.21	-10% to +10%	0%	0.36	0.39	-10% to +10%	9%
E4	0.27	0.27	-10% to +10%	-2%	0.50	0.51	-10% to +10%	1%
E5	0.34	0.26	-10% to +10%	-23%	0.56	0.50	-10% to +10%	-10%
E6	0.38	0.24	-10% to +10%	-37%	0.58	0.46	-10% to +10%	-20%

IN-13 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	8.54	23.16	-15% to +25%	171%	1.35	1.80	-10% to +20%	34%
E2	29.87	11.05	-15% to +25%	-63%	4.59	2.37	-10% to +20%	-48%
E3	21.47	5.53	-15% to +25%	-74%	2.28	1.91	-10% to +20%	-16%
E4	30.86	5.54	-15% to +25%	-82%	8.12	3.57	-10% to +20%	-56%
E5	11.35	7.59	-15% to +25%	-33%	2.53	2.15	-10% to +20%	-15%
E6	28.28	13.85	-15% to +25%	-51%	1.98	1.26	-10% to +20%	-36%

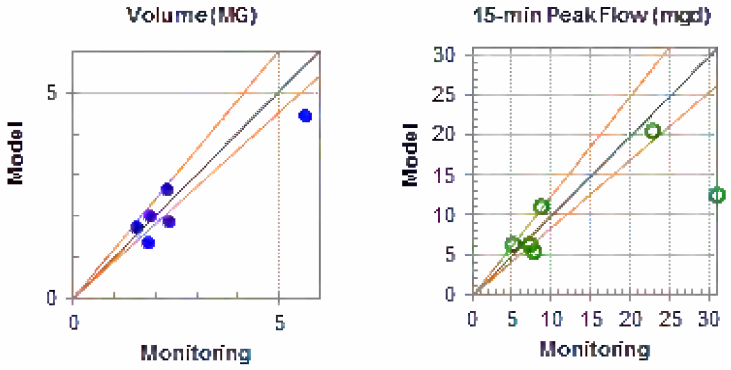
Note: This flow meter is hard to calibrate because flow meter data recorded for most of the events is not consistent with the recorded rainfall intensity. The calibration goal is to calibrate the meter to those wet weather response in line with the rainfall data.

FLOW METER IN-14 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events



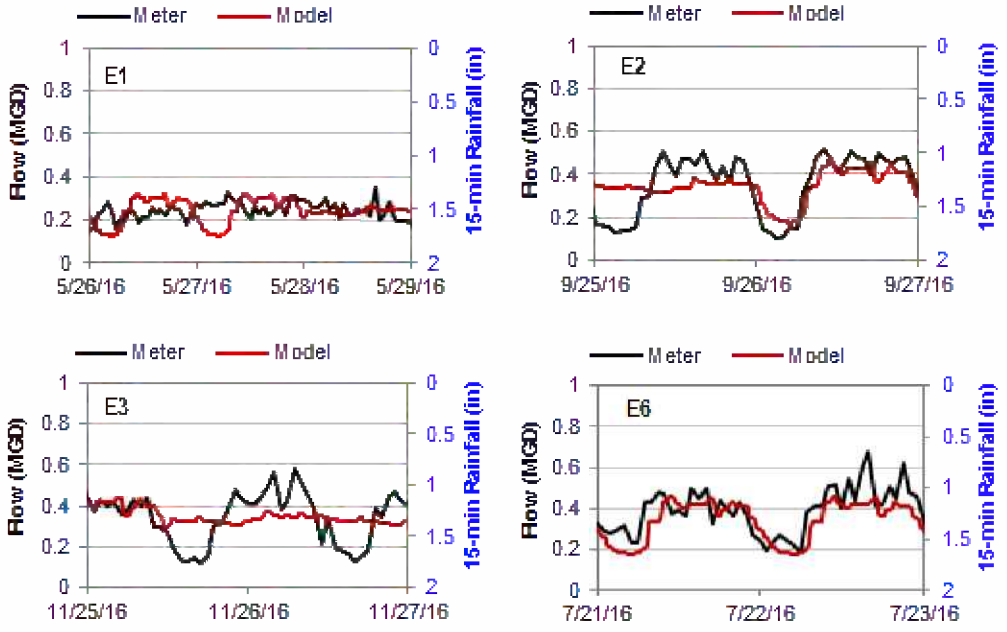


IN-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

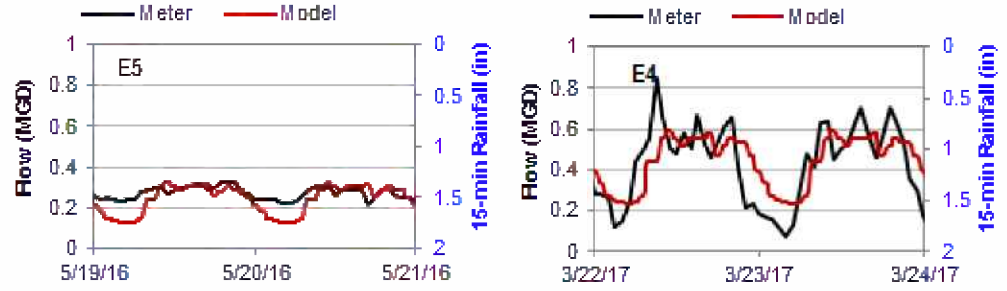


FLOW METER IN-14 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

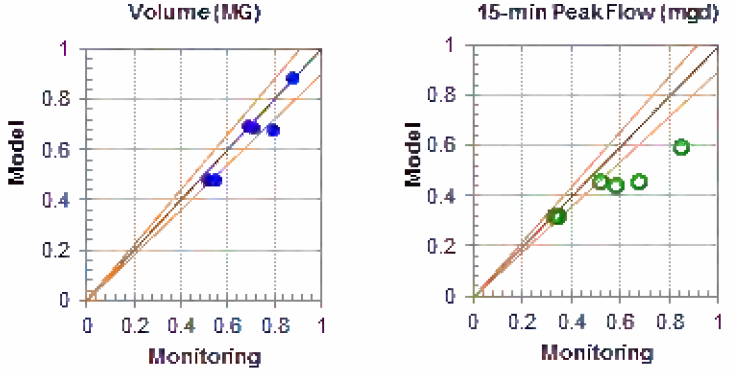
IN-14 Model Calibration Results (Metered and Modeled Flow)



IN-14 Model Validation Results (Metered and Modeled Flow)



IN-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

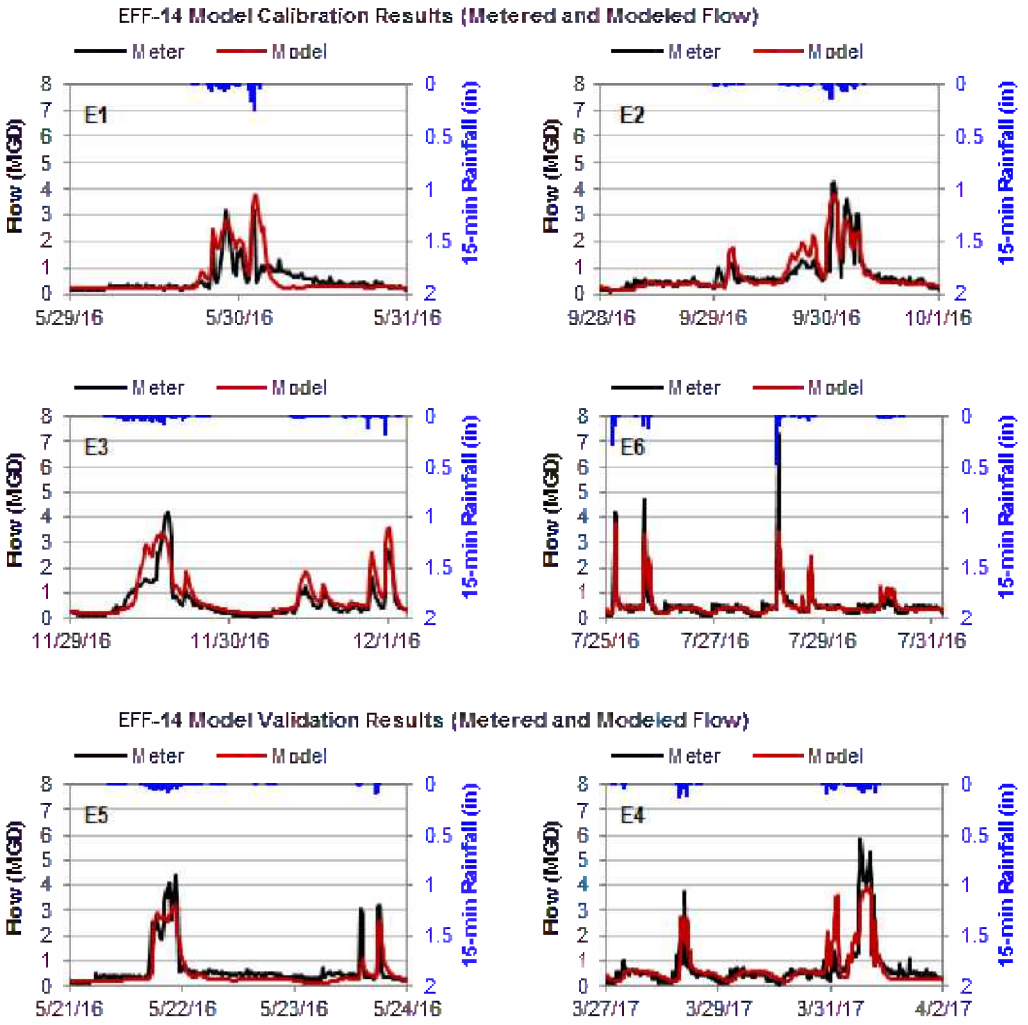


IN-14 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.35	0.32	-10% to +10%	-6%	0.51	0.48	-10% to +10%	-6%
E2	0.52	0.46	-10% to +10%	-11%	0.71	0.69	-10% to +10%	-3%
E3	0.58	0.44	-10% to +10%	-24%	0.68	0.70	-10% to +10%	2%
E4	0.84	0.59	-10% to +10%	-30%	0.87	0.89	-10% to +10%	2%
E5	0.33	0.32	-10% to +10%	0%	0.54	0.48	-10% to +10%	-11%
E6	0.67	0.46	-10% to +10%	-32%	0.79	0.68	-10% to +10%	-13%

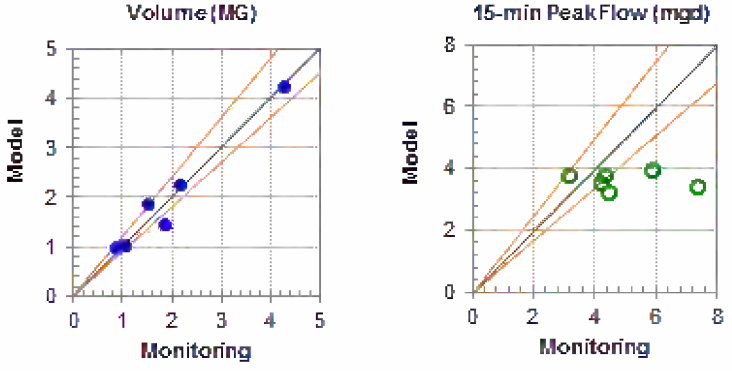
IN-14 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	22.85	20.54	-15% to +25%	-10%	1.54	1.74	-10% to +20%	13%
E2	8.60	11.12	-15% to +25%	29%	2.25	2.67	-10% to +20%	19%
E3	4.98	6.34	-15% to +25%	27%	1.84	2.05	-10% to +20%	11%
E4	7.74	5.54	-15% to +25%	-28%	5.62	4.46	-10% to +20%	-21%
E5	7.13	6.48	-15% to +25%	-9%	2.29	1.88	-10% to +20%	-18%
E6	30.94	12.50	-15% to +25%	-60%	1.81	1.39	-10% to +20%	-23%

Note: Four of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER EFF-14 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

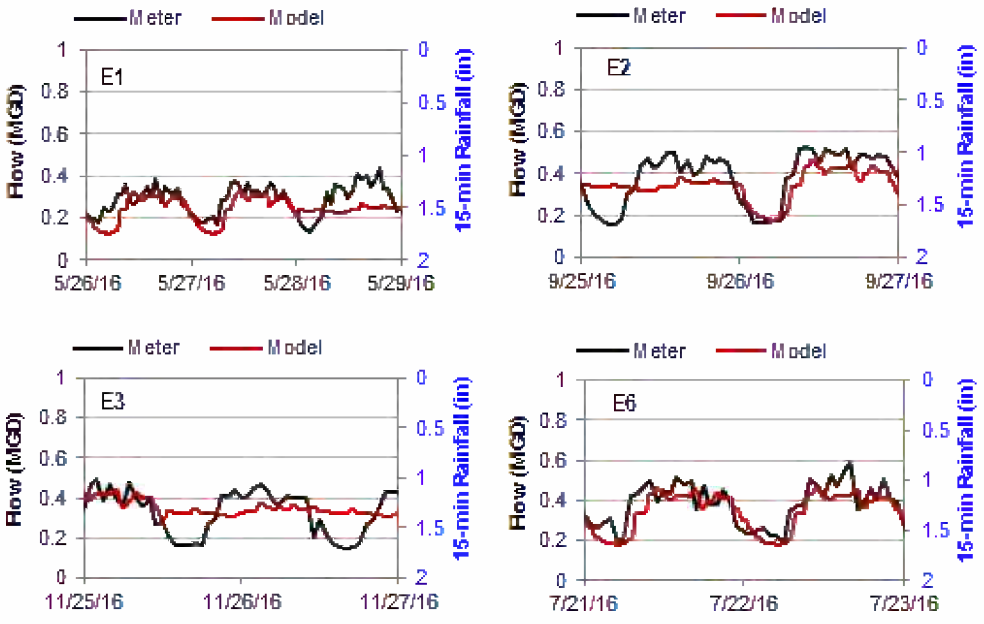


EFF-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

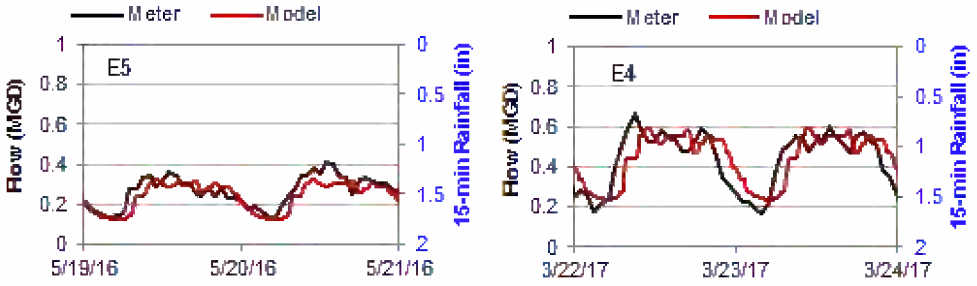


FLOW METER EFF-14 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

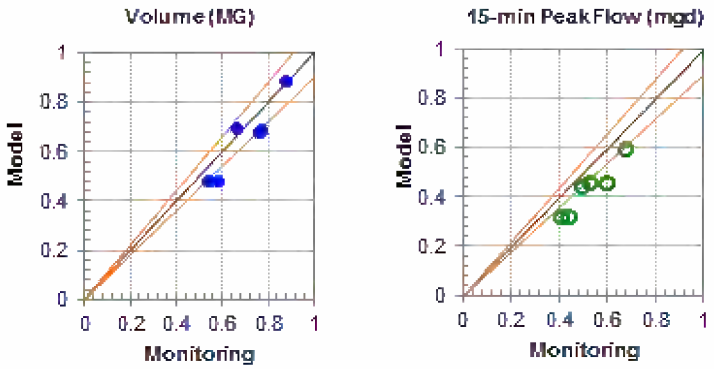
EFF-14 Model Calibration Results (Metered and Modeled Flow)



EFF-14 Model Validation Results (Metered and Modeled Flow)



EFF-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



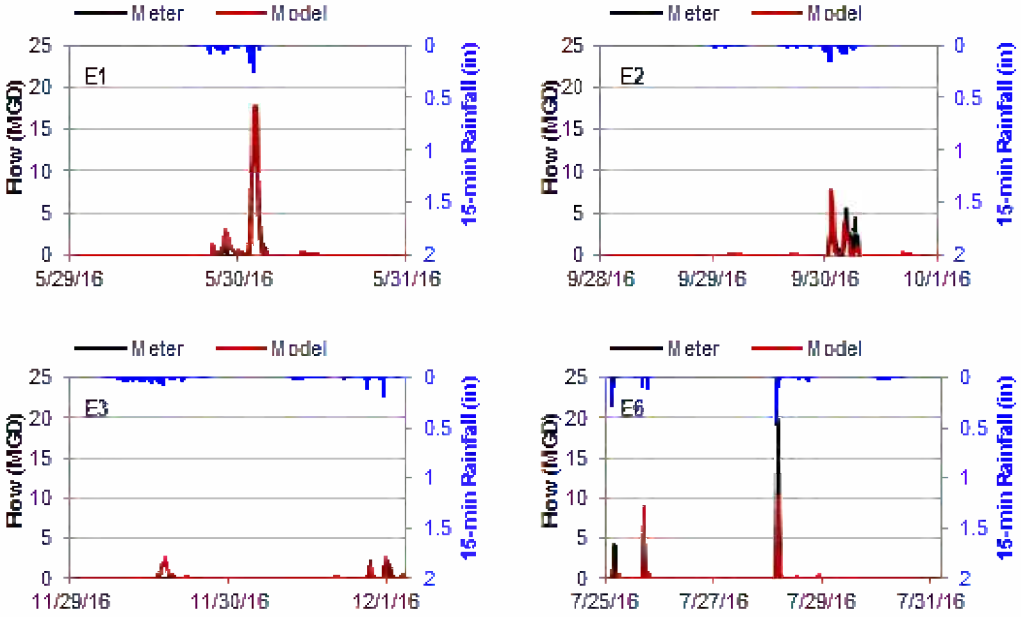
EFF-14 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.44	0.32	-10% to +10%	-26%	0.58	0.48	-10% to +10%	-17%
E2	0.53	0.46	-10% to +10%	-12%	0.76	0.69	-10% to +10%	-10%
E3	0.49	0.44	-10% to +10%	-11%	0.66	0.70	-10% to +10%	6%
E4	0.67	0.59	-10% to +10%	-11%	0.87	0.89	-10% to +10%	2%
E5	0.41	0.32	-10% to +10%	-21%	0.54	0.48	-10% to +10%	-9%
E6	0.59	0.46	-10% to +10%	-23%	0.76	0.68	-10% to +10%	-10%

EFF-14 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.17	3.78	-15% to +25%	19%	0.85	1.00	-10% to +20%	17%
E2	4.29	3.77	-15% to +25%	-12%	2.14	2.27	-10% to +20%	6%
E3	4.20	3.56	-15% to +25%	-15%	1.50	1.89	-10% to +20%	26%
E4	5.84	3.99	-15% to +25%	-32%	4.25	4.25	-10% to +20%	0%
E5	4.47	3.25	-15% to +25%	-27%	1.84	1.46	-10% to +20%	-21%
E6	7.32	3.42	-15% to +25%	-53%	1.05	1.05	-10% to +20%	0%

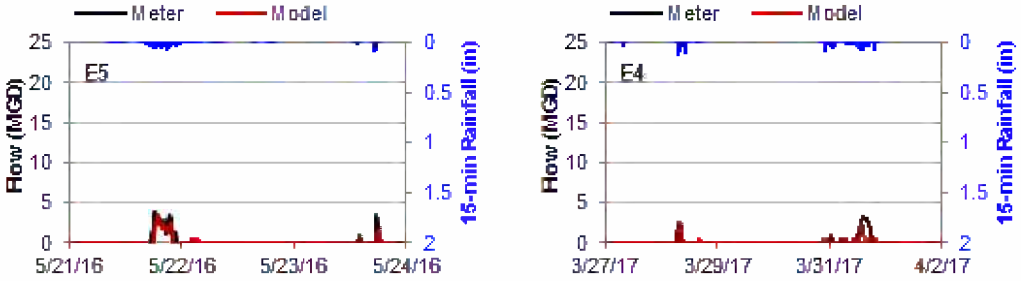
Note: Four of the six wet weather events are calibrated well within the industry criteria. The EFF-14 meter is the effluent meter from Regulator 14. The calibration of Regulator 14 meters (which include the IN-14, EFF-14 and CSO-14 meters) are more focused on the influent IN-14 meter and the overflow CSO-14 meter when the total metered influent flow (IN-14) is not balanced with the total metered effluent flow (EFF-14 plus CSO-14). Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CSO-14 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

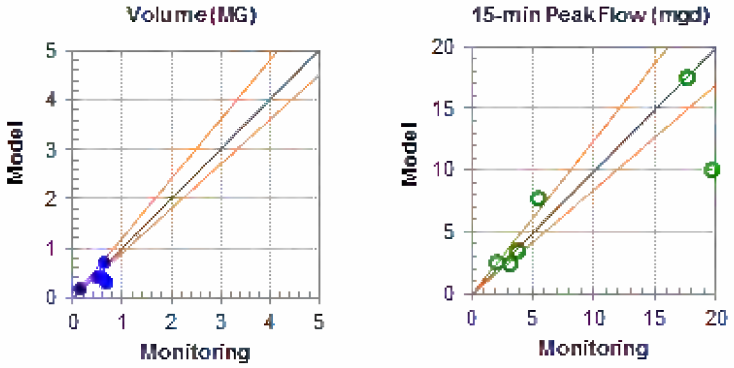
CSO-14 Model Calibration Results (Metered and Modeled Flow)



CSO-14 Model Validation Results (Metered and Modeled Flow)



CSO-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

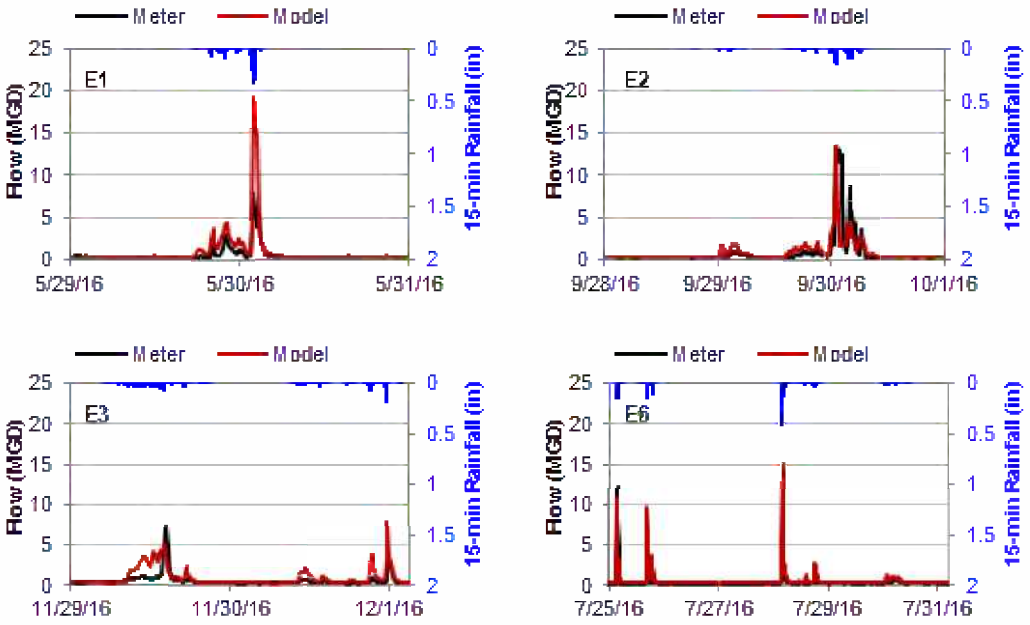


CSO-14 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	17.57	17.55	-15% to +25%	0%	0.63	0.75	-10% to +20%	19%
E2	5.47	7.82	-15% to +25%	43%	0.45	0.43	-10% to +20%	-4%
E3	2.03	2.59	-15% to +25%	27%	0.10	0.21	-10% to +20%	100%
E4	3.16	2.50	-15% to +25%	-21%	0.65	0.33	-10% to +20%	-49%
E5	3.76	3.49	-15% to +25%	-7%	0.57	0.42	-10% to +20%	-25%
E6	19.66	10.03	-15% to +25%	-49%	0.67	0.36	-10% to +20%	-46%

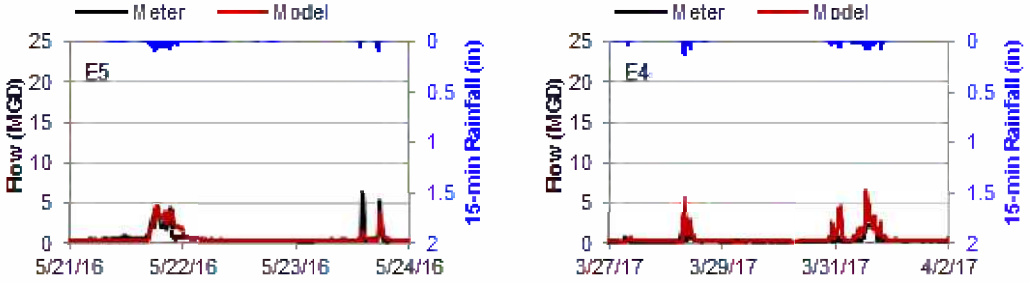
Note: Four of the six wet weather event volumes are calibrated well within or close to the industry criteria. This is the CSO meter from Regulator 14, the calibration of Regulator 14 meters (including Influent meter, effluent meter and CSO meter) are more focused on matching the peak flow and flow volume of the influent and CSO meters. The CSO meter flow volume is challenging to calibrate especially for the small overflow events like E3. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-16 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

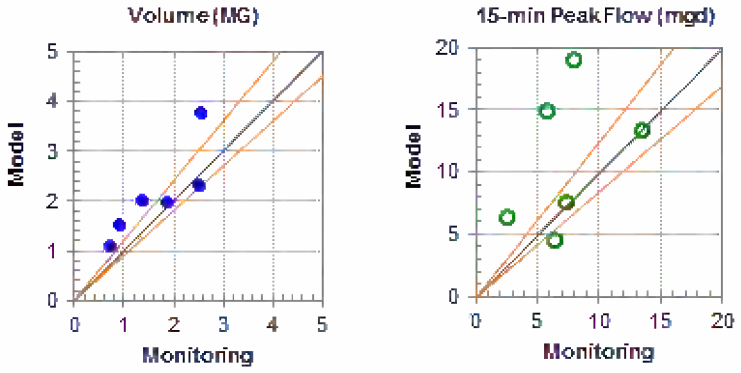
IN-16 Model Calibration Results (Metered and Modeled Flow)



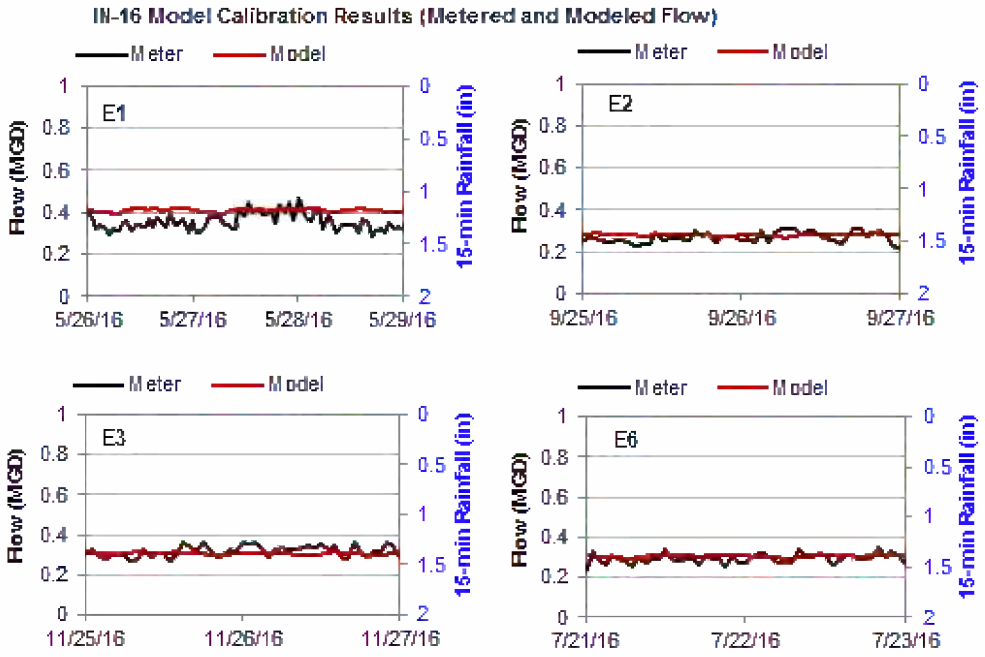
IN-16 Model Validation Results (Metered and Modeled Flow)

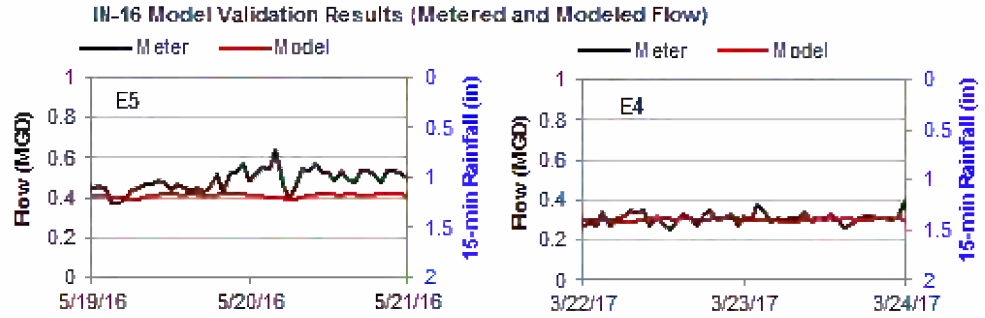


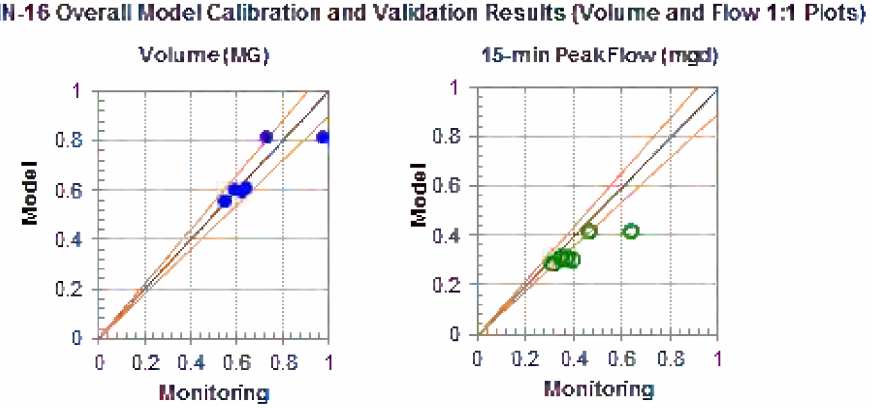
IN-16 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-16 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







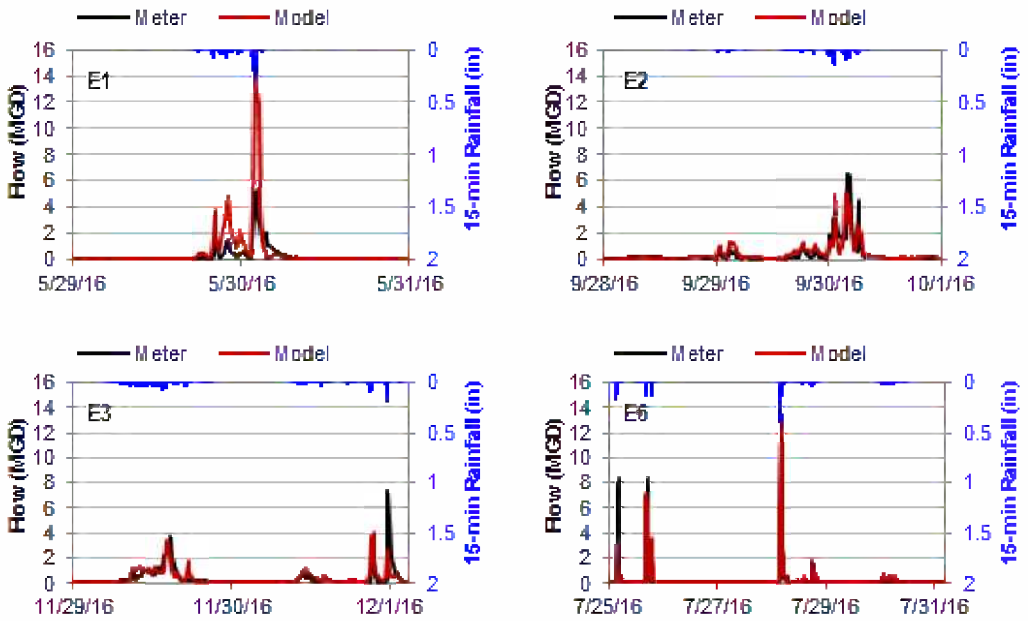
IN-16 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.46	0.42	-10% to +10%	-9%	0.72	0.82	-10% to +10%	13%
E2	0.31	0.29	-10% to +10%	-7%	0.54	0.56	-10% to +10%	4%
E3	0.37	0.31	-10% to +10%	-14%	0.63	0.61	-10% to +10%	-4%
E4	0.39	0.31	-10% to +10%	-20%	0.62	0.60	-10% to +10%	-3%
E5	0.64	0.42	-10% to +10%	-34%	0.97	0.82	-10% to +10%	-16%
E6	0.35	0.31	-10% to +10%	-9%	0.59	0.61	-10% to +10%	4%

IN-16 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	7.94	19.10	-15% to +25%	141%	0.88	1.56	-10% to +20%	77%
E2	13.37	13.45	-15% to +25%	1%	2.48	2.35	-10% to +20%	-5%
E3	7.23	7.64	-15% to +25%	6%	1.35	2.05	-10% to +20%	52%
E4	2.48	6.49	-15% to +25%	161%	2.54	3.80	-10% to +20%	50%
E5	6.35	4.62	-15% to +25%	-27%	1.83	2.02	-10% to +20%	10%
E6	5.72	15.05	-15% to +25%	163%	0.68	1.14	-10% to +20%	66%

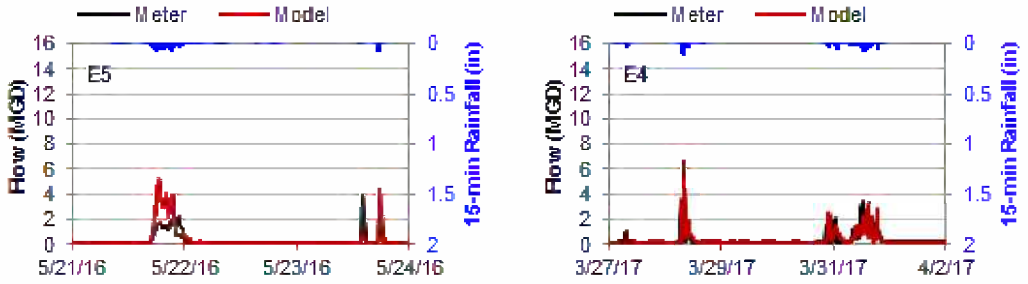
Note: Only two of the six wet weather event volumes are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1, E4, E5, and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-17 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

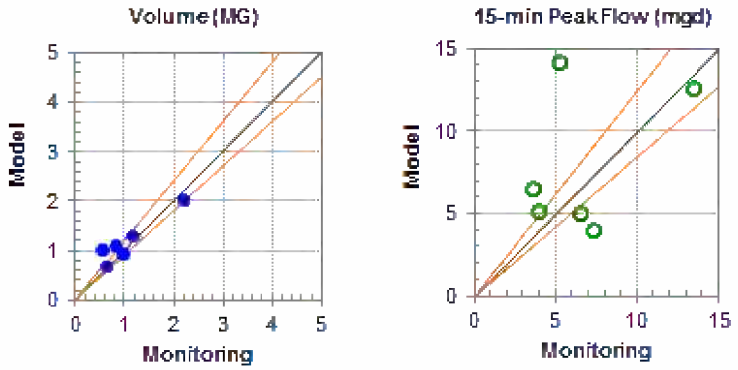
IN-17 Model Calibration Results (Metered and Modeled Flow)



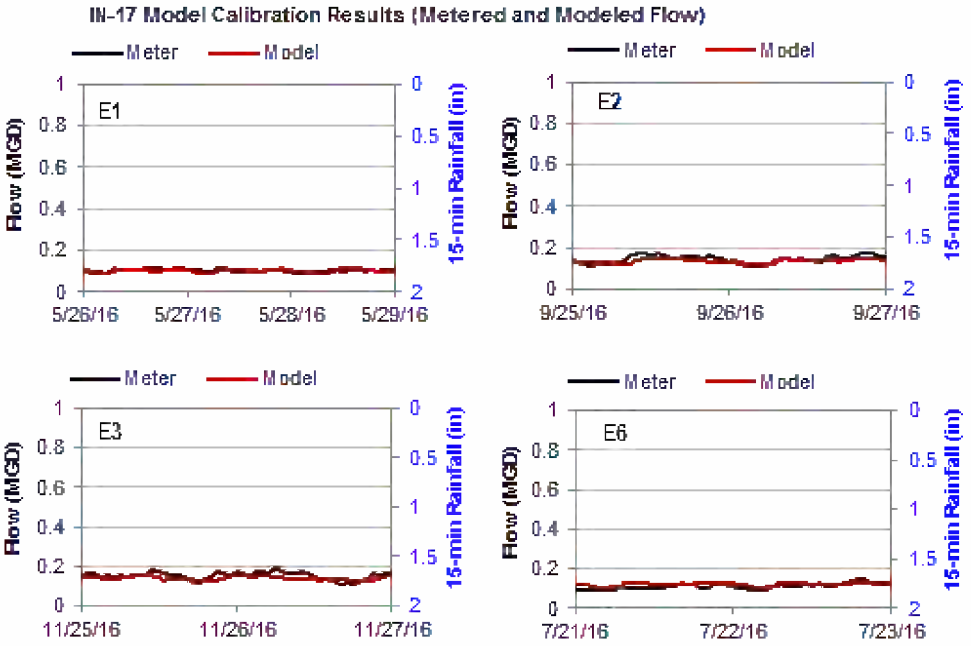
IN-17 Model Validation Results (Metered and Modeled Flow)

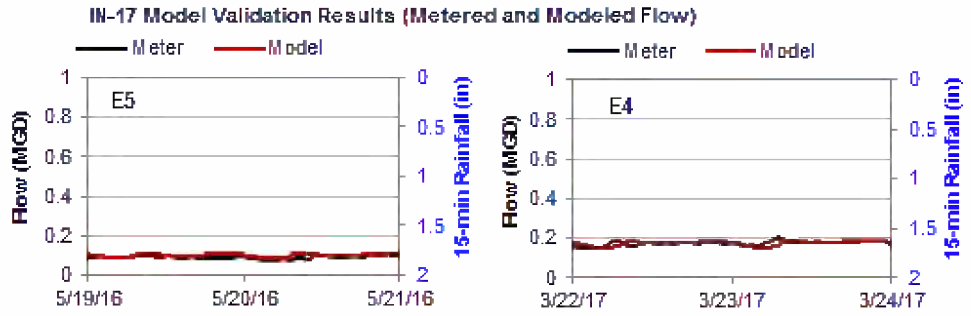


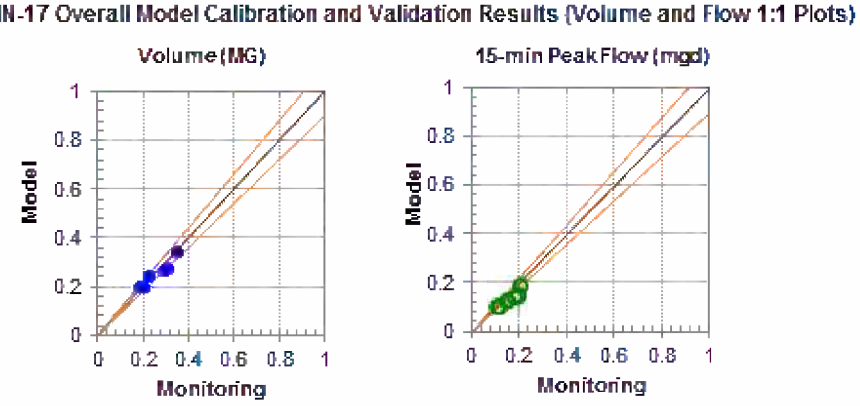
IN-17 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-17 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







IN-17 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.12	0.11	-10% to +10%	-6%	0.20	0.20	-10% to +10%	0%
E2	0.18	0.15	-10% to +10%	-15%	0.29	0.27	-10% to +10%	-7%
E3	0.19	0.15	-10% to +10%	-19%	0.31	0.28	-10% to +10%	-9%
E4	0.20	0.19	-10% to +10%	-6%	0.35	0.35	-10% to +10%	0%
E5	0.11	0.11	-10% to +10%	1%	0.19	0.20	-10% to +10%	9%
E6	0.15	0.13	-10% to +10%	-11%	0.22	0.24	-10% to +10%	9%

IN-17 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	5.19	14.26	-15% to +25%	175%	0.53	1.06	-10% to +20%	101%
E2	6.54	5.11	-15% to +25%	-22%	1.15	1.30	-10% to +20%	13%
E3	7.31	4.01	-15% to +25%	-45%	0.95	0.99	-10% to +20%	4%
E4	3.64	6.57	-15% to +25%	81%	2.19	2.05	-10% to +20%	-6%
E5	3.95	5.17	-15% to +25%	31%	0.79	1.10	-10% to +20%	39%
E6	13.38	12.67	-15% to +25%	-5%	0.61	0.72	-10% to +20%	18%

Note: Only two of the six wet weather event volumes are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1, E4) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

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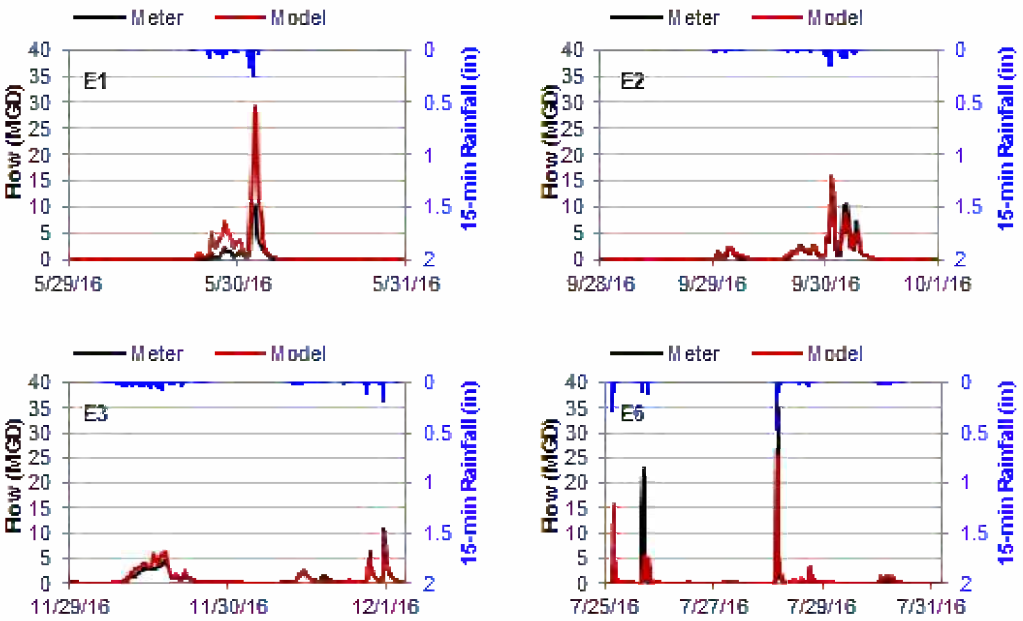
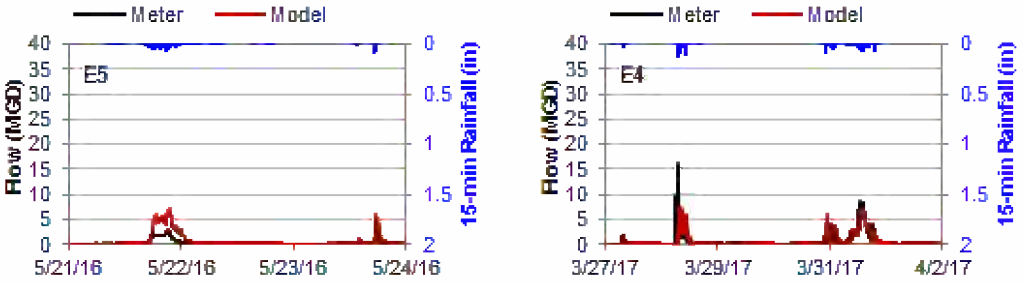
FLOW METER IN-18 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

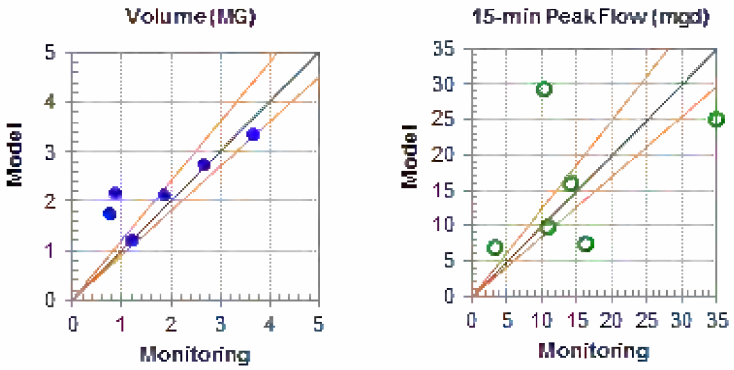
IN-18 Model Calibration Results (Metered and Modeled Flow)



IN-18 Model Validation Results (Metered and Modeled Flow)

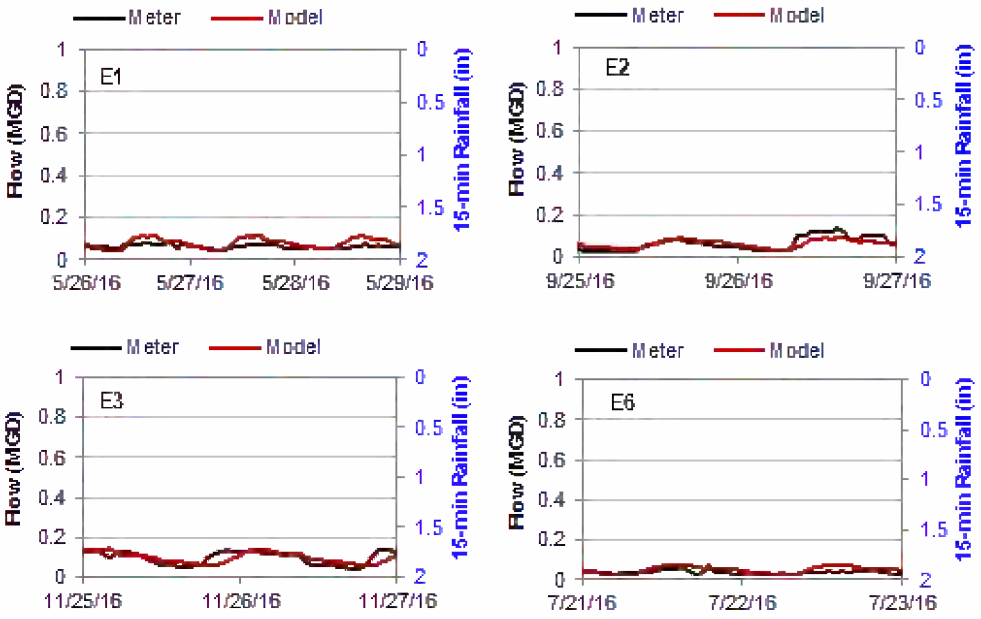


IN-18 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

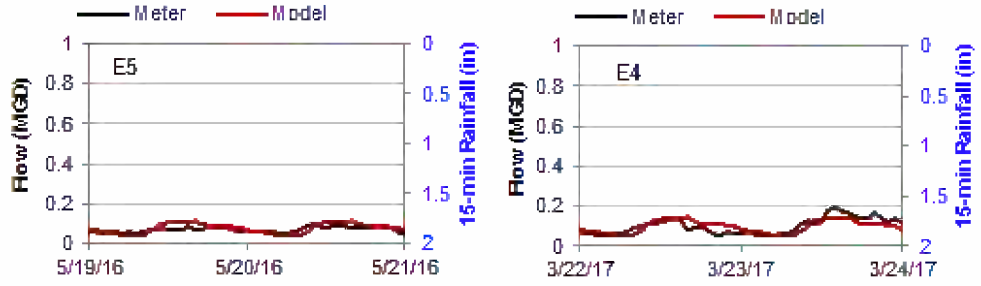


FLOW METER IN-18 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

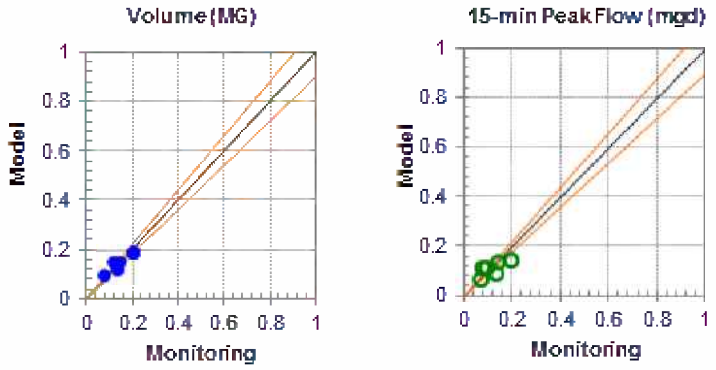
IN-18 Model Calibration Results (Metered and Modeled Flow)



IN-18 Model Validation Results (Metered and Modeled Flow)



IN-18 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



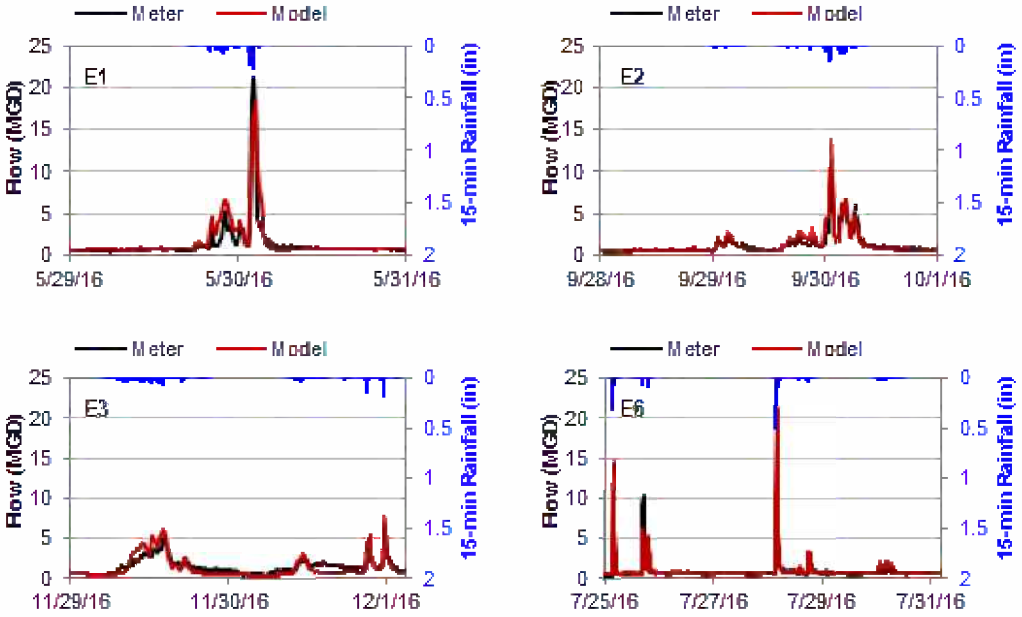
IN-18 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.08	0.11	-10% to +10%	40%	0.12	0.16	-10% to +10%	32%
E2	0.14	0.09	-10% to +10%	-32%	0.13	0.13	-10% to +10%	-5%
E3	0.14	0.14	-10% to +10%	1%	0.20	0.19	-10% to +10%	-1%
E4	0.20	0.14	-10% to +10%	-27%	0.20	0.20	-10% to +10%	-3%
E5	0.09	0.11	-10% to +10%	20%	0.14	0.16	-10% to +10%	9%
E6	0.07	0.07	-10% to +10%	2%	0.08	0.10	-10% to +10%	33%

IN-18 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	10.33	29.33	-15% to +25%	184%	0.83	2.19	-10% to +20%	162%
E2	14.07	16.01	-15% to +25%	14%	2.64	2.78	-10% to +20%	5%
E3	10.70	10.00	-15% to +25%	-7%	1.84	2.14	-10% to +20%	16%
E4	16.28	7.62	-15% to +25%	-53%	3.63	3.39	-10% to +20%	-7%
E5	3.15	6.92	-15% to +25%	119%	0.75	1.78	-10% to +20%	138%
E6	34.92	25.11	-15% to +25%	-28%	1.19	1.22	-10% to +20%	2%

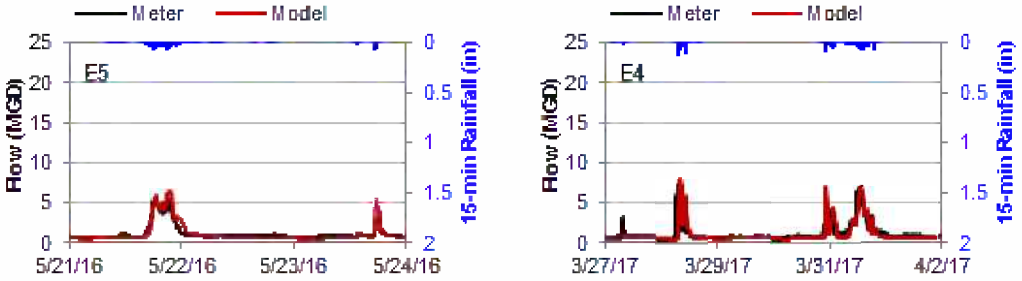
Note: Only two of the six wet weather event volumes are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1, E4, E5, and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-19-1 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

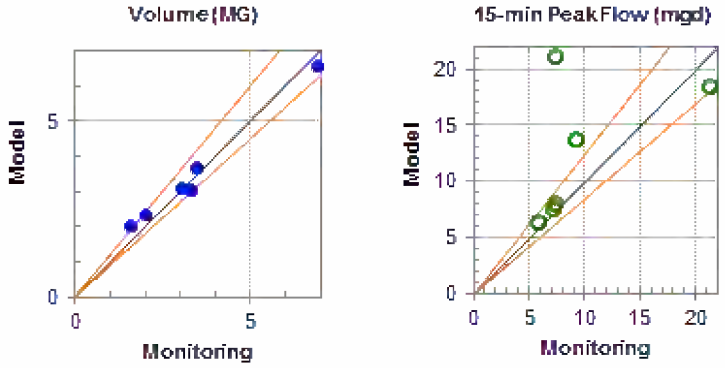
IN-19-1 Model Calibration Results (Metered and Modeled Flow)



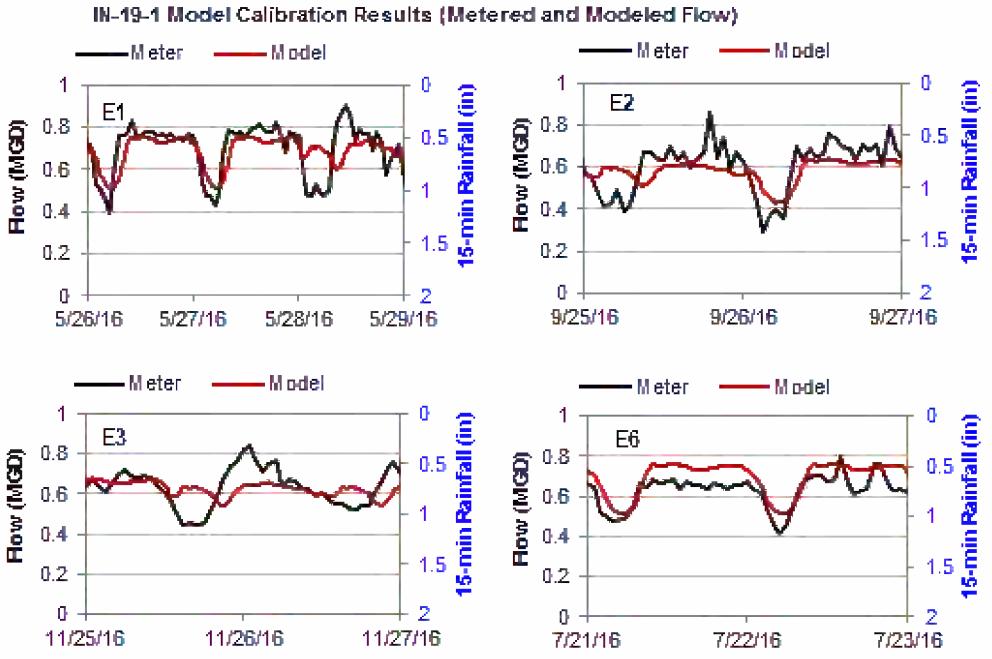
IN-19-1 Model Validation Results (Metered and Modeled Flow)

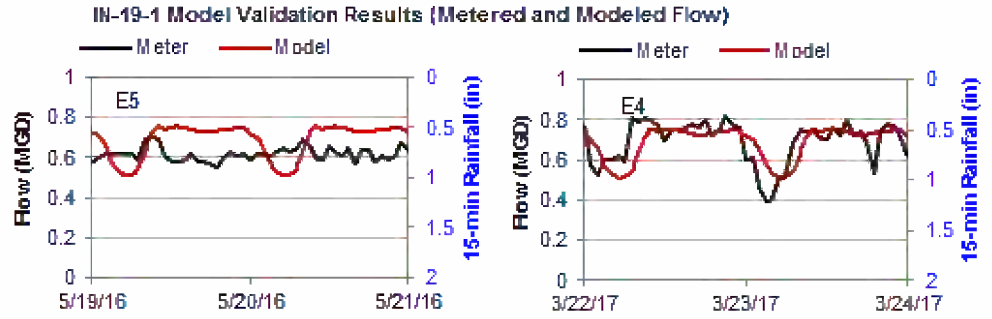


IN-19-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

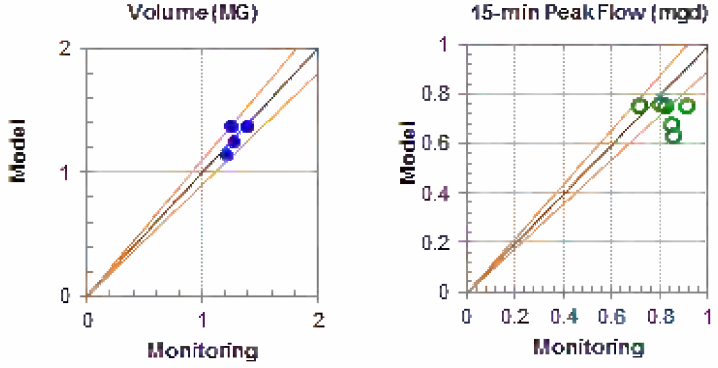


FLOW METER IN-19-1 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





IN-19-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



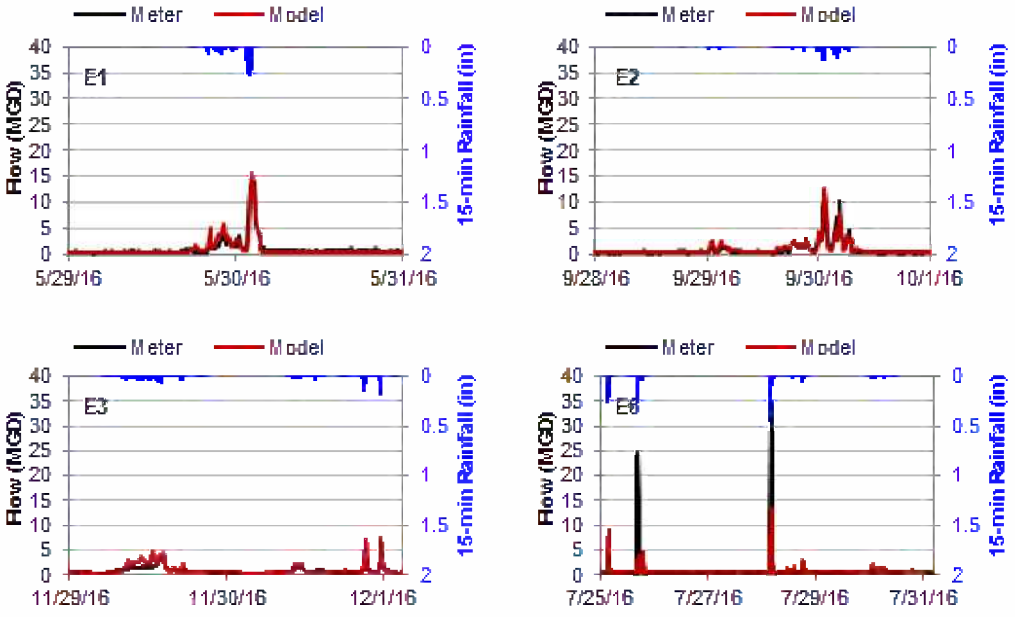
IN-19-1 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.91	0.76	-10% to +10%	-17%	1.38	1.37	-10% to +10%	-1%
E2	0.85	0.64	-10% to +10%	-25%	1.20	1.16	-10% to +10%	-4%
E3	0.84	0.68	-10% to +10%	-20%	1.27	1.25	-10% to +10%	-2%
E4	0.82	0.76	-10% to +10%	-8%	1.38	1.37	-10% to +10%	0%
E5	0.72	0.76	-10% to +10%	6%	1.24	1.38	-10% to +10%	11%
E6	0.79	0.76	-10% to +10%	-4%	1.26	1.39	-10% to +10%	10%

IN-19-1 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	21.30	18.54	-15% to +25%	-13%	2.01	2.36	-10% to +20%	17%
E2	9.15	13.77	-15% to +25%	50%	3.42	3.71	-10% to +20%	9%
E3	7.04	7.66	-15% to +25%	9%	3.28	3.09	-10% to +20%	-6%
E4	7.33	8.01	-15% to +25%	9%	6.87	6.61	-10% to +20%	-4%
E5	5.73	6.40	-15% to +25%	12%	3.00	3.11	-10% to +20%	4%
E6	7.26	21.13	-15% to +25%	191%	1.56	2.04	-10% to +20%	30%

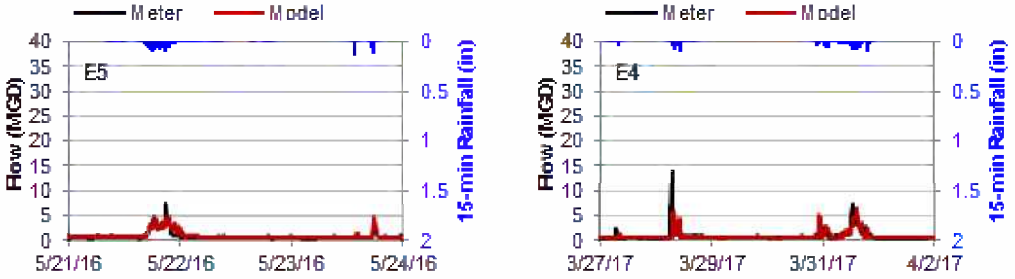
Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E2 and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-19-2 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

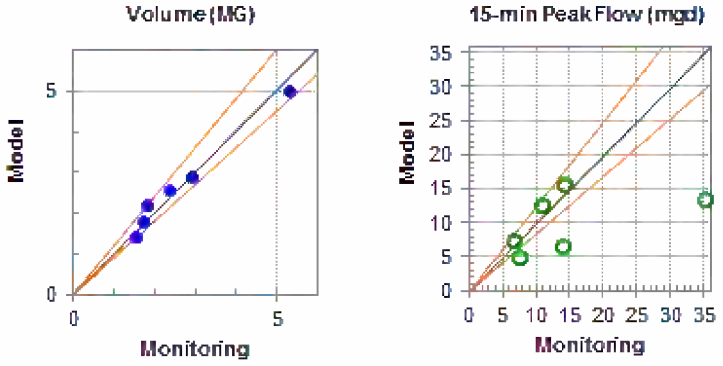
IN-19-2 Model Calibration Results (Metered and Modeled Flow)



IN-19-2 Model Validation Results (Metered and Modeled Flow)

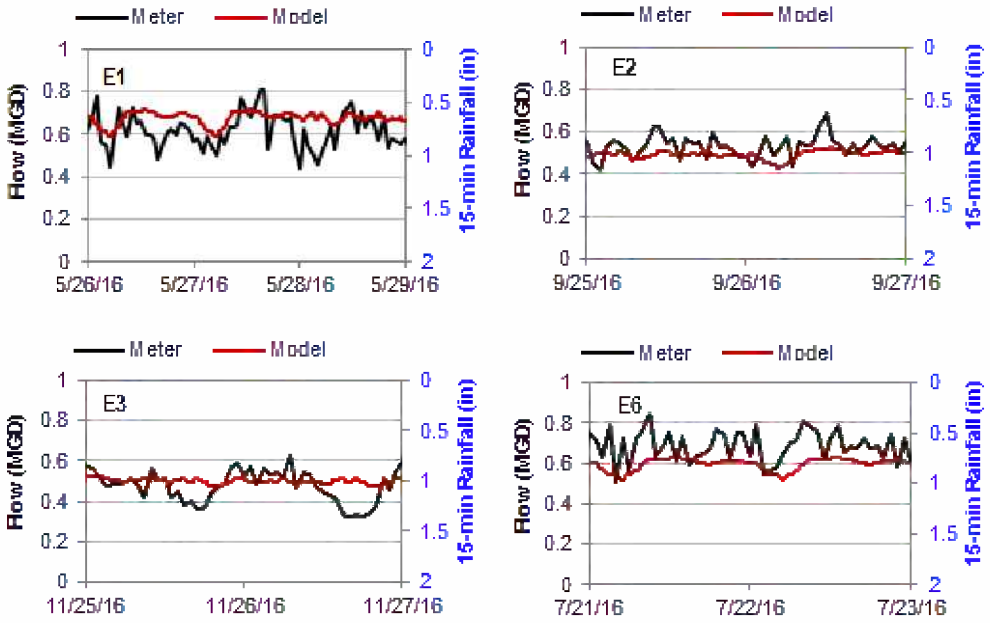


IN-19-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

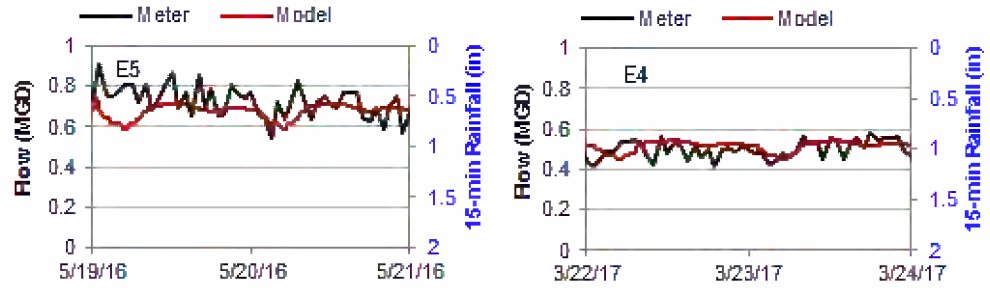


FLOW METER IN-19-2 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

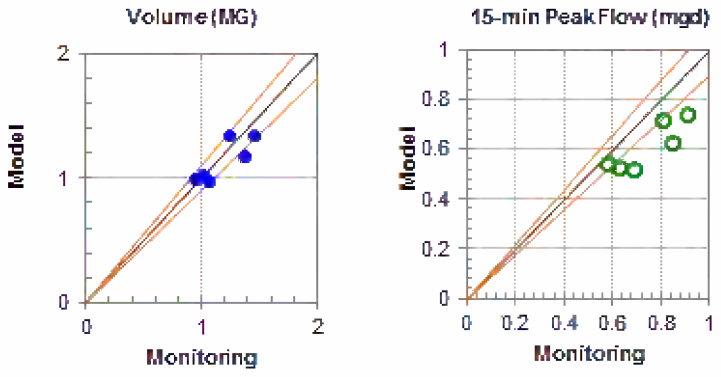
IN-19-2 Model Calibration Results (Metered and Modeled Flow)



IN-19-2 Model Validation Results (Metered and Modeled Flow)



IN-19-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



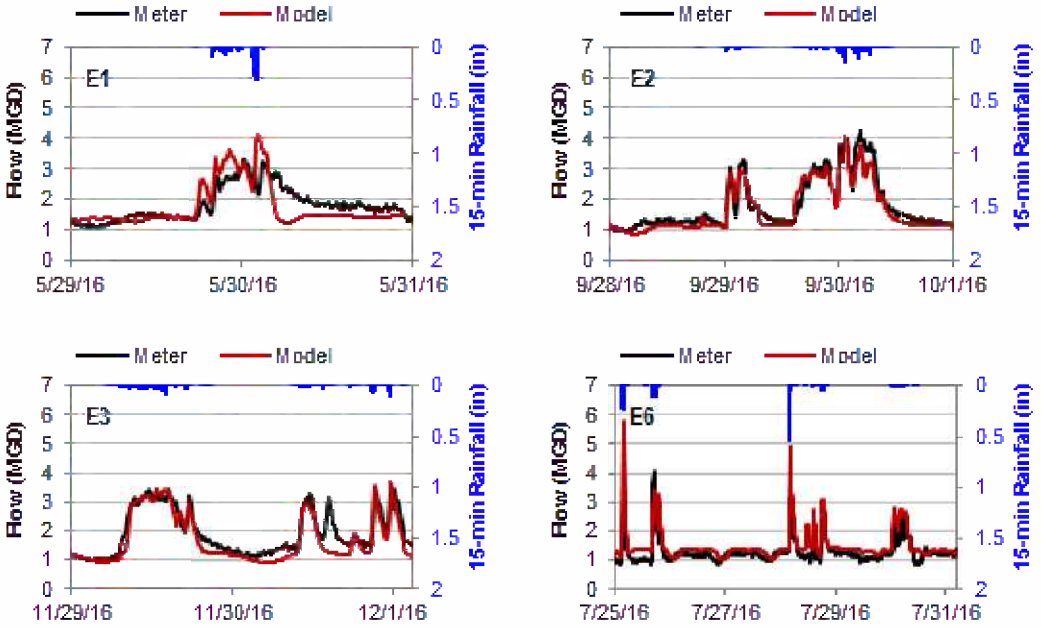
IN-19-2 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.81	0.72	-10% to +10%	-11%	1.24	1.35	-10% to +10%	9%
E2	0.69	0.52	-10% to +10%	-24%	1.06	0.98	-10% to +10%	-7%
E3	0.63	0.53	-10% to +10%	-16%	0.95	1.00	-10% to +10%	5%
E4	0.58	0.54	-10% to +10%	-6%	1.00	1.03	-10% to +10%	3%
E5	0.91	0.74	-10% to +10%	-18%	1.45	1.35	-10% to +10%	-7%
E6	0.85	0.63	-10% to +10%	-25%	1.37	1.19	-10% to +10%	-13%

IN-19-2 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	14.15	15.72	-15% to +25%	11%	1.69	1.80	-10% to +20%	6%
E2	10.79	12.67	-15% to +25%	18%	2.90	2.91	-10% to +20%	0%
E3	6.61	7.58	-15% to +25%	15%	1.80	2.22	-10% to +20%	23%
E4	13.88	6.56	-15% to +25%	-53%	5.29	4.99	-10% to +20%	-6%
E5	7.59	4.90	-15% to +25%	-35%	2.37	2.60	-10% to +20%	10%
E6	35.07	13.51	-15% to +25%	-61%	1.51	1.44	-10% to +20%	-4%

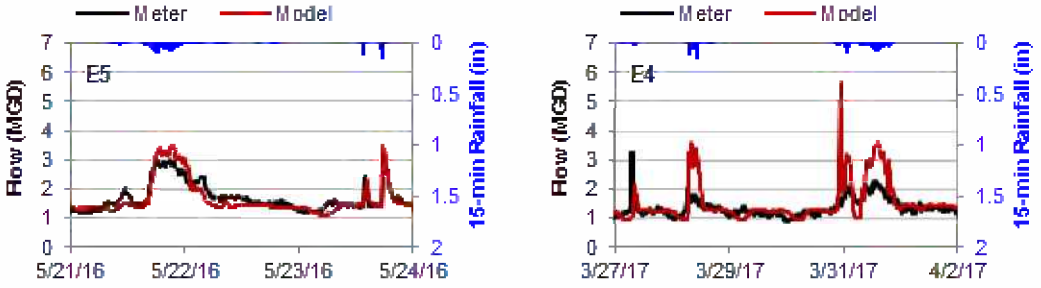
Note: Four of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E4, E5 and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER EFF-19 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

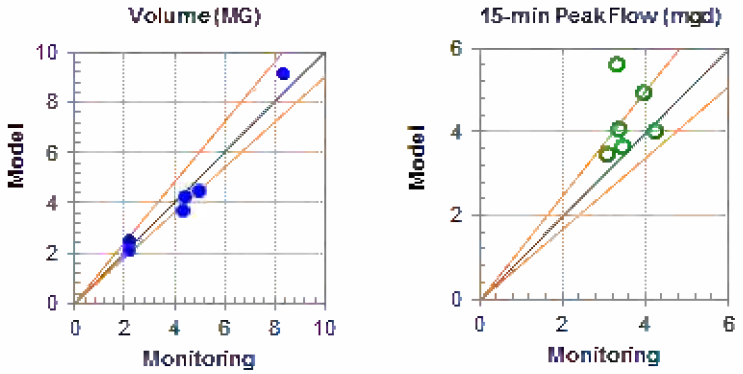
EFF-19 Model Calibration Results (Metered and Modeled Flow)



EFF-19 Model Validation Results (Metered and Modeled Flow)

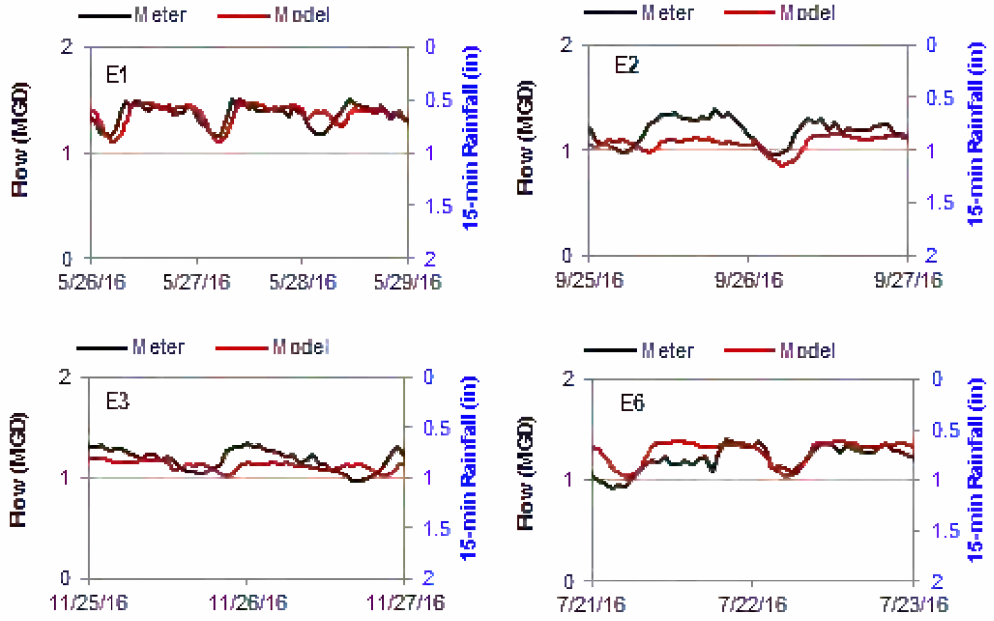


EFF-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

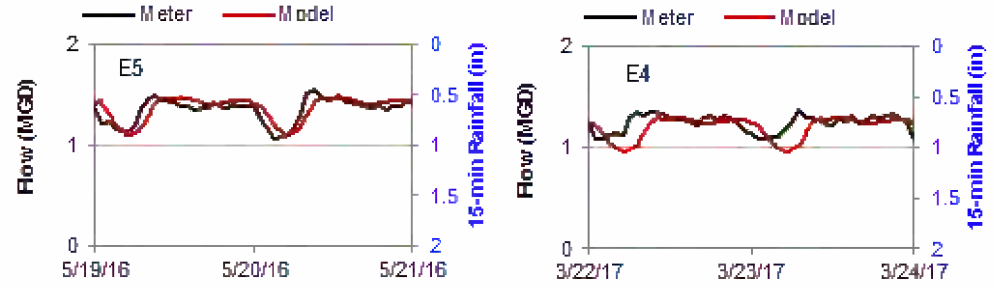


LOW METER EFF-19 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

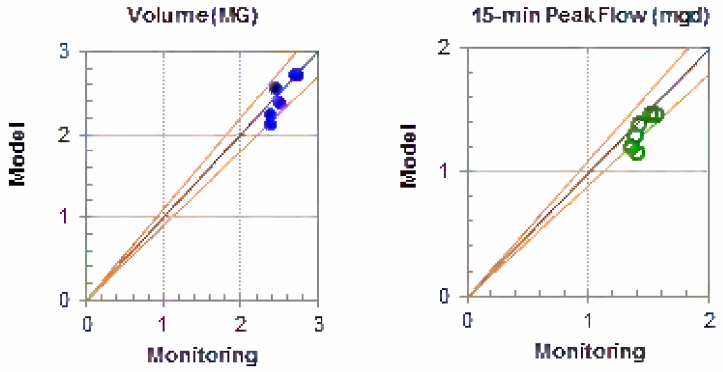
EFF-19 Model Calibration Results (Metered and Modeled Flow)



EFF-19 Model Validation Results (Metered and Modeled Flow)



EFF-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



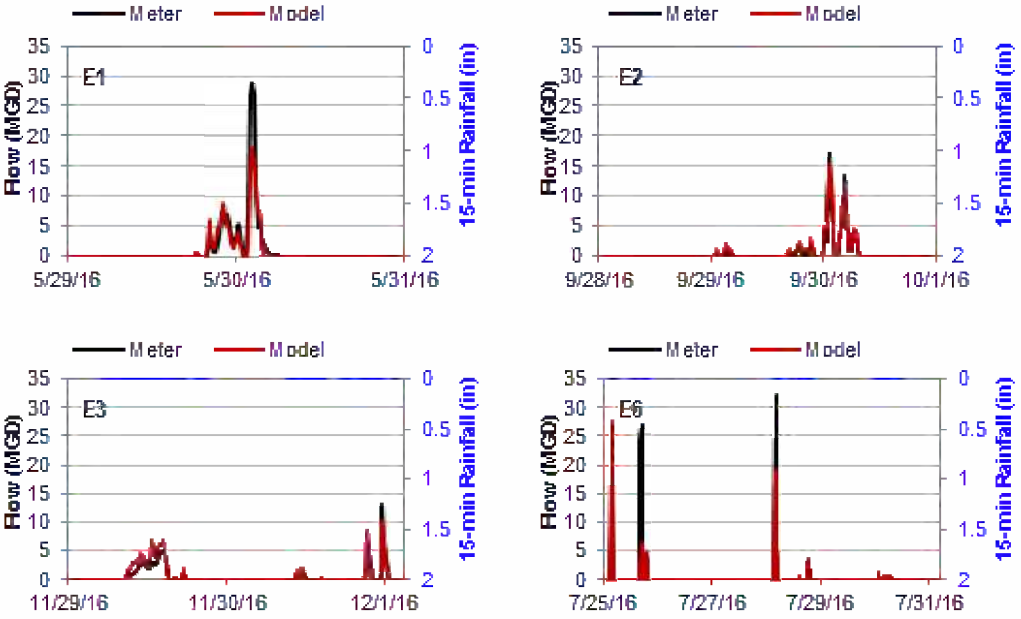
EFF-19 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.51	1.47	-10% to +10%	-2%	2.72	2.73	-10% to +10%	0%
E2	1.40	1.16	-10% to +10%	-17%	2.38	2.14	-10% to +10%	-10%
E3	1.34	1.21	-10% to +10%	-10%	2.37	2.25	-10% to +10%	-5%
E4	1.38	1.30	-10% to +10%	-6%	2.49	2.40	-10% to +10%	-4%
E5	1.55	1.47	-10% to +10%	-5%	2.70	2.73	-10% to +10%	1%
E6	1.41	1.39	-10% to +10%	-1%	2.44	2.58	-10% to +10%	6%

EFF-19 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.33	4.09	-15% to +25%	23%	2.18	2.13	-10% to +20%	-2%
E2	4.22	4.05	-15% to +25%	-4%	4.90	4.55	-10% to +20%	-7%
E3	3.43	3.69	-15% to +25%	8%	4.33	3.79	-10% to +20%	-12%
E4	3.28	5.63	-15% to +25%	72%	8.28	9.18	-10% to +20%	11%
E5	3.05	3.51	-15% to +25%	15%	4.41	4.31	-10% to +20%	-2%
E6	3.93	4.96	-15% to +25%	26%	2.12	2.54	-10% to +20%	20%

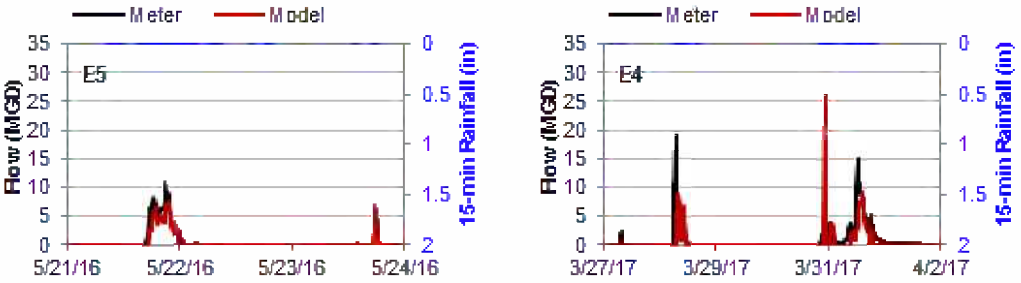
Note: Five of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E4) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CSO-19 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

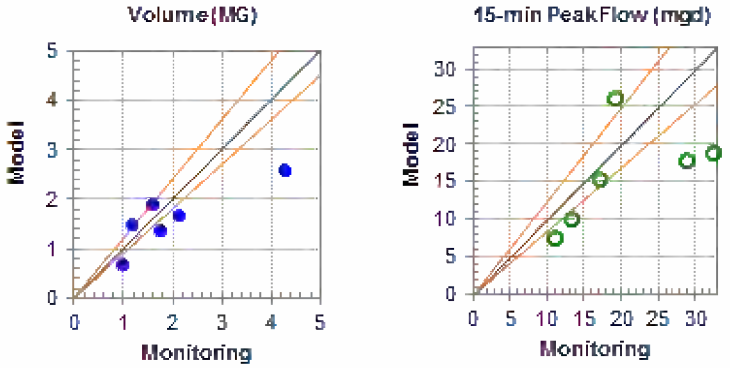
CSO-19 Model Calibration Results (Metered and Modeled Flow)



CSO-19 Model Validation Results (Metered and Modeled Flow)



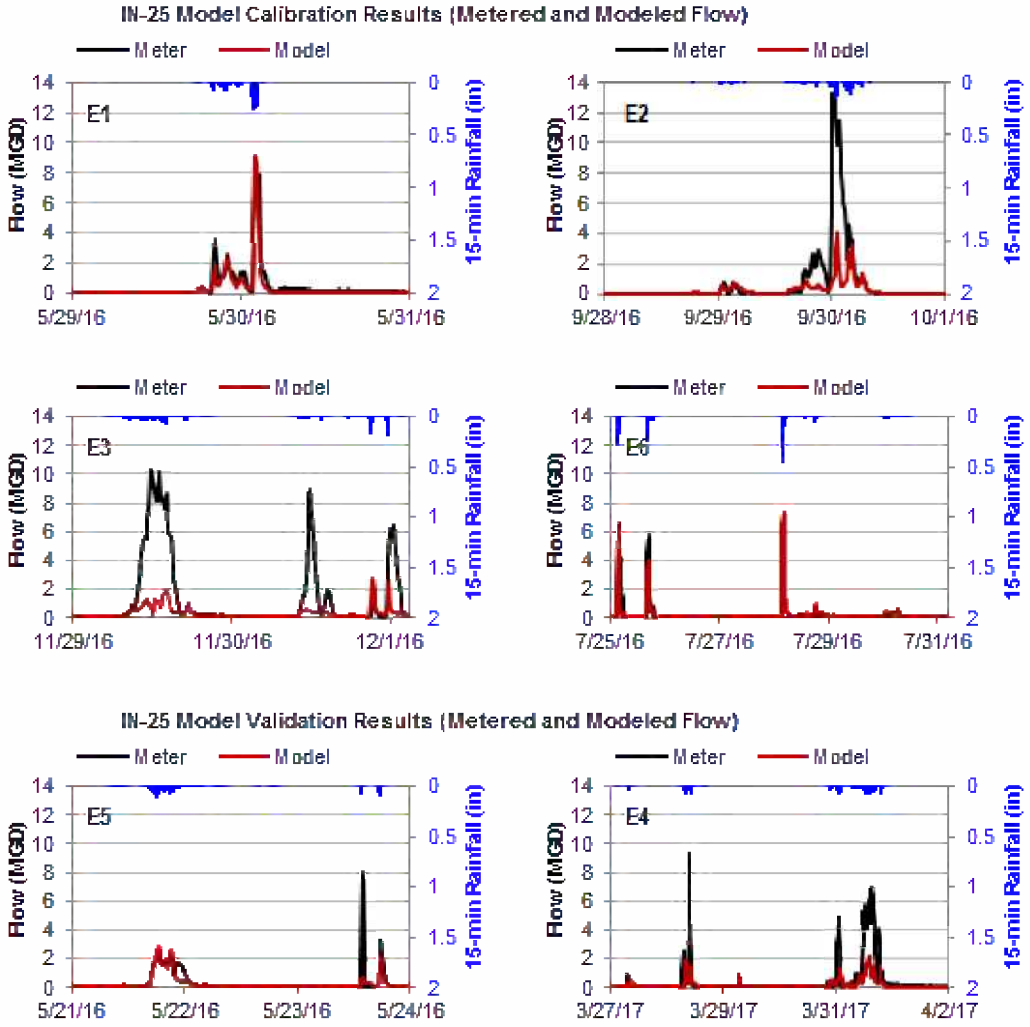
CSO-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



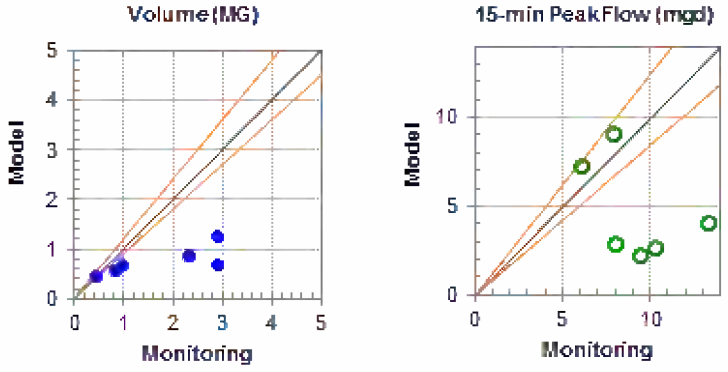
CSO-19 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	28.77	17.93	-15% to +25%	-38%	2.13	1.70	-10% to +20%	-20%
E2	17.03	15.36	-15% to +25%	-10%	1.56	1.91	-10% to +20%	22%
E3	13.23	10.18	-15% to +25%	-23%	1.16	1.51	-10% to +20%	30%
E4	19.16	26.11	-15% to +25%	36%	4.26	2.63	-10% to +20%	-38%
E5	10.84	7.63	-15% to +25%	-30%	1.72	1.40	-10% to +20%	-19%
E6	32.37	19.04	-15% to +25%	-41%	0.98	0.70	-10% to +20%	-28%

Note: Three of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E1 and E6) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall Regulator 19 flow meters, the model calibration is adequate for purposes of long term control planning.

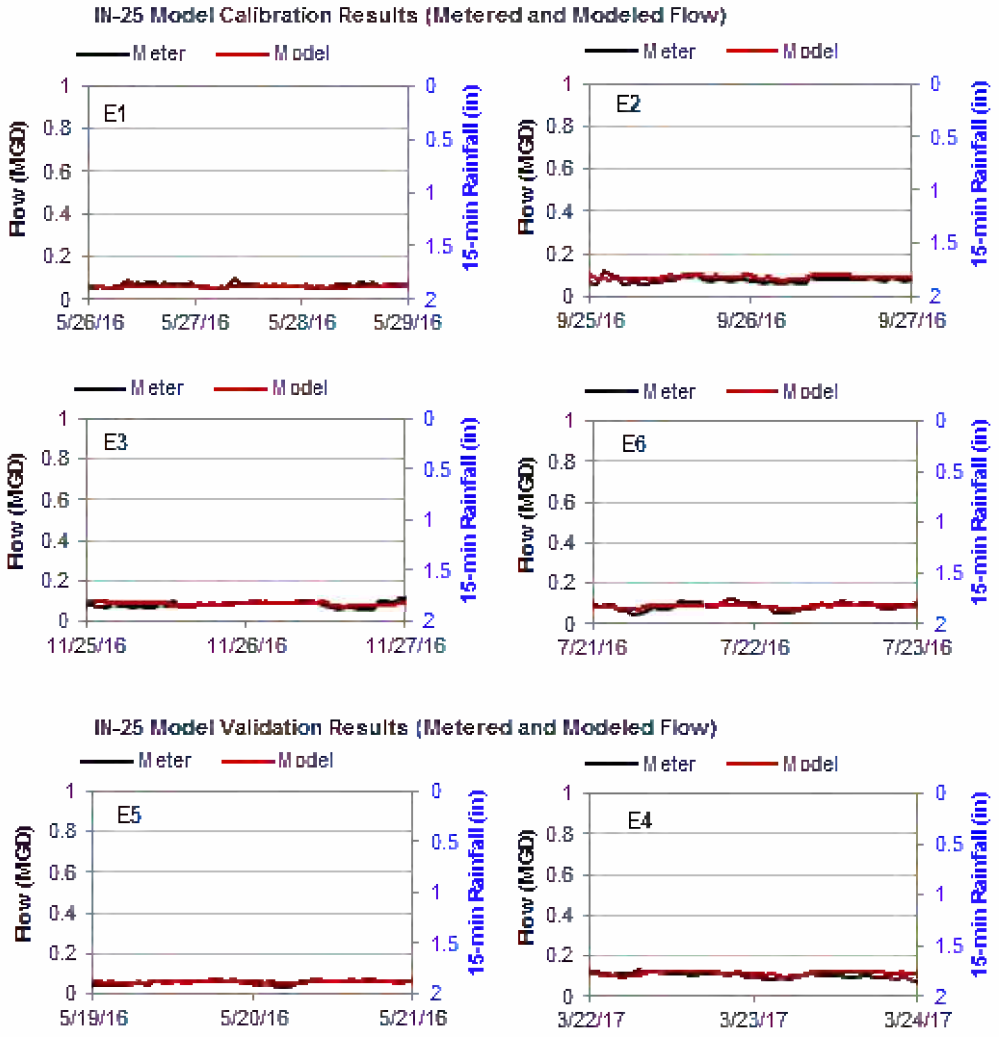
FLOW METER IN-25 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

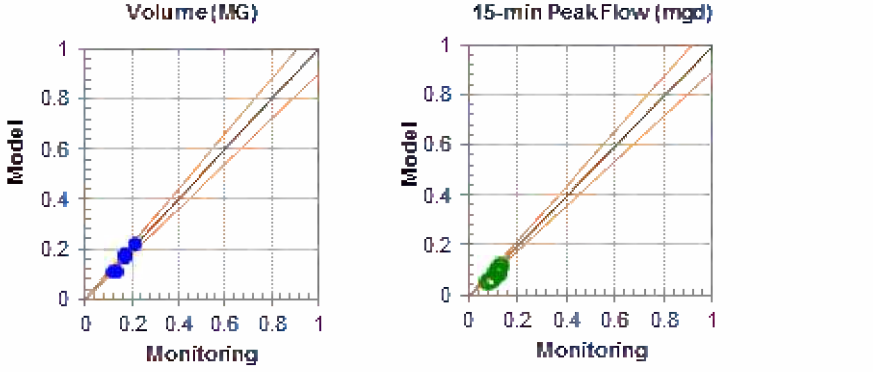


IN-25 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-25 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





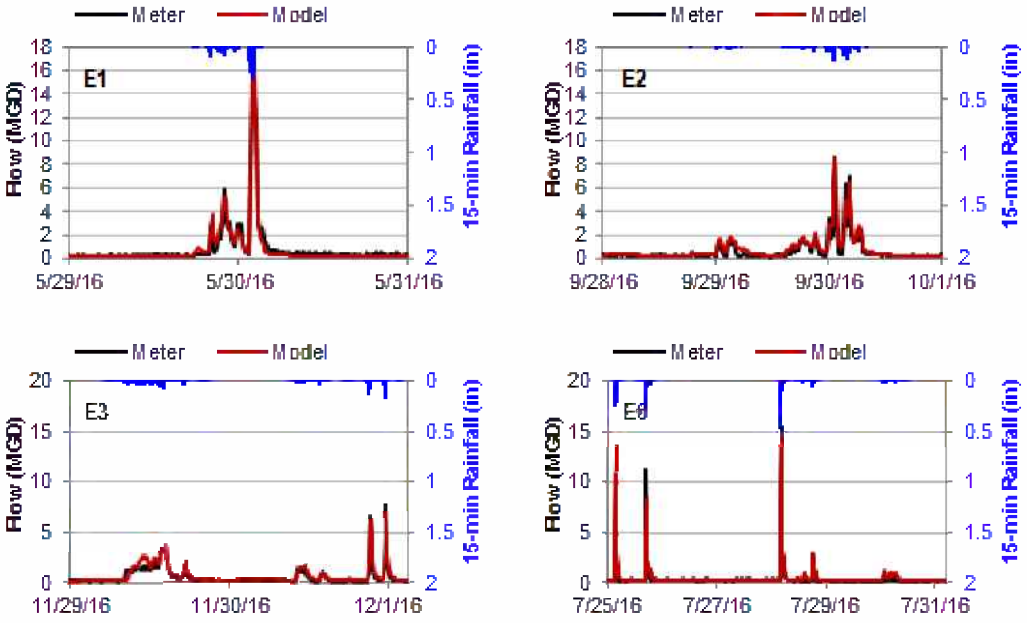
IN-25 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.09	0.07	-10% to +10%	-27%	0.13	0.12	-10% to +10%	-10%
E2	0.12	0.11	-10% to +10%	-9%	0.16	0.19	-10% to +10%	15%
E3	0.11	0.10	-10% to +10%	-9%	0.17	0.17	-10% to +10%	4%
E4	0.13	0.12	-10% to +10%	-3%	0.21	0.22	-10% to +10%	9%
E5	0.07	0.06	-10% to +10%	-14%	0.11	0.12	-10% to +10%	4%
E6	0.12	0.09	-10% to +10%	-19%	0.17	0.17	-10% to +10%	2%

IN-25 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	7.88	9.09	-15% to +25%	15%	0.82	0.60	-10% to +20%	-28%
E2	13.30	4.04	-15% to +25%	-70%	2.30	0.91	-10% to +20%	-61%
E3	10.24	2.68	-15% to +25%	-74%	2.89	0.71	-10% to +20%	-75%
E4	9.39	2.21	-15% to +25%	-76%	2.90	1.29	-10% to +20%	-56%
E5	8.02	2.87	-15% to +25%	-64%	0.97	0.72	-10% to +20%	-26%
E6	6.04	7.32	-15% to +25%	21%	0.42	0.47	-10% to +20%	12%

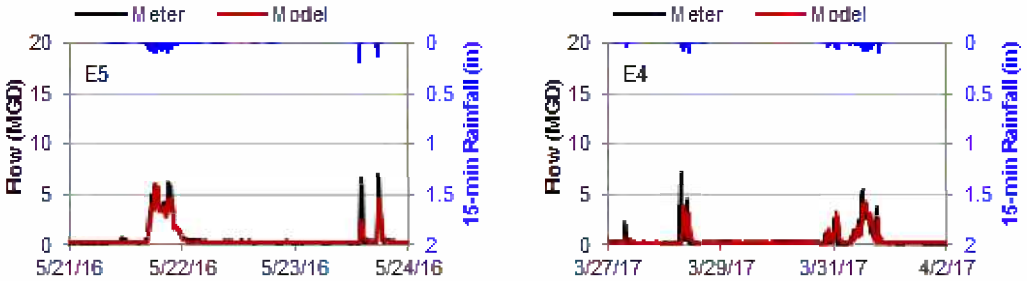
Note: Only two of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E2, E3, E4, and E5) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER IN-26 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

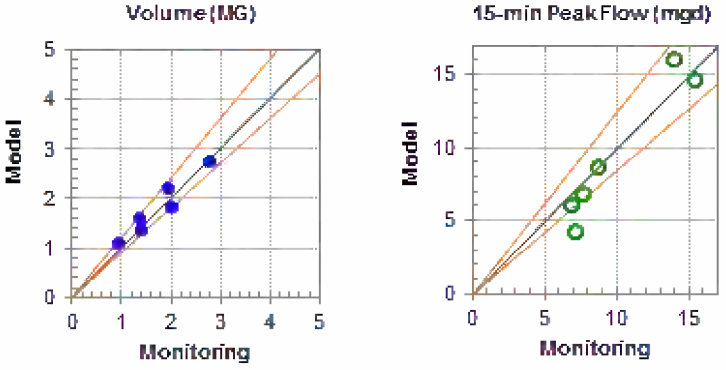
IN-26 Model Calibration Results (Metered and Modeled Flow)



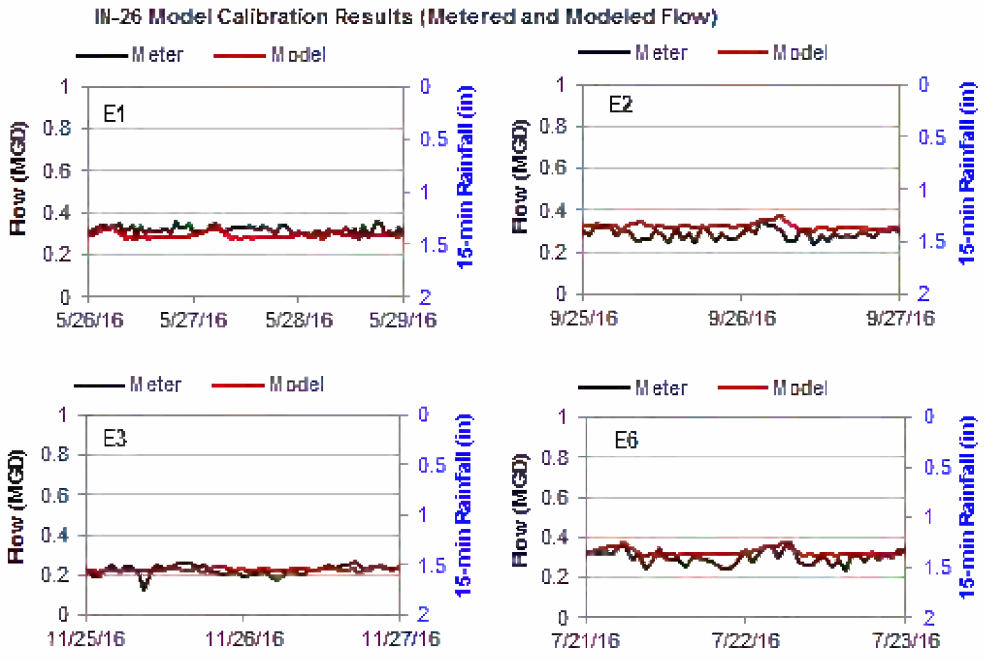
IN-26 Model Validation Results (Metered and Modeled Flow)

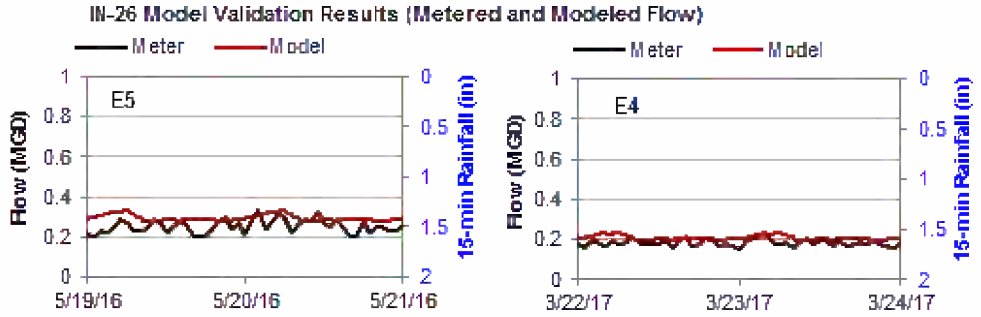


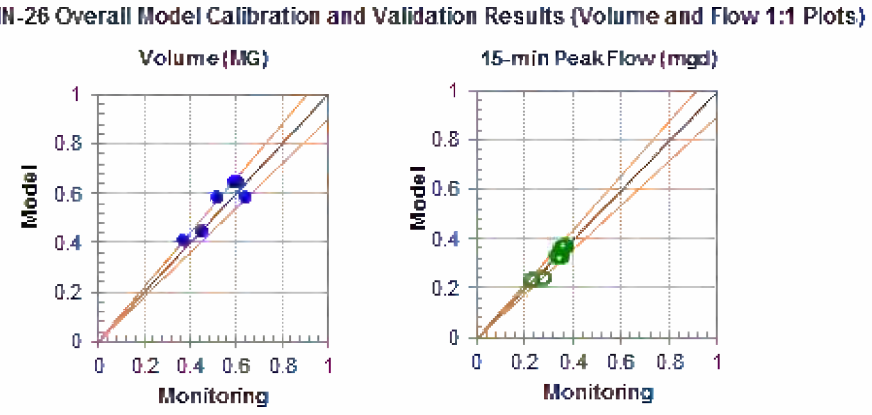
IN-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER IN-26 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







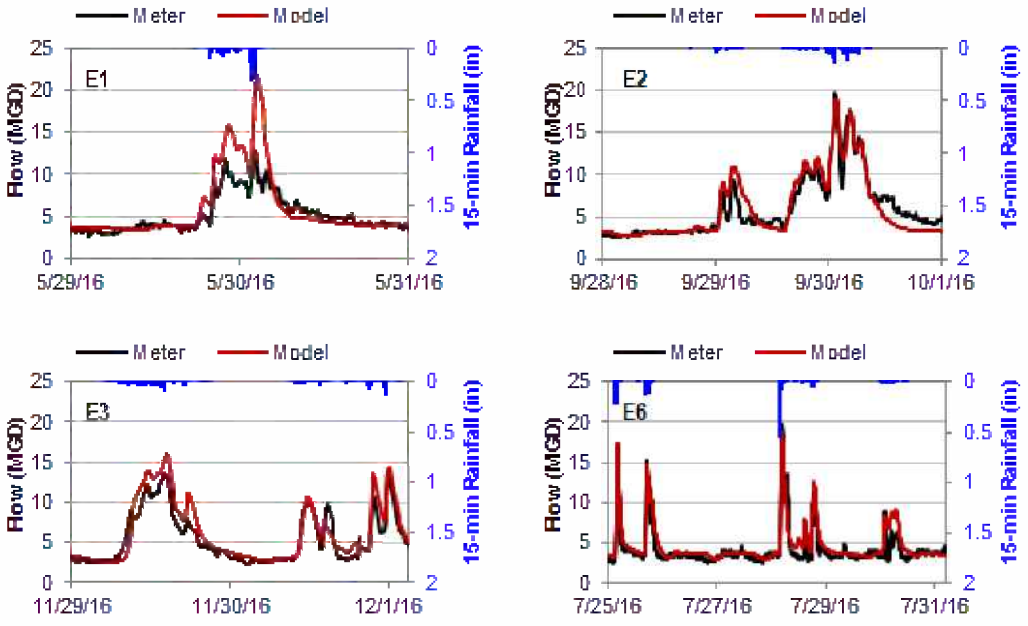
IN-26 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.35	0.34	-10% to +10%	-5%	0.64	0.59	-10% to +10%	-7%
E2	0.35	0.37	-10% to +10%	4%	0.58	0.65	-10% to +10%	12%
E3	0.27	0.24	-10% to +10%	-11%	0.45	0.45	-10% to +10%	1%
E4	0.23	0.24	-10% to +10%	4%	0.37	0.42	-10% to +10%	13%
E5	0.34	0.34	-10% to +10%	0%	0.51	0.59	-10% to +10%	16%
E6	0.37	0.37	-10% to +10%	1%	0.60	0.65	-10% to +10%	8%

IN-26 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	13.97	16.12	-15% to +25%	15%	1.40	1.38	-10% to +20%	-1%
E2	8.60	8.69	-15% to +25%	1%	1.92	2.24	-10% to +20%	17%
E3	7.66	6.92	-15% to +25%	-10%	1.35	1.61	-10% to +20%	19%
E4	7.06	4.37	-15% to +25%	-38%	2.78	2.78	-10% to +20%	0%
E5	6.84	6.07	-15% to +25%	-11%	2.01	1.83	-10% to +20%	-9%
E6	15.36	14.64	-15% to +25%	-5%	0.92	1.14	-10% to +20%	24%

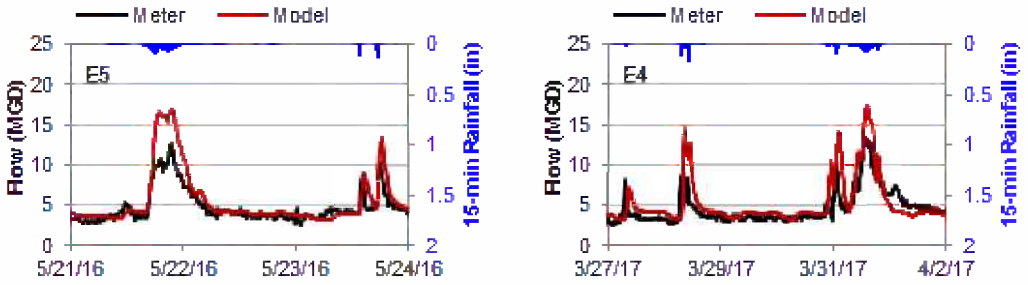
Note: All the six wet weather events are calibrated well within the industry criteria except flow peak for E4 because flow meter data recorded for E4 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER INT-2ND ST MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

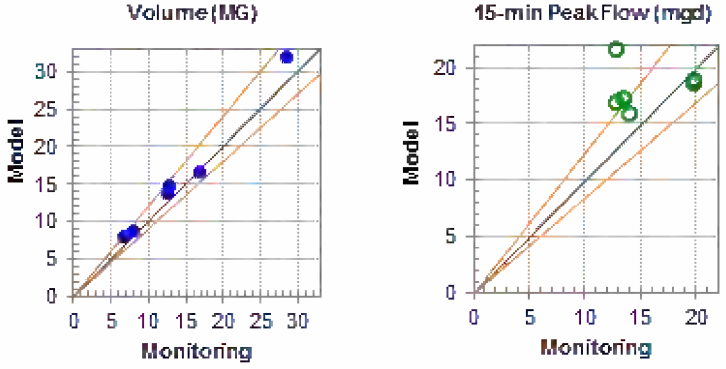
INT-2nd St Model Calibration Results (Metered and Modeled Flow)



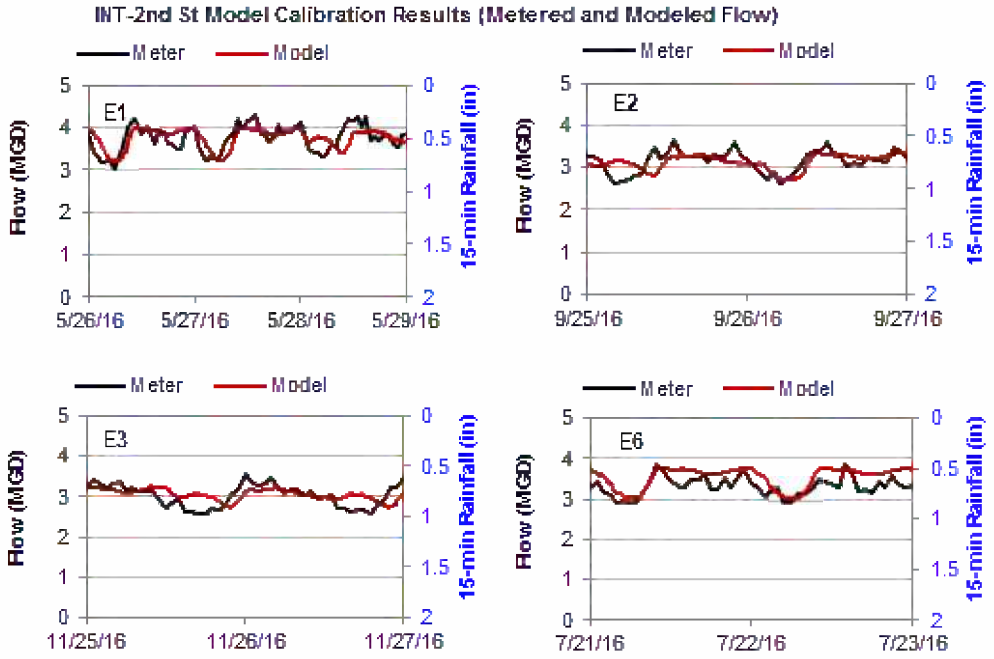
INT-2nd St Model Validation Results (Metered and Modeled Flow)

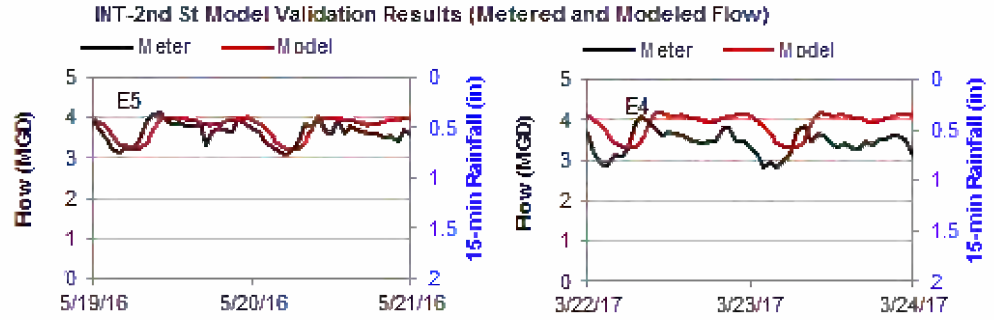


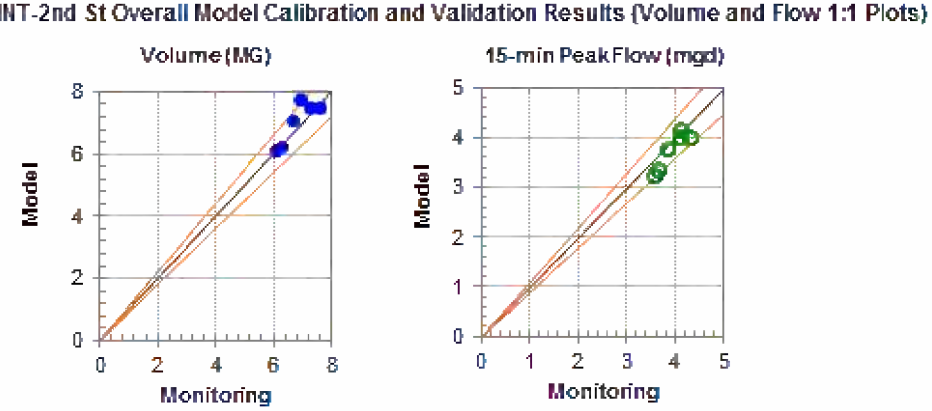
INT-2nd St Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER INT-2ND ST MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







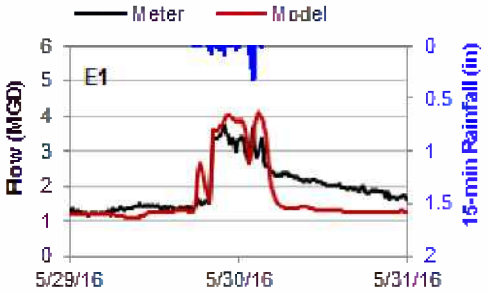
INT-2nd St Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	4.32	4.01	-10% to +10%	-7%	7.58	7.51	-10% to +10%	-1%
E2	3.64	3.35	-10% to +10%	-8%	6.29	6.25	-10% to +10%	-1%
E3	3.56	3.26	-10% to +10%	-8%	6.05	6.10	-10% to +10%	1%
E4	4.11	4.18	-10% to +10%	2%	6.89	7.79	-10% to +10%	13%
E5	4.10	4.01	-10% to +10%	-2%	7.26	7.52	-10% to +10%	4%
E6	3.85	3.78	-10% to +10%	-2%	6.65	7.08	-10% to +10%	7%

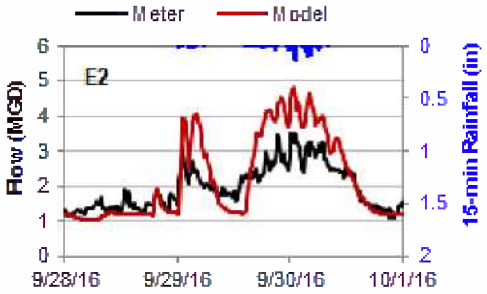
INT-2nd St Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	12.71	21.71	-15% to +25%	71%	6.63	8.13	-10% to +20%	23%
E2	19.69	19.00	-15% to +25%	-3%	16.80	16.79	-10% to +20%	0%
E3	13.92	16.04	-15% to +25%	15%	12.44	13.88	-10% to +20%	12%
E4	13.36	17.30	-15% to +25%	30%	28.36	32.16	-10% to +20%	13%
E5	12.76	16.98	-15% to +25%	33%	12.74	15.01	-10% to +20%	18%
E6	19.67	18.72	-15% to +25%	-5%	7.79	8.80	-10% to +20%	13%

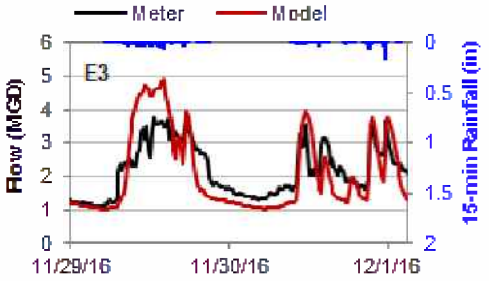
Note: Four of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some events (E1, E4, E5) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

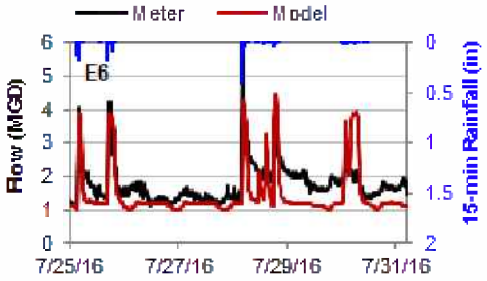
FLOW METER INT-DRI MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

INT-DRI Model Calibration Results (Metered and Modeled Flow)

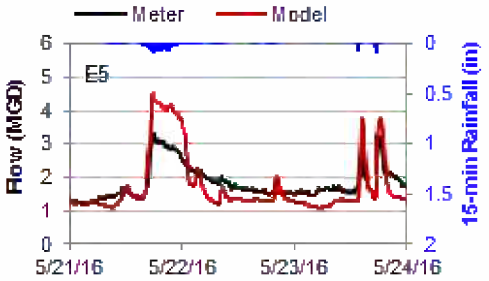


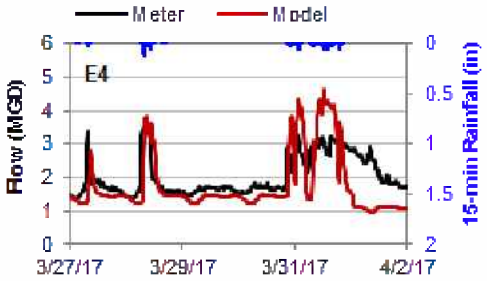




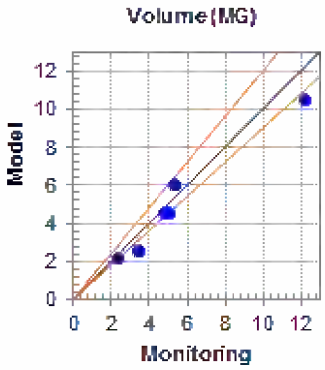


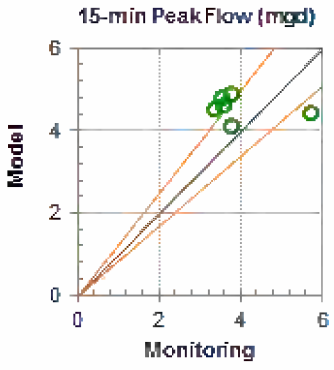
INT-DRI Model Validation Results (Metered and Modeled Flow)



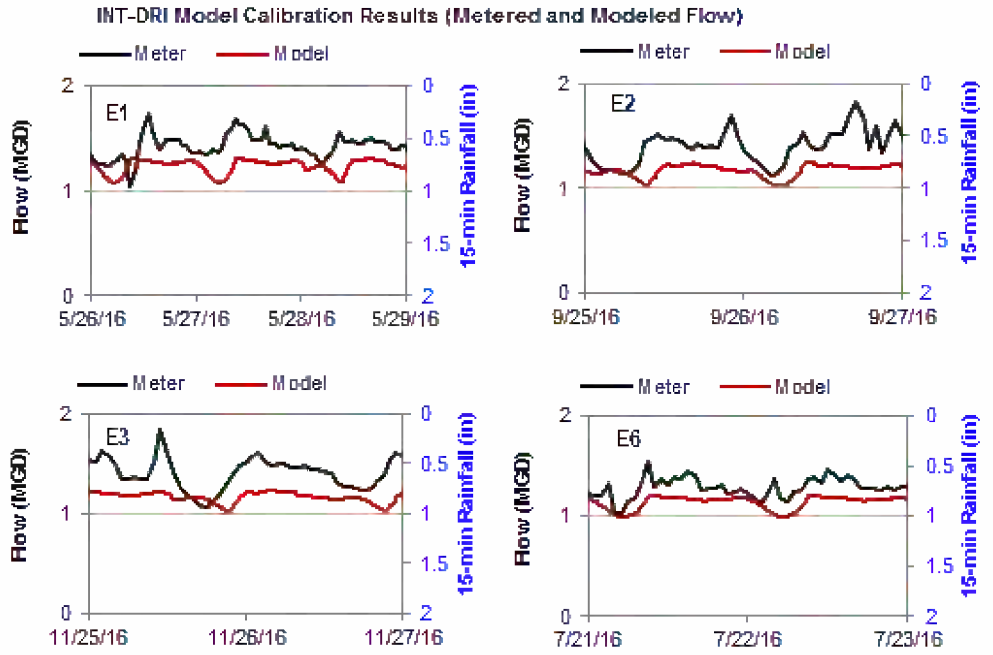


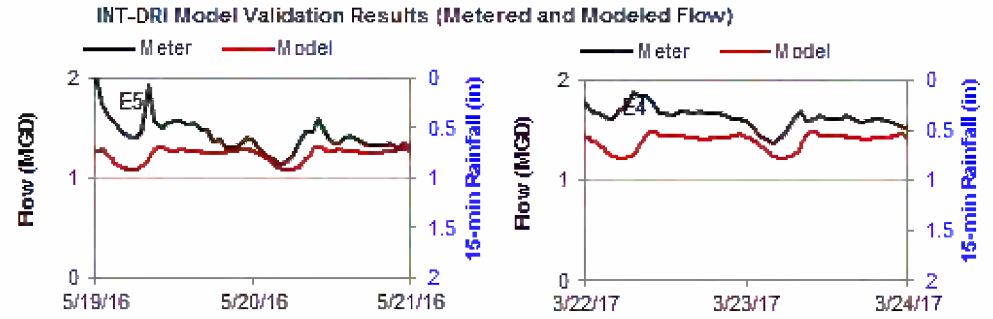
INT-DRI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

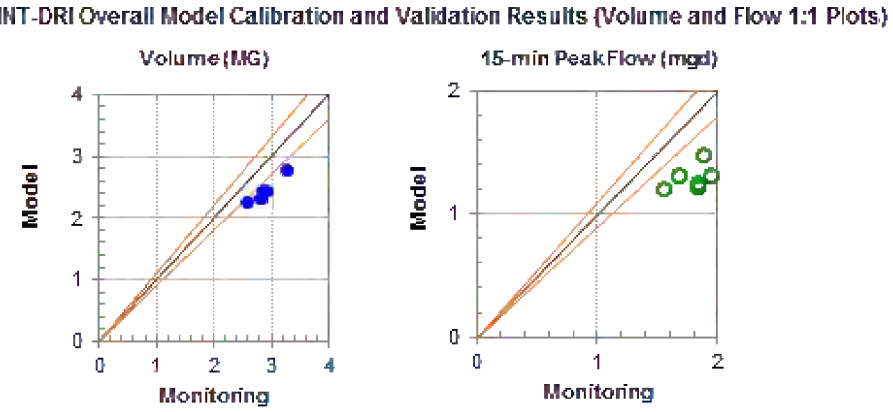




FLOW METER INT-DRI MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





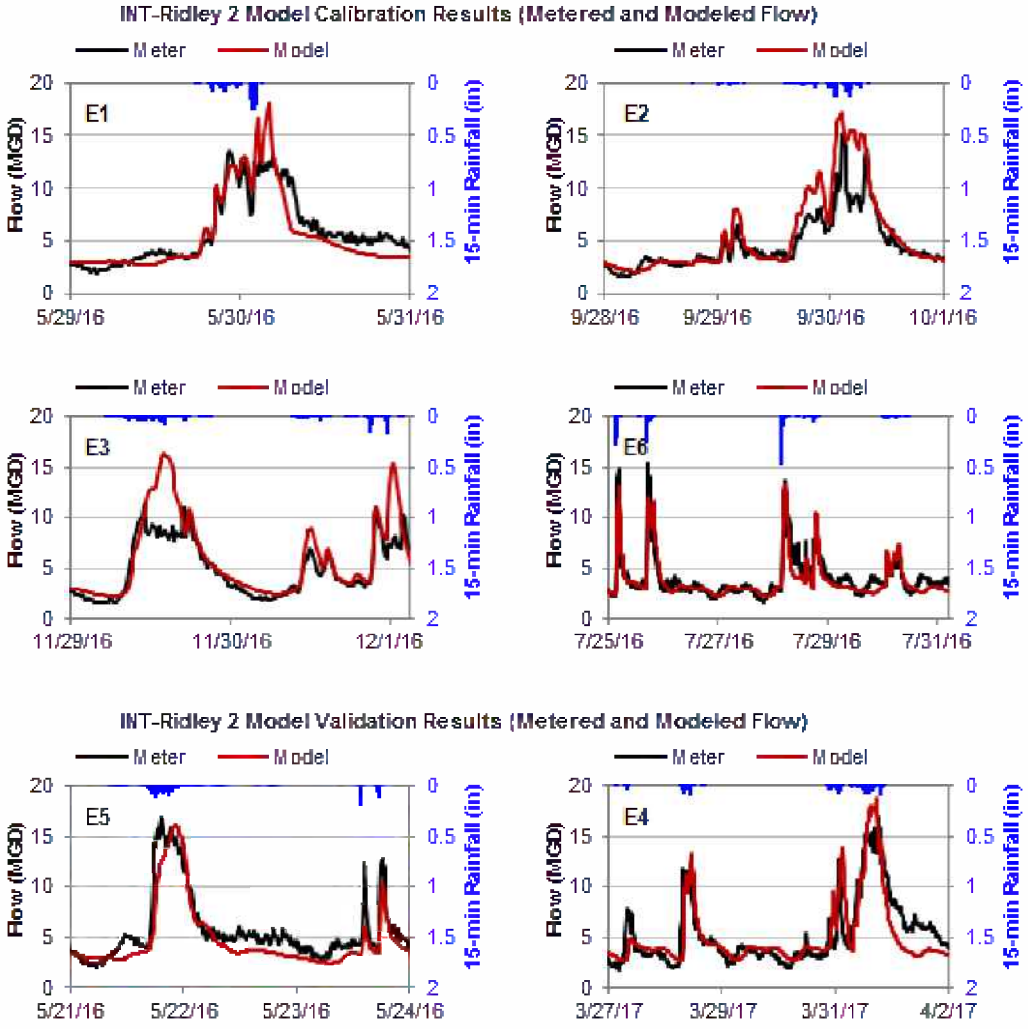


INT-DRI Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.68	1.31	-10% to +10%	-22%	2.90	2.47	-10% to +10%	-15%
E2	1.83	1.25	-10% to +10%	-32%	2.80	2.34	-10% to +10%	-17%
E3	1.83	1.23	-10% to +10%	-33%	2.81	2.33	-10% to +10%	-17%
E4	1.88	1.49	-10% to +10%	-21%	3.26	2.78	-10% to +10%	-15%
E5	1.94	1.31	-10% to +10%	-32%	2.84	2.47	-10% to +10%	-13%
E6	1.55	1.21	-10% to +10%	-22%	2.57	2.27	-10% to +10%	-12%

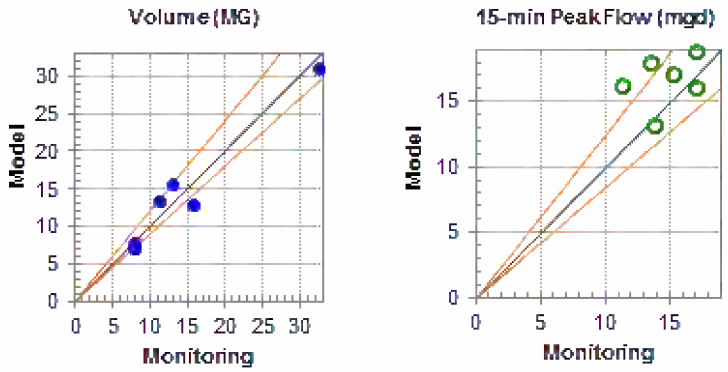
INT-DRI Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.75	4.13	-15% to +25%	10%	2.35	2.26	-10% to +20%	-4%
E2	3.51	4.79	-15% to +25%	37%	5.27	6.10	-10% to +20%	16%
E3	3.76	4.92	-15% to +25%	31%	5.00	4.63	-10% to +20%	-7%
E4	3.57	4.62	-15% to +25%	30%	12.18	10.51	-10% to +20%	-14%
E5	3.32	4.53	-15% to +25%	36%	4.78	4.62	-10% to +20%	-3%
E6	5.70	4.45	-15% to +25%	-22%	3.40	2.64	-10% to +20%	-22%

Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E2, E3, E4, and E5) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER INT-RIDLEY 2 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

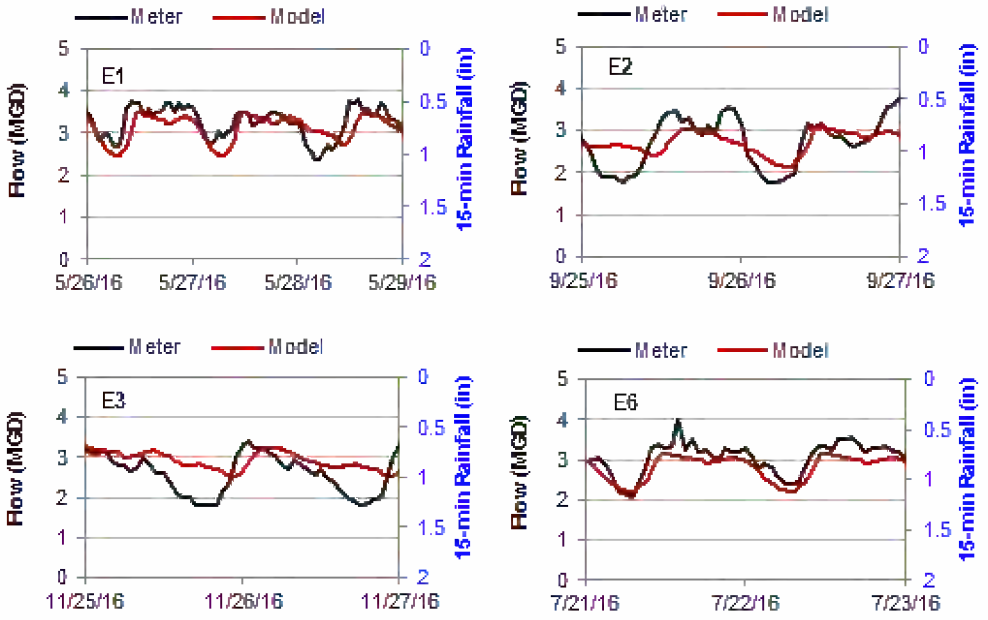


INT-Ridley 2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

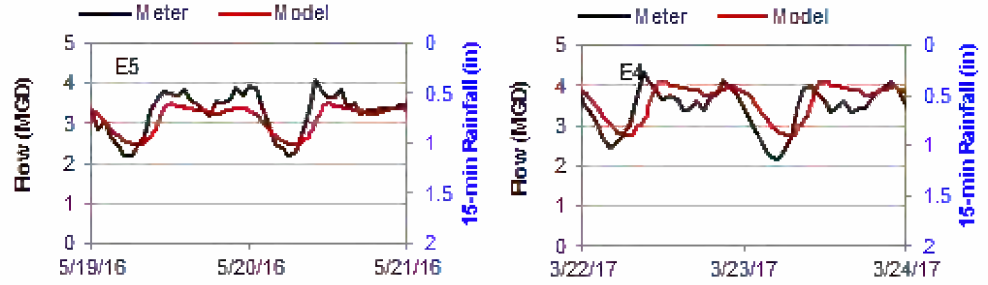


FLOW METER INT-RIDLEY 2 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

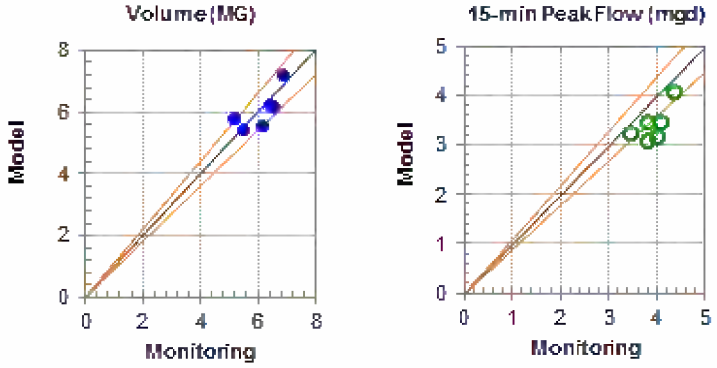
INT-Ridley 2 Model Calibration Results (Metered and Modeled Flow)



INT-Ridley 2 Model Validation Results (Metered and Modeled Flow)



INT-Ridley 2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



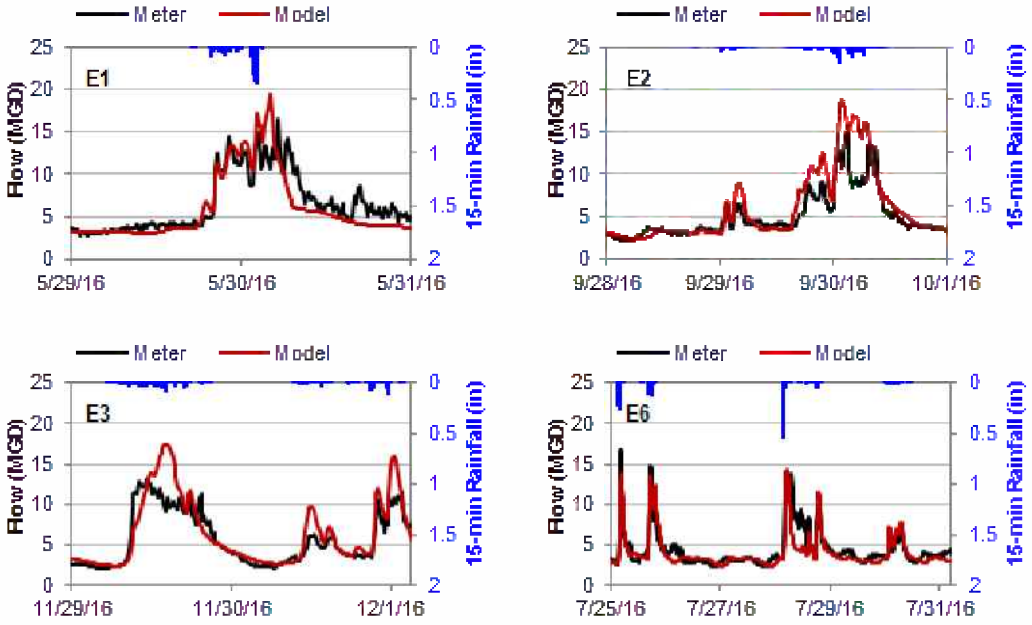
INT-Ridley 2 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.81	3.49	-10% to +10%	-8%	6.38	6.23	-10% to +10%	-2%
E2	3.78	3.08	-10% to +10%	-18%	5.45	5.43	-10% to +10%	0%
E3	3.43	3.26	-10% to +10%	-5%	5.15	5.82	-10% to +10%	13%
E4	4.32	4.10	-10% to +10%	-5%	6.84	7.20	-10% to +10%	5%
E5	4.07	3.49	-10% to +10%	-14%	6.54	6.20	-10% to +10%	-5%
E6	4.00	3.16	-10% to +10%	-21%	6.12	5.60	-10% to +10%	-8%

INT-Ridley 2 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	13.52	17.98	-15% to +25%	33%	7.96	7.95	-10% to +20%	0%
E2	15.19	17.15	-15% to +25%	13%	13.05	15.68	-10% to +20%	20%
E3	11.34	16.32	-15% to +25%	44%	11.24	13.57	-10% to +20%	21%
E4	17.00	18.81	-15% to +25%	11%	32.32	31.09	-10% to +20%	-4%
E5	17.00	16.14	-15% to +25%	-5%	15.68	12.99	-10% to +20%	-17%
E6	13.72	13.29	-15% to +25%	-3%	7.98	7.27	-10% to +20%	-9%

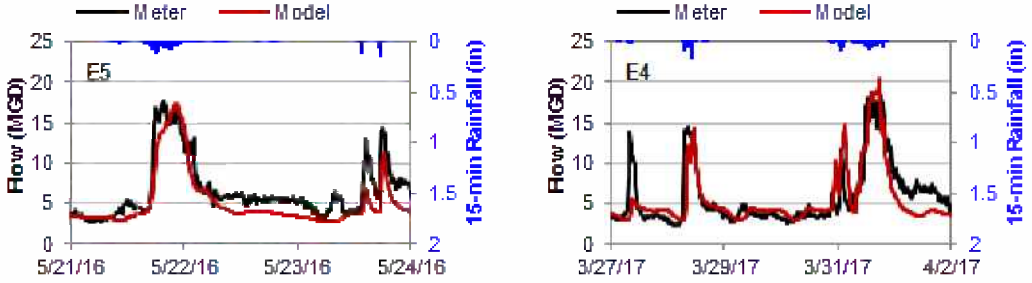
Note: Four of the six wet weather events are calibrated well within or close to the industry criteria. Flow meter data recorded for some of the events (E1 and E3) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER INT-RIDLEY 3 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

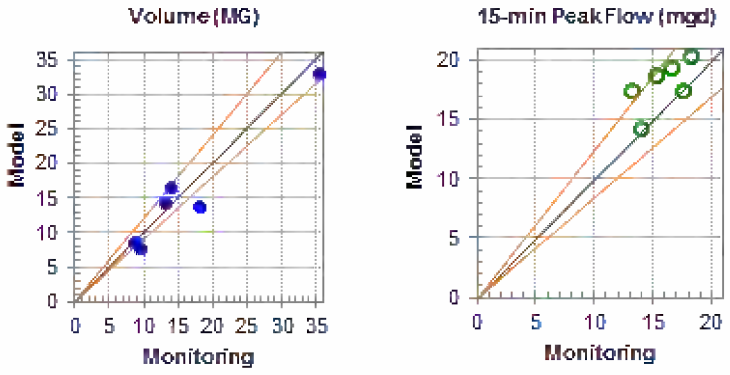
INT-Ridley 3 Model Calibration Results (Metered and Modeled Flow)



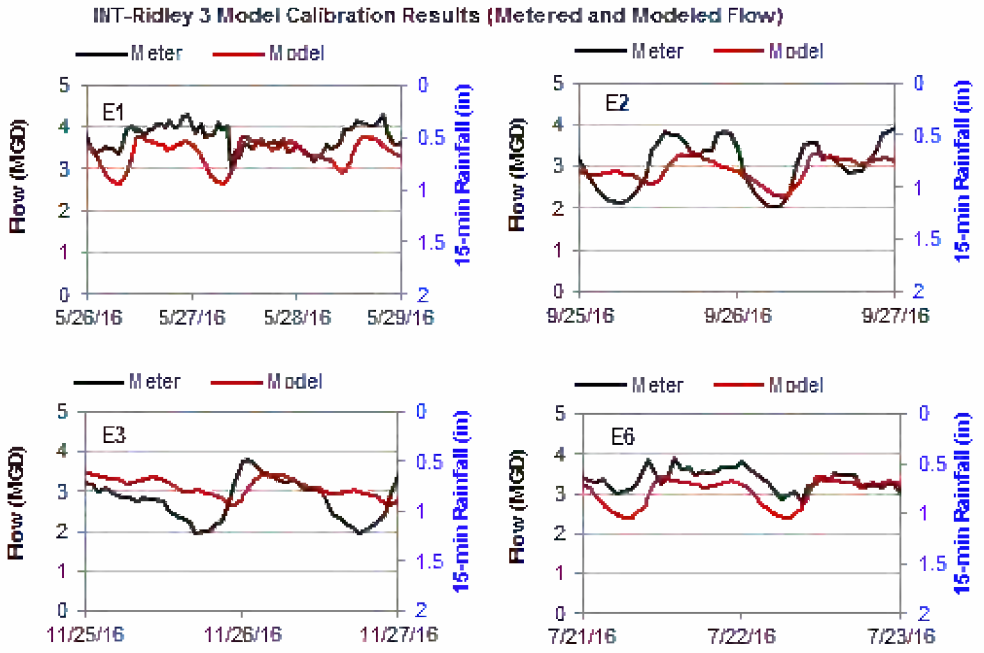
INT-Ridley 3 Model Validation Results (Metered and Modeled Flow)

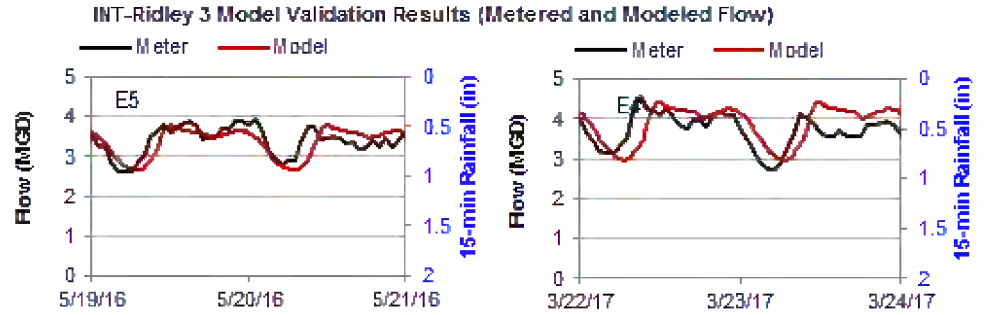


INT-Ridley 3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

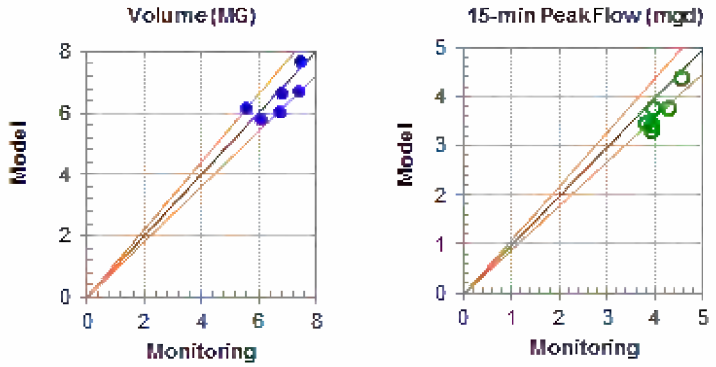


FLOW METER INT-RIDLEY 3 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events





INT-Ridley 3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



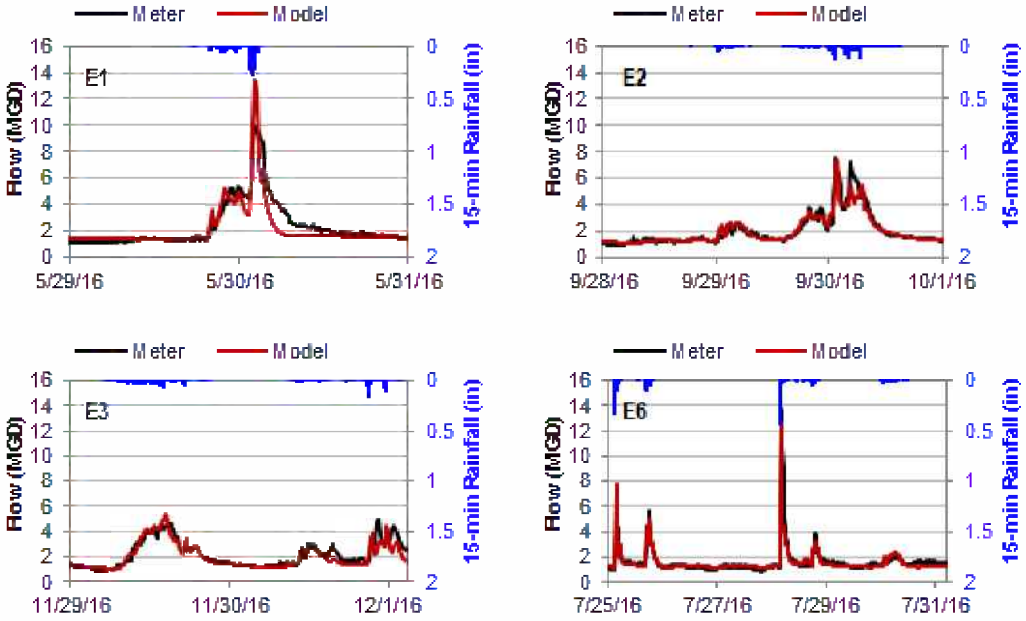
INT-Ridley 3 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	4.28	3.78	-10% to +10%	-12%	7.39	6.74	-10% to +10%	-9%
E2	3.92	3.31	-10% to +10%	-16%	6.07	5.84	-10% to +10%	-4%
E3	3.78	3.48	-10% to +10%	-8%	5.56	6.22	-10% to +10%	12%
E4	4.55	4.41	-10% to +10%	-3%	7.42	7.74	-10% to +10%	4%
E5	3.95	3.77	-10% to +10%	-5%	6.78	6.70	-10% to +10%	-1%
E6	3.90	3.43	-10% to +10%	-12%	6.73	6.07	-10% to +10%	-10%

INT-Ridley 3 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	16.50	19.45	-15% to +25%	18%	8.57	8.49	-10% to +20%	-1%
E2	15.23	18.76	-15% to +25%	23%	13.85	16.70	-10% to +20%	21%
E3	13.11	17.45	-15% to +25%	33%	13.01	14.42	-10% to +20%	11%
E4	18.23	20.42	-15% to +25%	12%	35.43	33.21	-10% to +20%	-6%
E5	17.50	17.44	-15% to +25%	0%	18.03	13.98	-10% to +20%	-22%
E6	13.88	14.34	-15% to +25%	3%	9.31	7.80	-10% to +20%	-16%

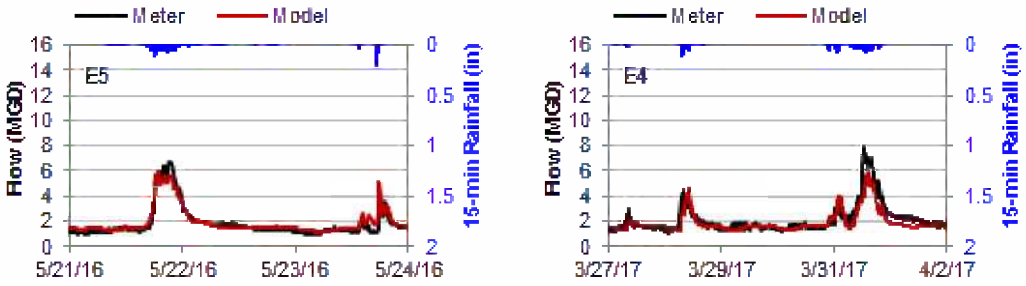
Note: All of the six wet weather events are calibrated well within or close to the industry criteria.

FLOW METER INT-WEI MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

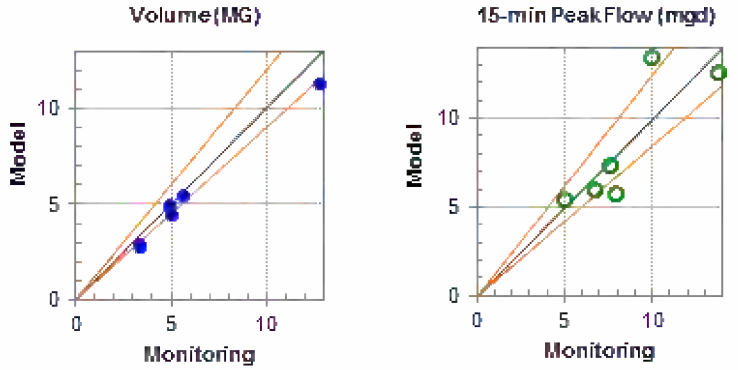
INT-WEI Model Calibration Results (Metered and Modeled Flow)



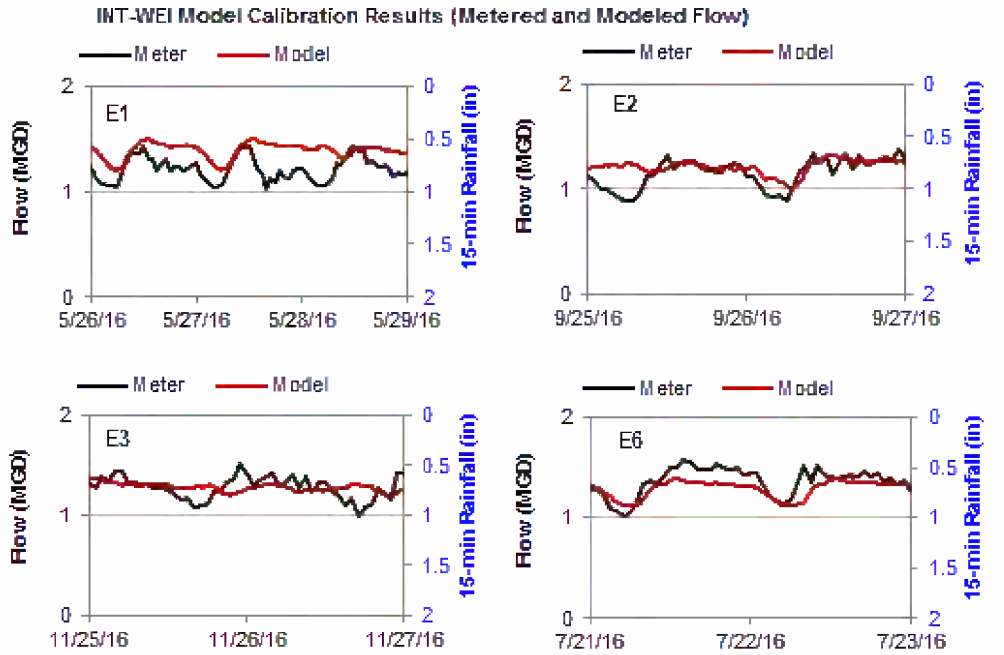
INT-WEI Model Validation Results (Metered and Modeled Flow)

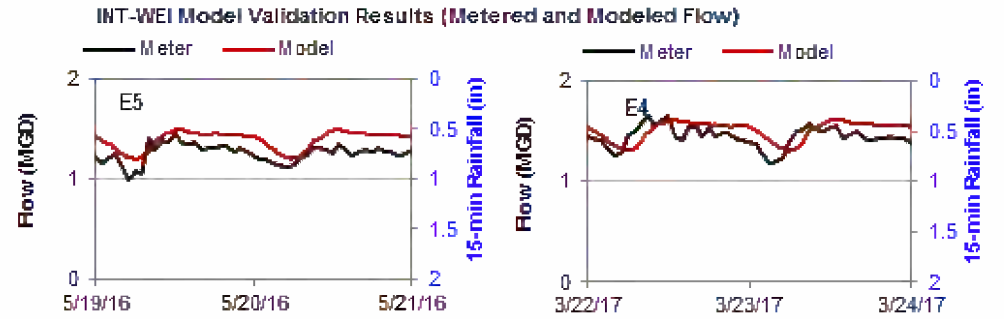


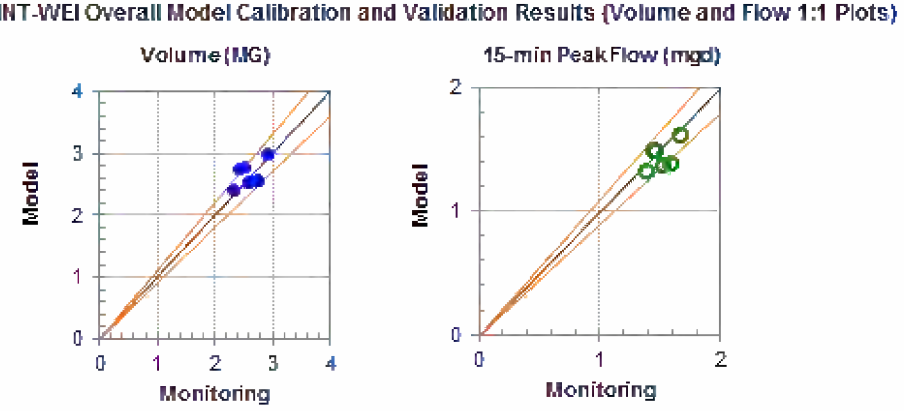
INT-WEI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER INT-WEI MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







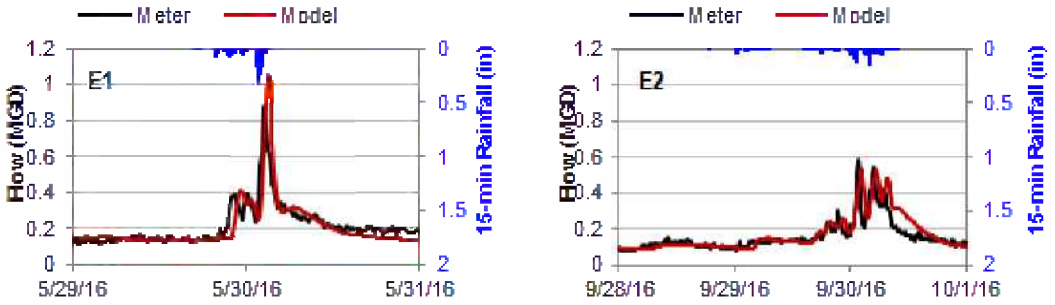
INT-WEI Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.44	1.50	-10% to +10%	5%	2.41	2.77	-10% to +10%	15%
E2	1.37	1.33	-10% to +10%	-3%	2.31	2.42	-10% to +10%	5%
E3	1.51	1.37	-10% to +10%	-9%	2.56	2.56	-10% to +10%	0%
E4	1.66	1.62	-10% to +10%	-2%	2.90	3.02	-10% to +10%	4%
E5	1.46	1.50	-10% to +10%	3%	2.52	2.78	-10% to +10%	10%
E6	1.58	1.39	-10% to +10%	-12%	2.73	2.58	-10% to +10%	-6%

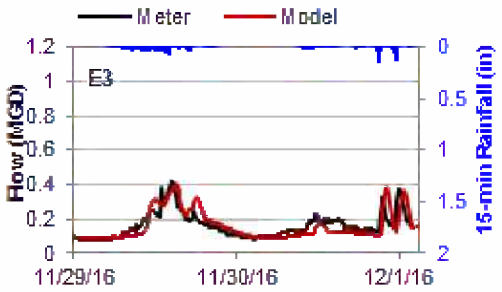
INT-WEI Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	9.99	13.44	-15% to +25%	35%	3.27	2.84	-10% to +20%	-13%
E2	7.54	7.44	-15% to +25%	-1%	5.64	5.46	-10% to +20%	-3%
E3	4.93	5.44	-15% to +25%	10%	5.00	4.55	-10% to +20%	-9%
E4	7.91	5.83	-15% to +25%	-26%	12.77	11.34	-10% to +20%	-11%
E5	6.73	6.03	-15% to +25%	-10%	4.91	5.05	-10% to +20%	3%
E6	13.69	12.65	-15% to +25%	-8%	3.31	2.91	-10% to +20%	-12%

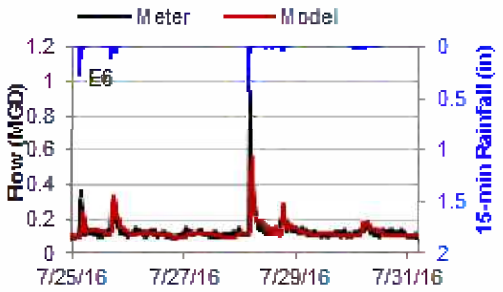
Note: All the six wet weather events are calibrated well within or close to the industry criteria.

FLOW METER SEP-1 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

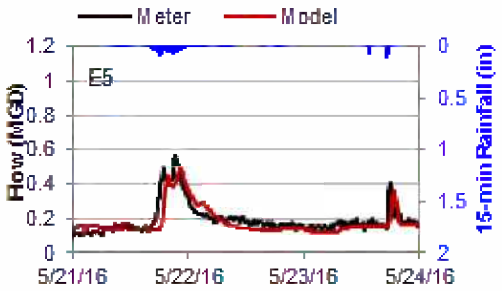
Sep-1 Model Calibration Results (Metered and Modeled Flow)

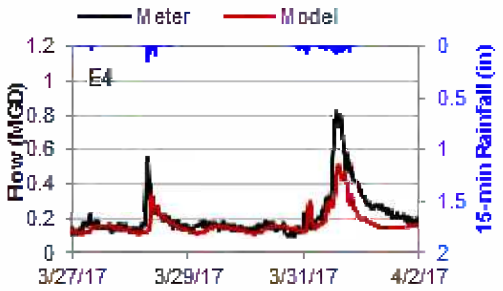




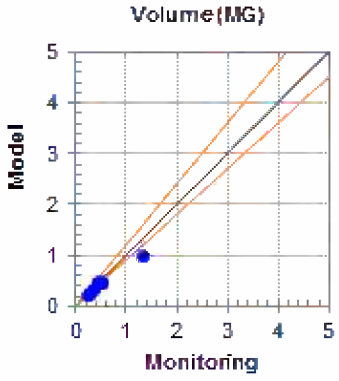


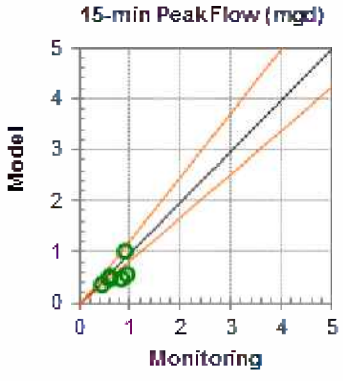
Sep-1 Model Validation Results (Metered and Modeled Flow)





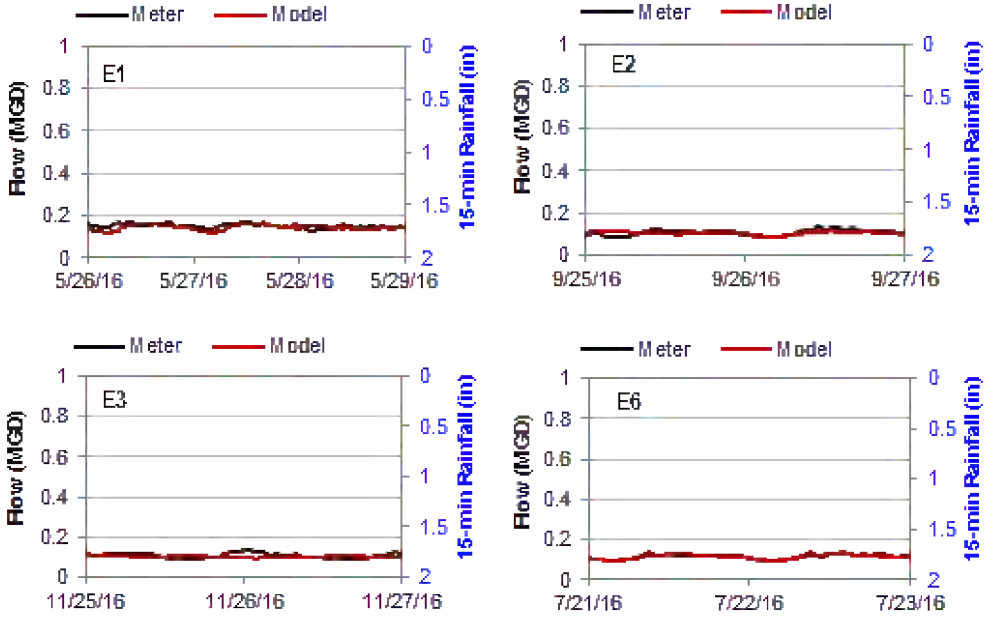
Sep-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



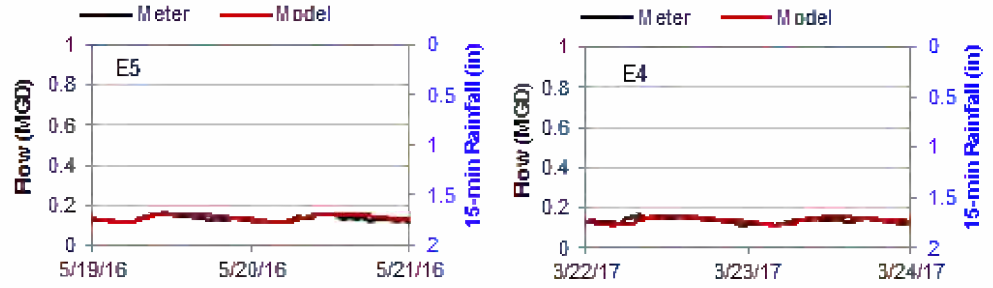


FLOW METER SEP-1 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

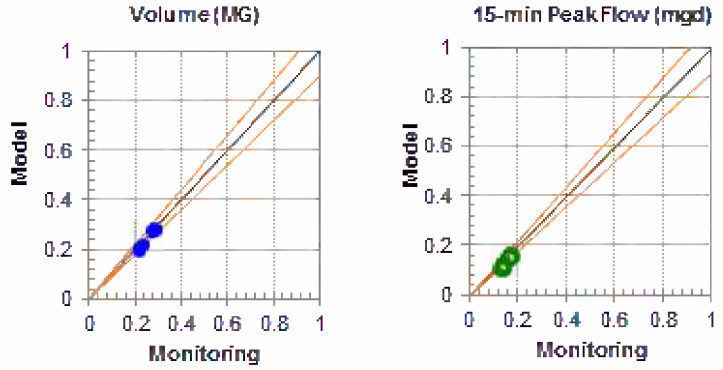
Sep-1 Model Calibration Results (Metered and Modeled Flow)



Sep-1 Model Validation Results (Metered and Modeled Flow)



Sep-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



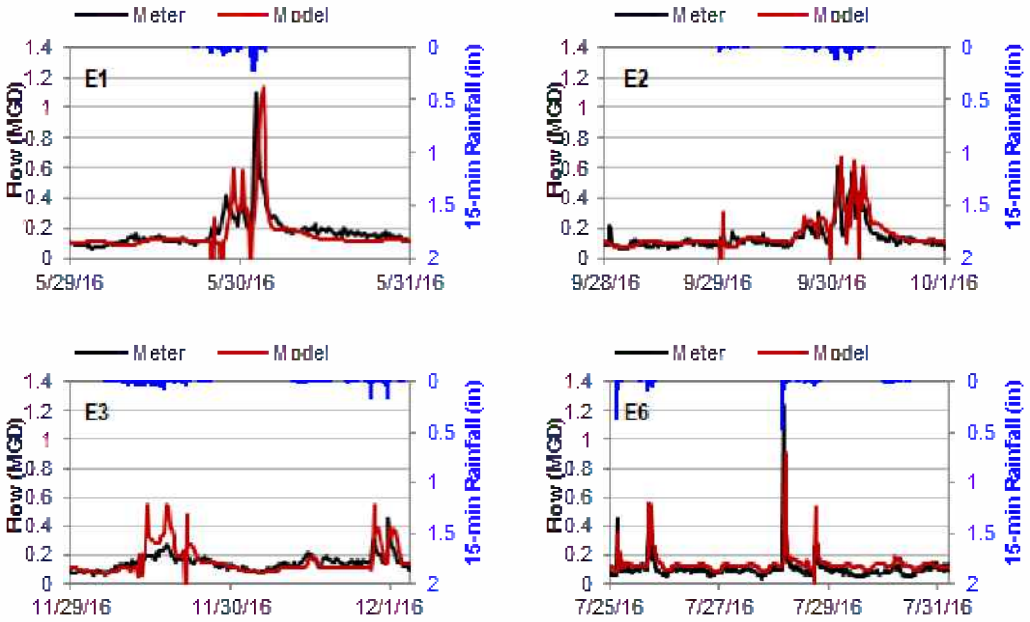
Sep-1 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.17	0.16	-10% to +10%	-7%	0.29	0.28	-10% to +10%	-4%
E2	0.14	0.12	-10% to +10%	-18%	0.22	0.21	-10% to +10%	-3%
E3	0.13	0.11	-10% to +10%	-16%	0.22	0.20	-10% to +10%	-6%
E4	0.16	0.16	-10% to +10%	-4%	0.28	0.28	-10% to +10%	1%
E5	0.17	0.16	-10% to +10%	-4%	0.27	0.28	-10% to +10%	4%
E6	0.14	0.13	-10% to +10%	-7%	0.23	0.22	-10% to +10%	-3%

Sep-1 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.88	1.05	-15% to +25%	19%	0.27	0.27	-10% to +20%	2%
E2	0.58	0.53	-15% to +25%	-8%	0.43	0.47	-10% to +20%	10%
E3	0.42	0.40	-15% to +25%	-5%	0.37	0.36	-10% to +20%	-3%
E4	0.82	0.51	-15% to +25%	-38%	1.30	1.01	-10% to +20%	-22%
E5	0.56	0.49	-15% to +25%	-11%	0.51	0.47	-10% to +20%	-9%
E6	0.94	0.57	-15% to +25%	-40%	0.25	0.25	-10% to +20%	-2%

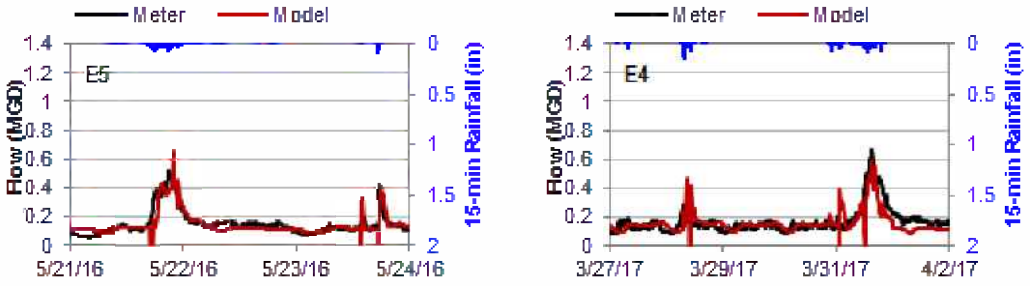
Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E4) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER SEP-2 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

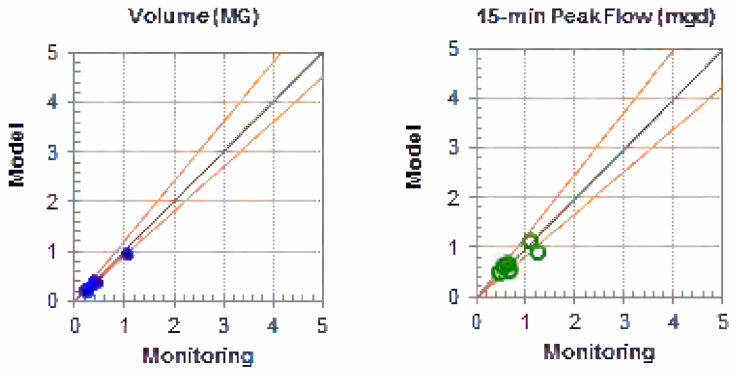
Sep-2 Model Calibration Results (Metered and Modeled Flow)



Sep-2 Model Validation Results (Metered and Modeled Flow)

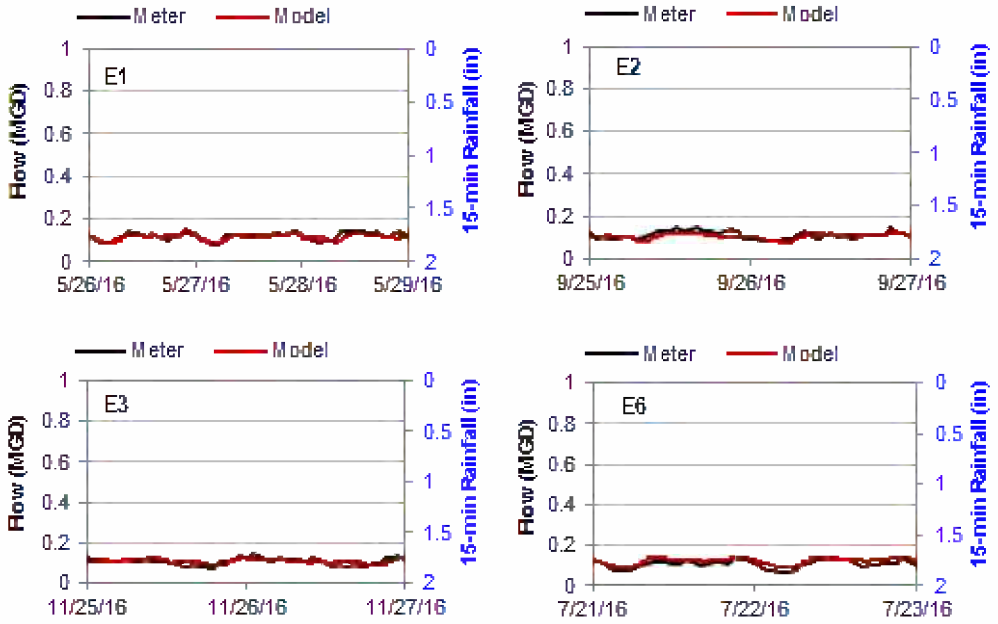


Sep-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

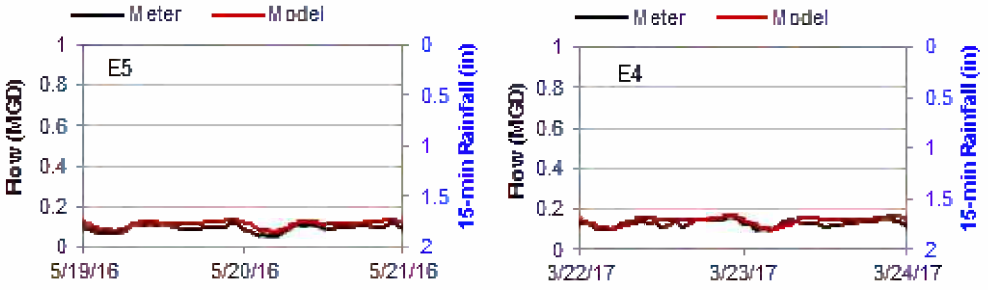


FLOW METER SEP-2 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

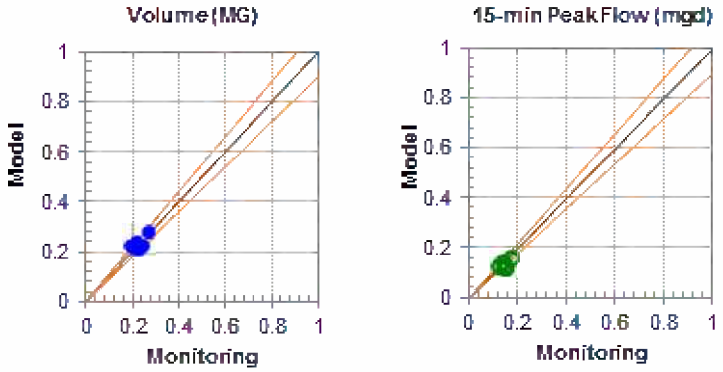
Sep-2 Model Calibration Results (Metered and Modeled Flow)



Sep-2 Model Validation Results (Metered and Modeled Flow)



Sep-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



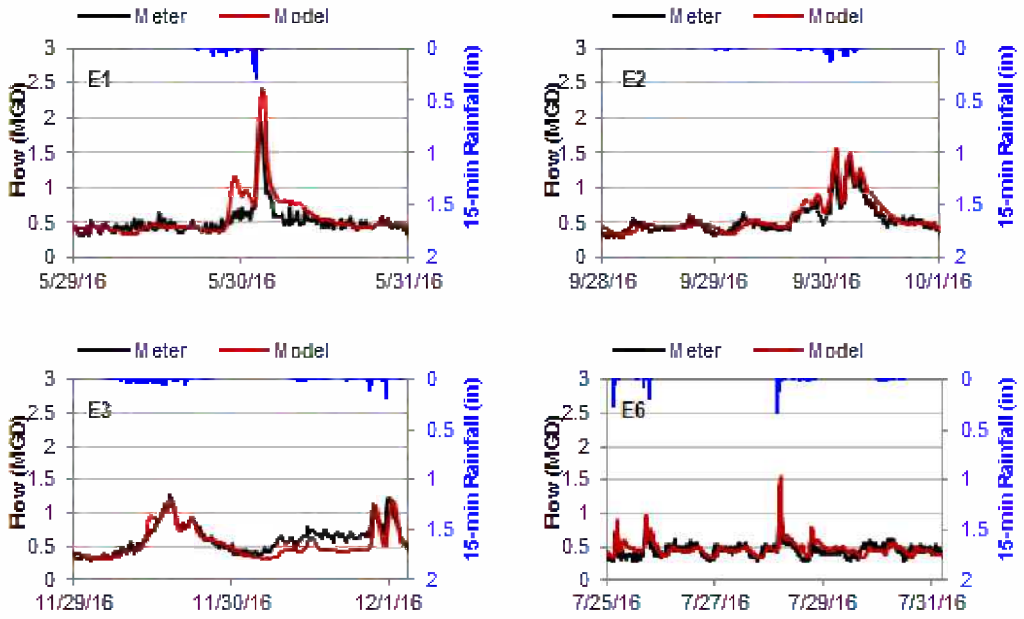
Sep-2 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.15	0.13	-10% to +10%	-8%	0.24	0.23	-10% to +10%	-4%
E2	0.15	0.12	-10% to +10%	-14%	0.23	0.22	-10% to +10%	-5%
E3	0.15	0.13	-10% to +10%	-15%	0.22	0.22	-10% to +10%	2%
E4	0.17	0.17	-10% to +10%	-3%	0.26	0.28	-10% to +10%	9%
E5	0.12	0.13	-10% to +10%	10%	0.19	0.23	-10% to +10%	20%
E6	0.14	0.14	-10% to +10%	2%	0.22	0.25	-10% to +10%	14%

Sep-2 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.10	1.15	-15% to +25%	5%	0.24	0.22	-10% to +20%	-7%
E2	0.61	0.66	-15% to +25%	7%	0.38	0.44	-10% to +20%	14%
E3	0.46	0.57	-15% to +25%	22%	0.34	0.36	-10% to +20%	5%
E4	0.67	0.59	-15% to +25%	-11%	1.04	0.95	-10% to +20%	-8%
E5	0.53	0.65	-15% to +25%	22%	0.42	0.38	-10% to +20%	-9%
E6	1.24	0.92	-15% to +25%	-26%	0.20	0.26	-10% to +20%	26%

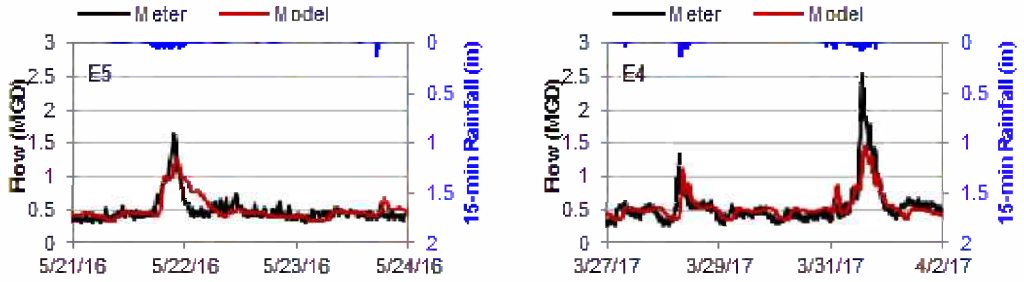
Note: All the six wet weather events are calibrated well within the industry criteria except E6 because the flow meter data recorded for E6 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER SEP-3 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

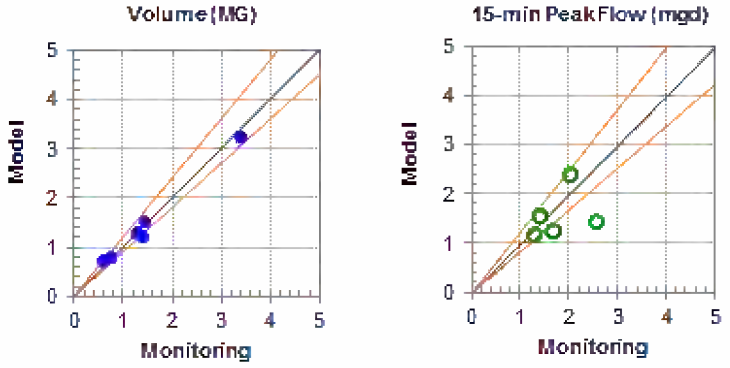
Sep-3 Model Calibration Results (Metered and Modeled Flow)



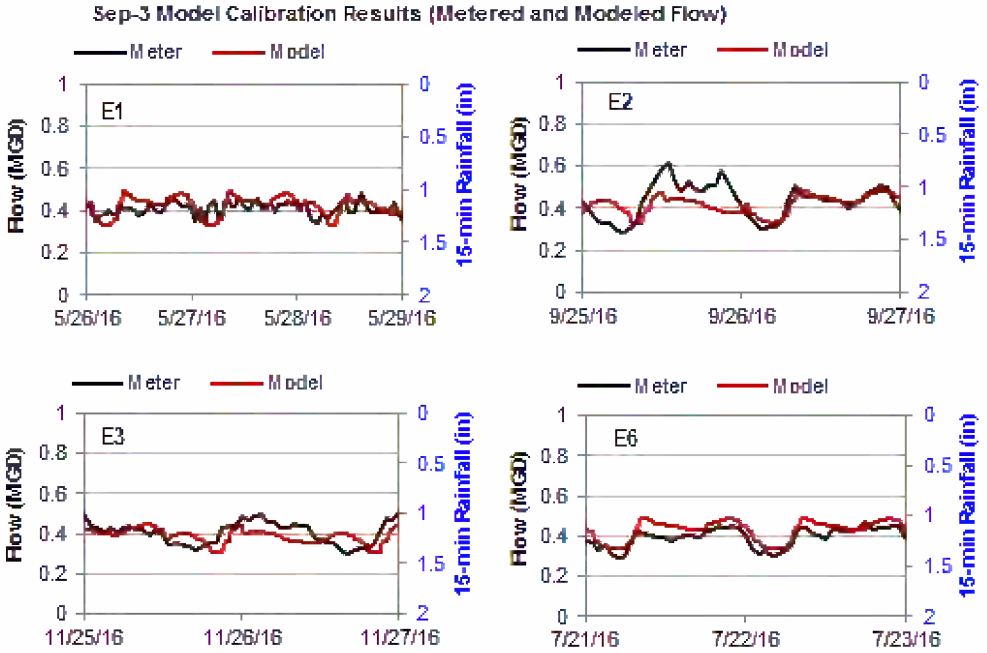
Sep-3 Model Validation Results (Metered and Modeled Flow)

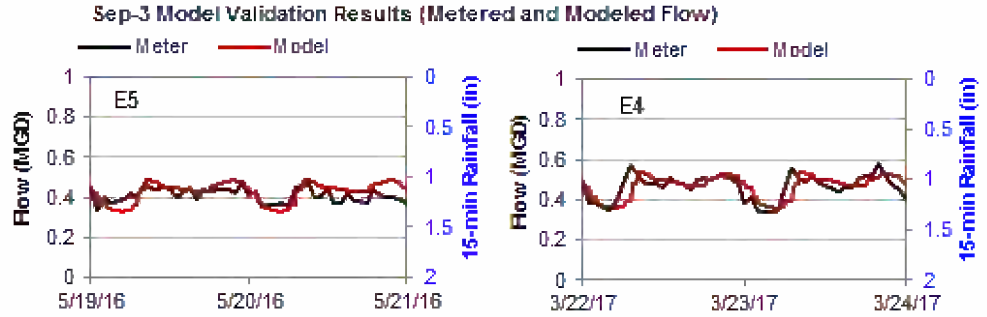


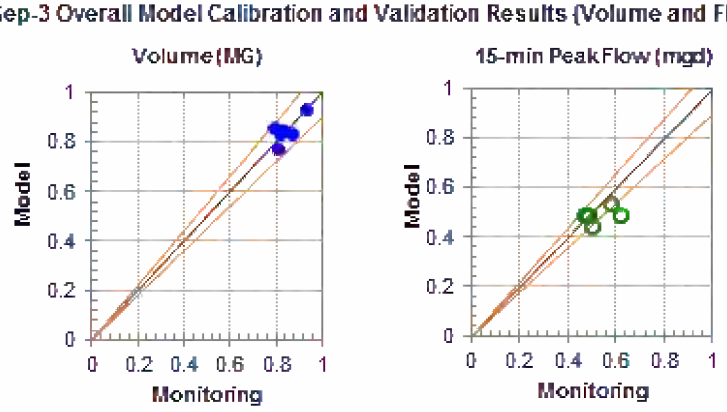
Sep-3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER SEP-3 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







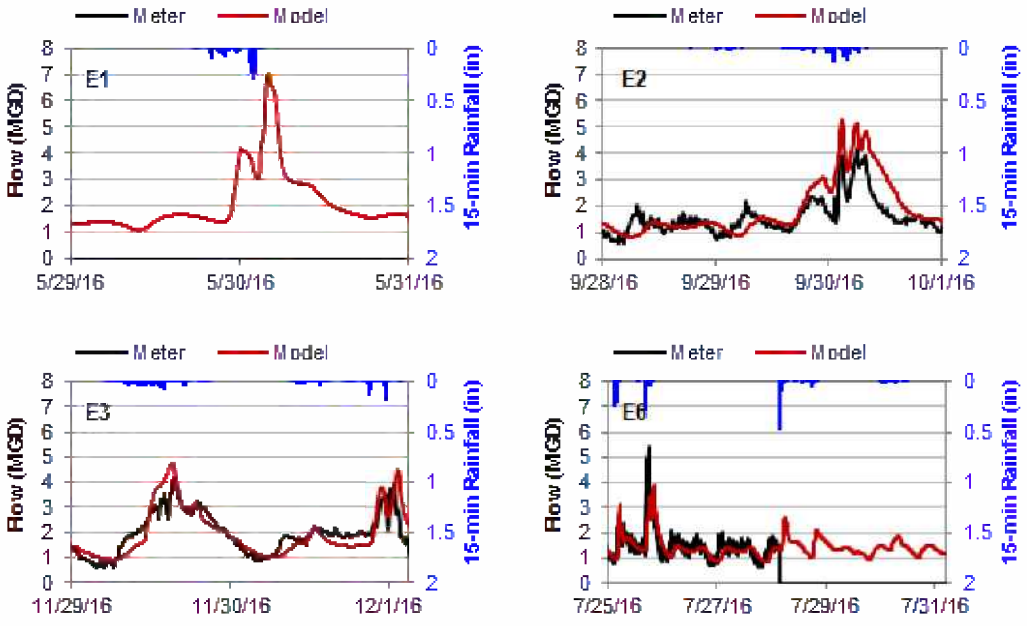
Sep-3 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.48	0.49	-10% to +10%	1%	0.82	0.84	-10% to +10%	2%
E2	0.61	0.49	-10% to +10%	-21%	0.87	0.84	-10% to +10%	-3%
E3	0.50	0.45	-10% to +10%	-11%	0.81	0.77	-10% to +10%	-4%
E4	0.58	0.53	-10% to +10%	-8%	0.93	0.93	-10% to +10%	1%
E5	0.48	0.49	-10% to +10%	2%	0.82	0.85	-10% to +10%	4%
E6	0.47	0.49	-10% to +10%	6%	0.79	0.86	-10% to +10%	9%

Sep-3 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.99	2.41	-15% to +25%	21%	0.59	0.73	-10% to +20%	24%
E2	1.40	1.56	-15% to +25%	11%	1.43	1.56	-10% to +20%	9%
E3	1.26	1.19	-15% to +25%	-6%	1.40	1.24	-10% to +20%	-12%
E4	2.55	1.47	-15% to +25%	-42%	3.39	3.26	-10% to +20%	-4%
E5	1.64	1.25	-15% to +25%	-24%	1.27	1.29	-10% to +20%	2%
E6	1.40	1.55	-15% to +25%	11%	0.72	0.83	-10% to +20%	15%

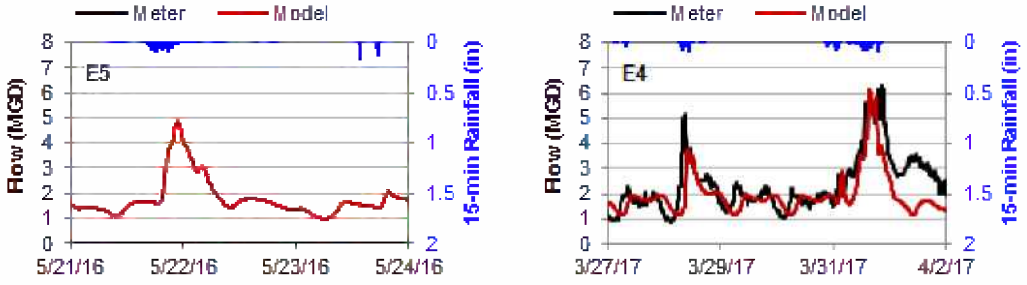
Note: All the six wet weather events are calibrated well within or close to the industry criteria except peak flow for Event E4 because the flow meter data recorded for E4 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER SEP-4 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

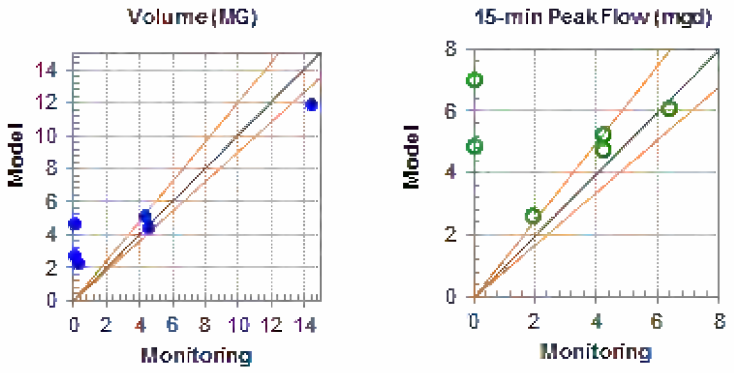
Sep-4 Model Calibration Results (Metered and Modeled Flow)



Sep-4 Model Validation Results (Metered and Modeled Flow)

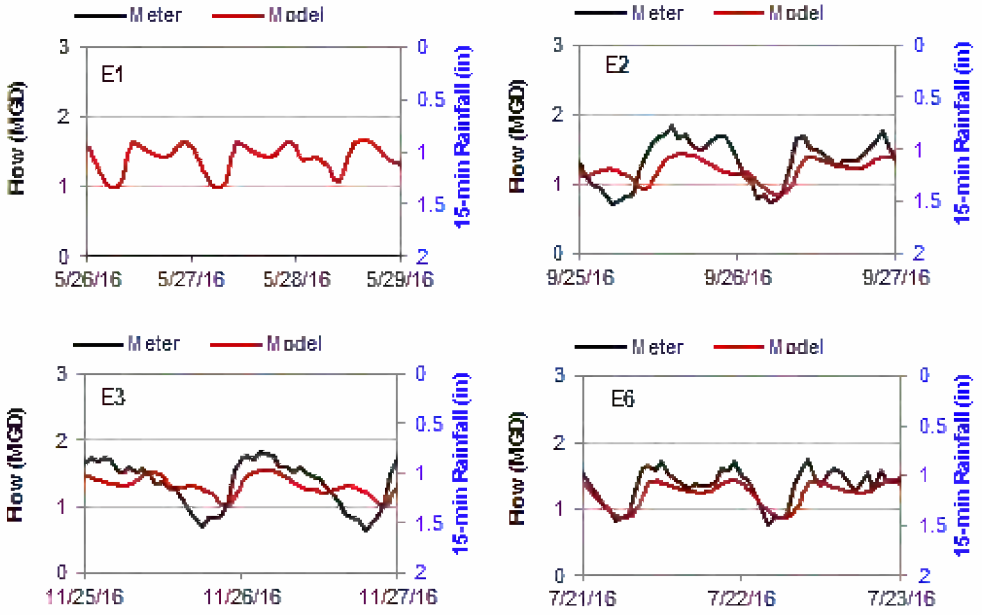


Sep-4 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

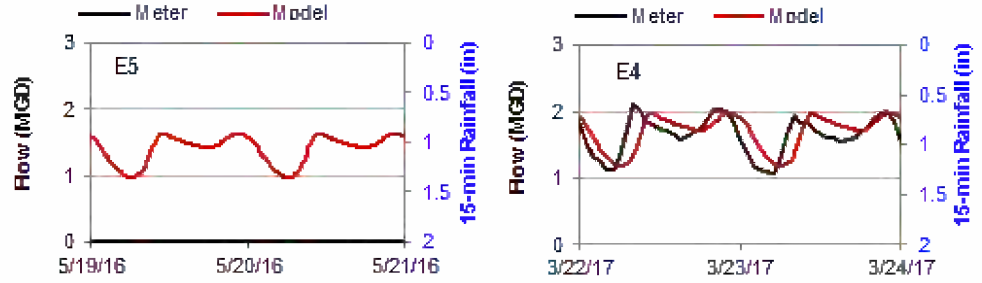


FLOW METER SEP-4 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

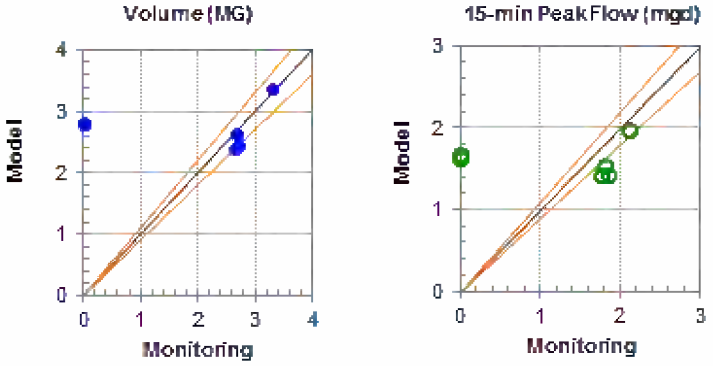
Sep-4 Model Calibration Results (Metered and Modeled Flow)



Sep-4 Model Validation Results (Metered and Modeled Flow)



Sep-4 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



Sep-4 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.00	1.67	-10% to +10%	See Note Below	0.00	2.82	-10% to +10%	See Note Below
E2	1.84	1.43	-10% to +10%	-22%	2.65	2.40	-10% to +10%	-9%
E3	1.82	1.55	-10% to +10%	-15%	2.66	2.62	-10% to +10%	-2%
E4	2.12	1.98	-10% to +10%	-7%	3.29	3.38	-10% to +10%	3%
E5	0.00	1.63	-10% to +10%	See Note Below	0.00	2.79	-10% to +10%	See Note Below
E6	1.75	1.43	-10% to +10%	-19%	2.70	2.45	-10% to +10%	-9%

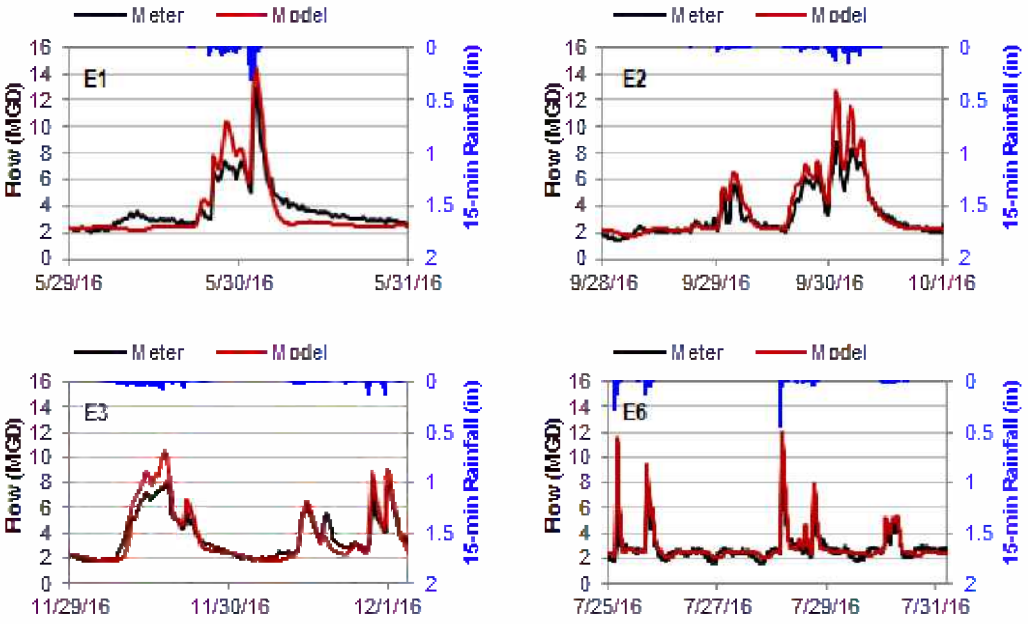
Sep-4 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.00	7.04	-15% to +25%	See Note Below!	0.00	2.77	-10% to +20%	See Note Below
E2	4.19	5.28	-15% to +25%	26%	4.27	5.24	-10% to +20%	23%
E3	4.17	4.77	-15% to +25%	14%	4.45	4.49	-10% to +20%	1%
E4	6.33	6.13	-15% to +25%	-3%	14.38	11.95	-10% to +20%	-17%
E5	0.00	4.91	-15% to +25%	See Note Below	0.00	4.68	-10% to +20%	See Note Below
E6	1.88	2.62	-15% to +25%	See Note Below	0.27	2.32	-10% to +20%	See Note Below

Note: Flow meter was included after the first quarter of flow monitoring; therefore no data was available for Events E1 and E5. Also, meter data was not available for part of E6.

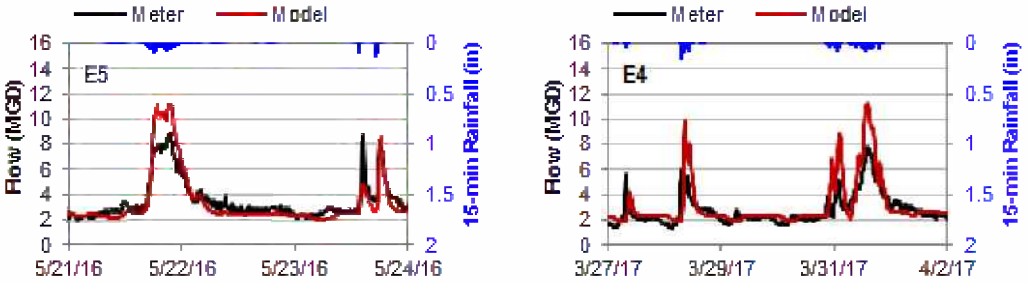
Three of the four available wet weather events are calibrated well within the industry criteria. Flow meter data recorded for E6 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER SIDE-1 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

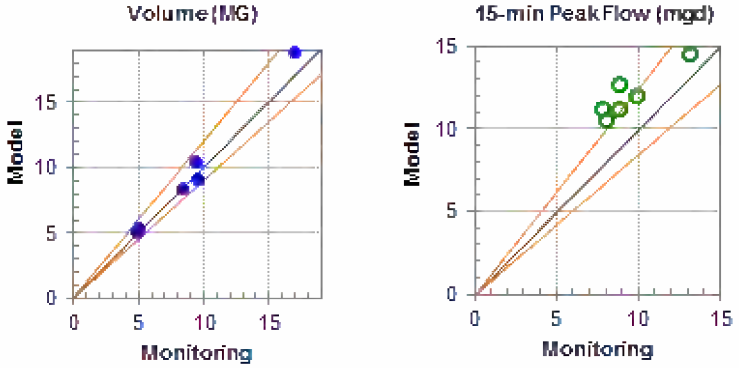
Side-1 Model Calibration Results (Metered and Modeled Flow)



Side-1 Model Validation Results (Metered and Modeled Flow)

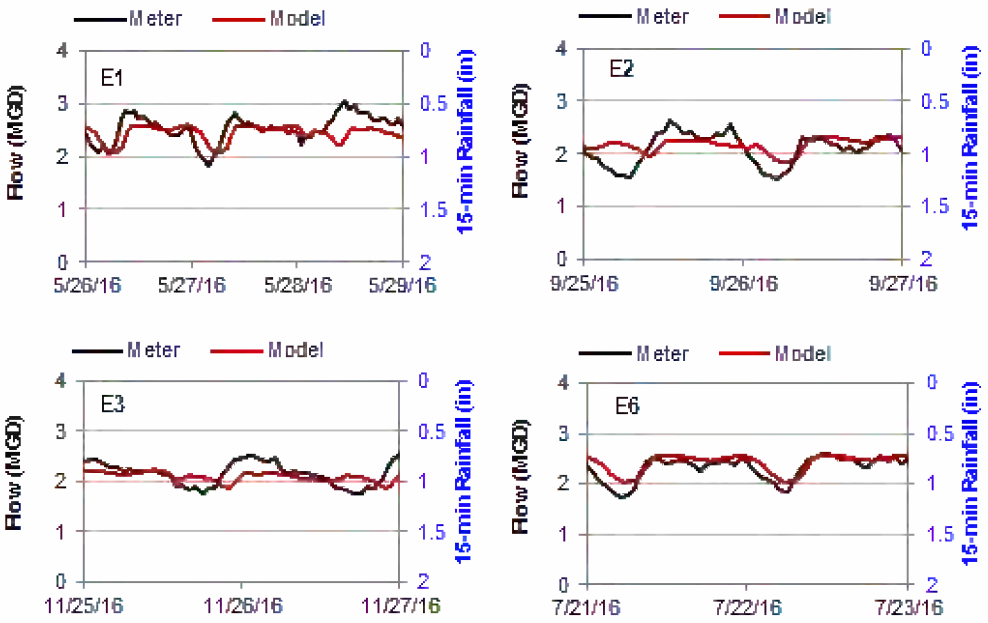


Side-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

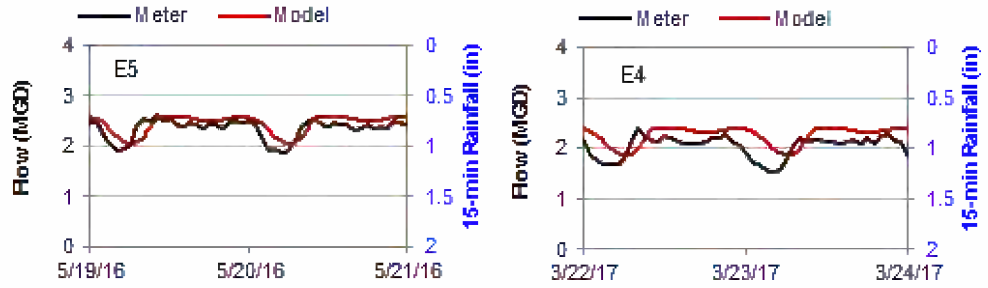


FLOW METER SIDE-1 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

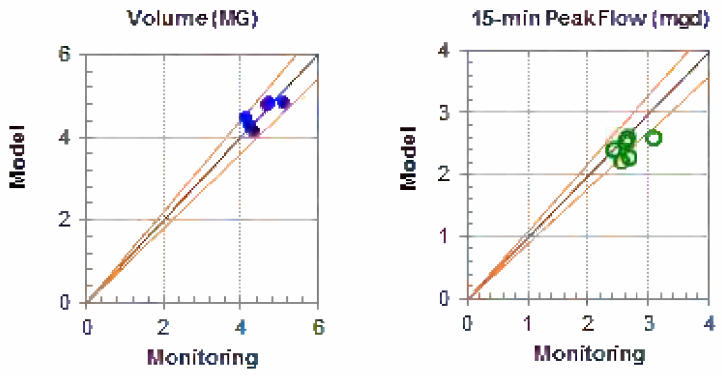
Side-1 Model Calibration Results (Metered and Modeled Flow)



Side-1 Model Validation Results (Metered and Modeled Flow)



Side-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



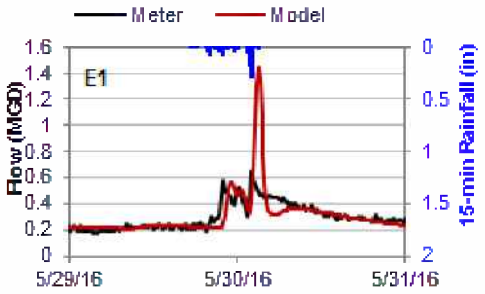
Side-1 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.05	2.59	-10% to +10%	-15%	5.11	4.87	-10% to +10%	-5%
E2	2.66	2.31	-10% to +10%	-13%	4.20	4.33	-10% to +10%	3%
E3	2.53	2.22	-10% to +10%	-12%	4.31	4.18	-10% to +10%	-3%
E4	2.42	2.41	-10% to +10%	0%	4.09	4.52	-10% to +10%	11%
E5	2.62	2.59	-10% to +10%	-1%	4.69	4.88	-10% to +10%	4%
E6	2.61	2.55	-10% to +10%	-2%	4.62	4.81	-10% to +10%	4%

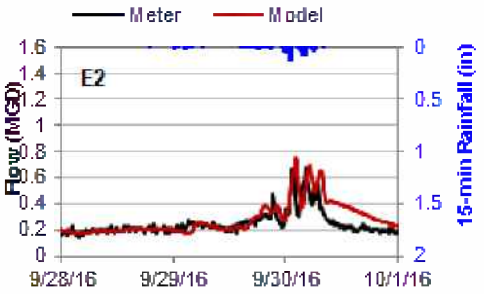
Side-1 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	13.05	14.57	-15% to +25%	12%	4.90	5.07	-10% to +20%	3%
E2	8.85	12.75	-15% to +25%	44%	9.30	10.43	-10% to +20%	12%
E3	8.03	10.54	-15% to +25%	31%	8.35	8.49	-10% to +20%	2%
E4	7.73	11.25	-15% to +25%	45%	16.90	18.97	-10% to +20%	12%
E5	8.84	11.19	-15% to +25%	27%	9.43	9.22	-10% to +20%	-2%
E6	9.88	12.03	-15% to +25%	22%	5.02	5.43	-10% to +20%	8%

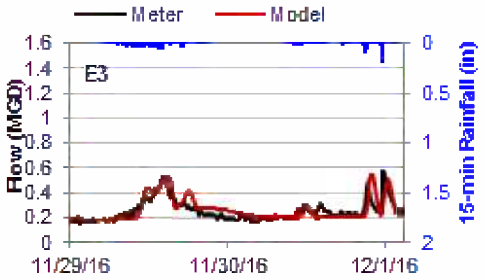
Note: All the six wet weather events are calibrated well within or close to the industry criteria except peak flows for Event E2 and E4 because the flow meter data recorded for the events is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

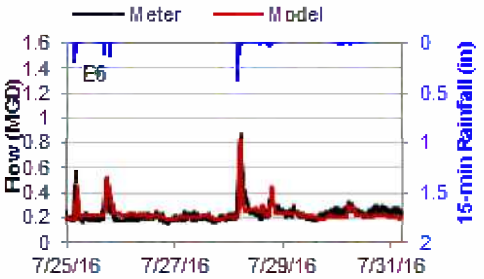
FLOW METER SIDE-2 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

Side-2 Model Calibration Results (Metered and Modeled Flow)









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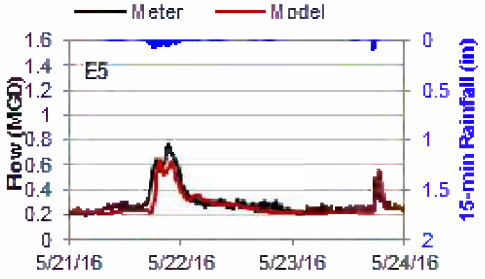
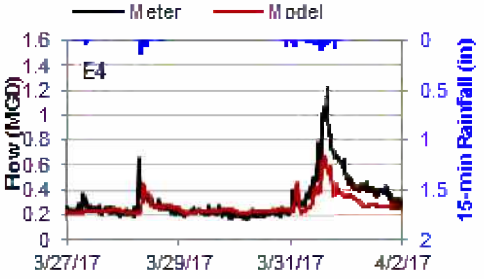
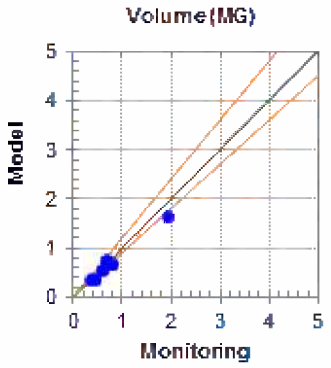
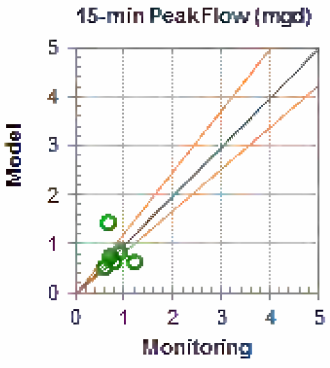
Side-2 Model Validation Results (Metered and Modeled Flow)





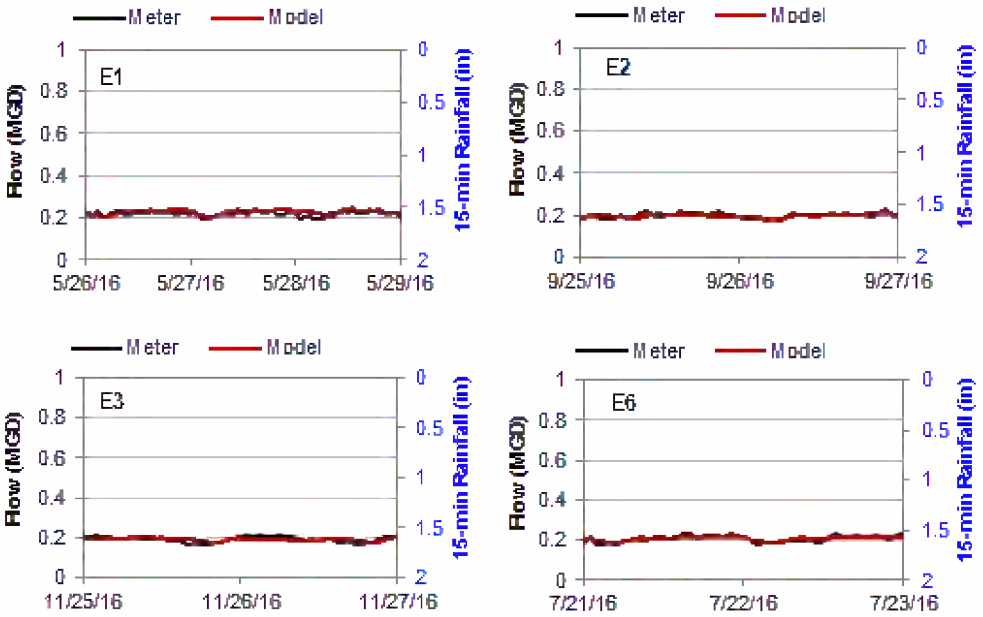
Side-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



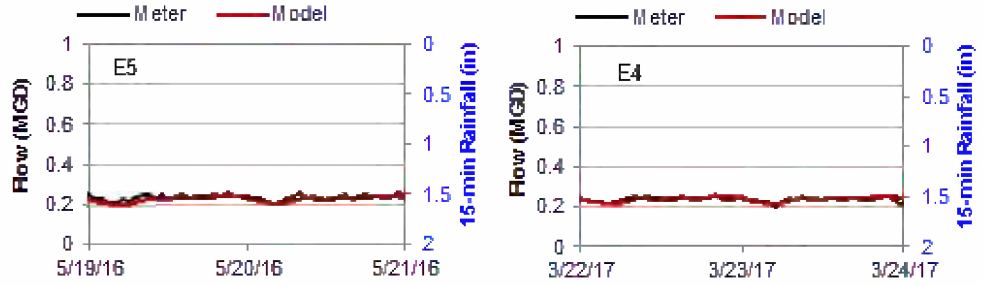


FLOW METER SIDE-2 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

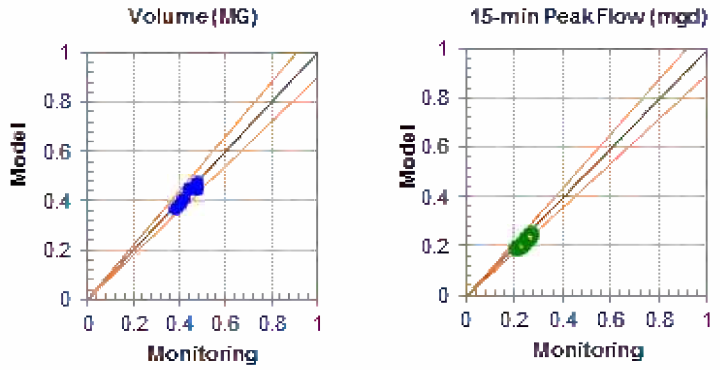
Side-2 Model Calibration Results (Metered and Modeled Flow)



Side-2 Model Validation Results (Metered and Modeled Flow)



Side-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



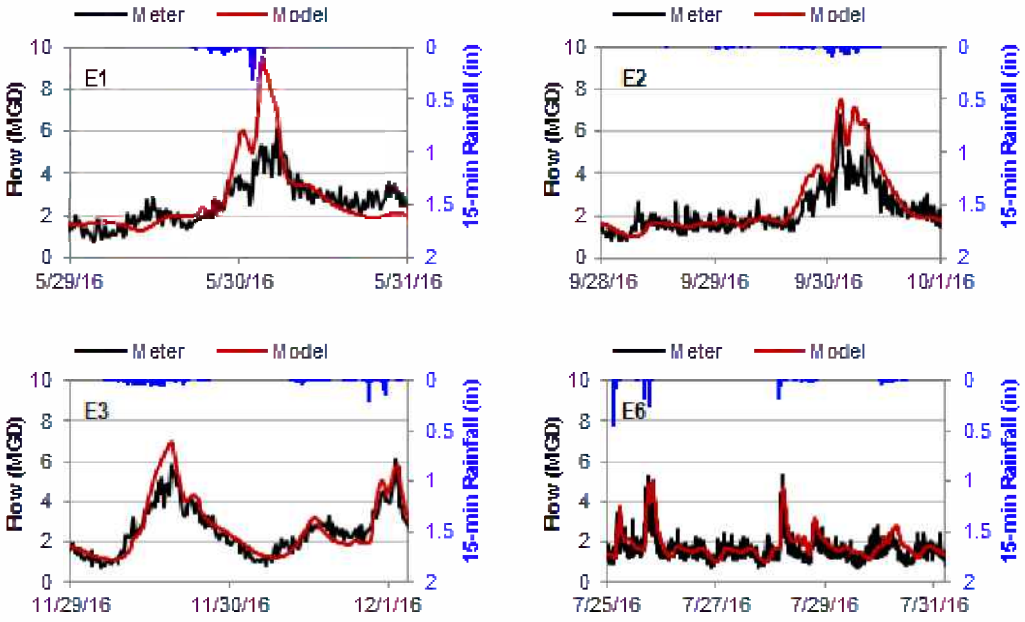
Side-2 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.25	0.24	-10% to +10%	-4%	0.44	0.45	-10% to +10%	2%
E2	0.23	0.21	-10% to +10%	-8%	0.40	0.39	-10% to +10%	-1%
E3	0.21	0.20	-10% to +10%	-4%	0.38	0.38	-10% to +10%	0%
E4	0.26	0.25	-10% to +10%	-5%	0.47	0.47	-10% to +10%	0%
E5	0.26	0.24	-10% to +10%	-7%	0.47	0.45	-10% to +10%	-5%
E6	0.23	0.22	-10% to +10%	-7%	0.41	0.41	-10% to +10%	-1%

Side-2 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.65	1.44	-15% to +25%	120%	0.36	0.38	-10% to +20%	5%
E2	0.68	0.75	-15% to +25%	10%	0.67	0.76	-10% to +20%	15%
E3	0.56	0.54	-15% to +25%	-3%	0.58	0.59	-10% to +20%	2%
E4	1.21	0.67	-15% to +25%	-45%	1.94	1.66	-10% to +20%	-14%
E5	0.76	0.65	-15% to +25%	-14%	0.78	0.71	-10% to +20%	-8%
E6	0.87	0.85	-15% to +25%	-3%	0.42	0.41	-10% to +20%	-4%

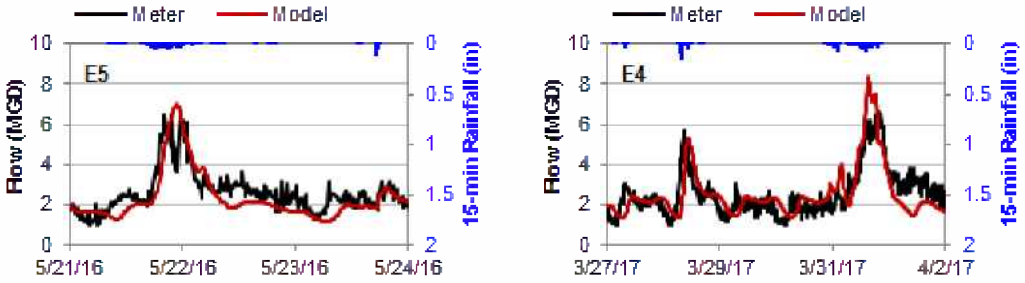
Note: Four of the six wet weather events are calibrated well within the industry criteria. Flow meter data recorded for some of the events (E1 and E4) is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER RC MH-26 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

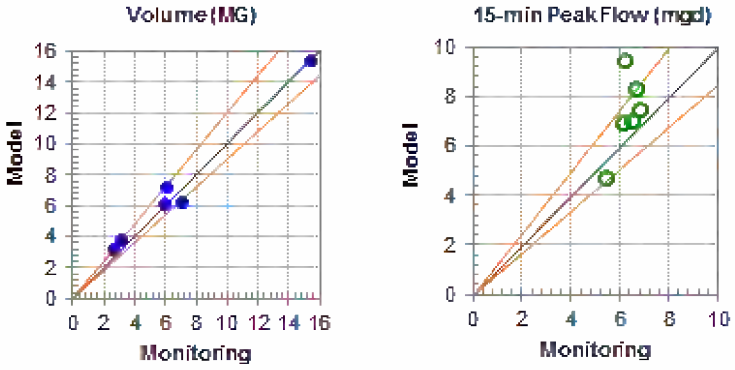
RC MH-26 Model Calibration Results (Metered and Modeled Flow)



RC MH-26 Model Validation Results (Metered and Modeled Flow)

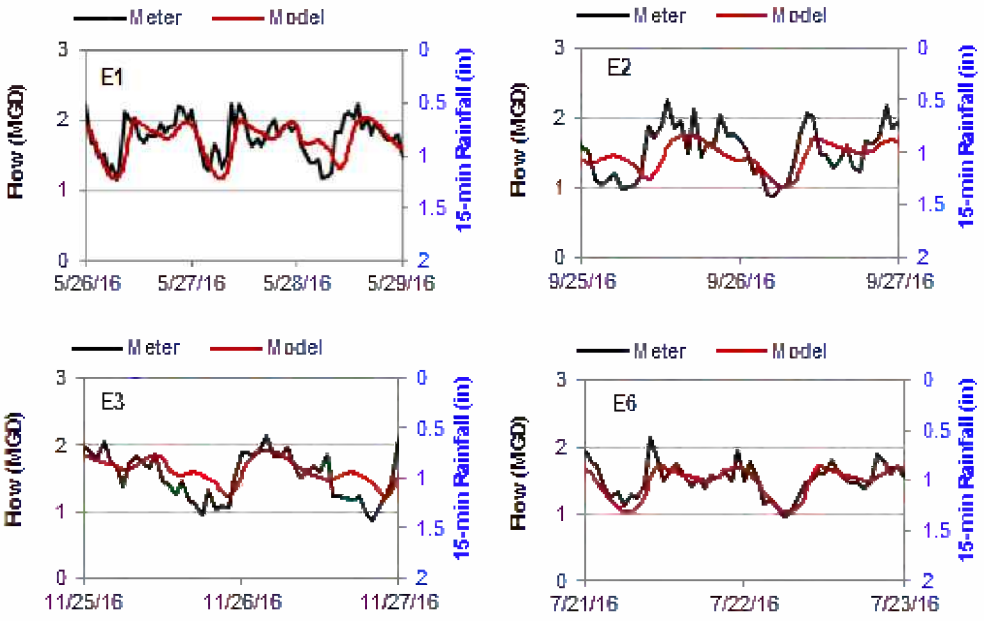


RC MH-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

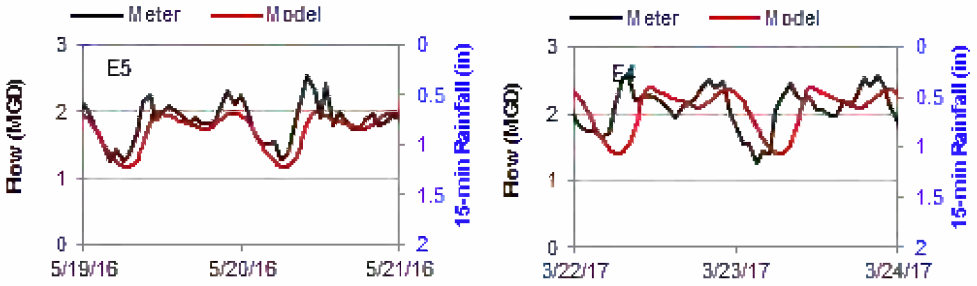


FLOW METER RC MH-26 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

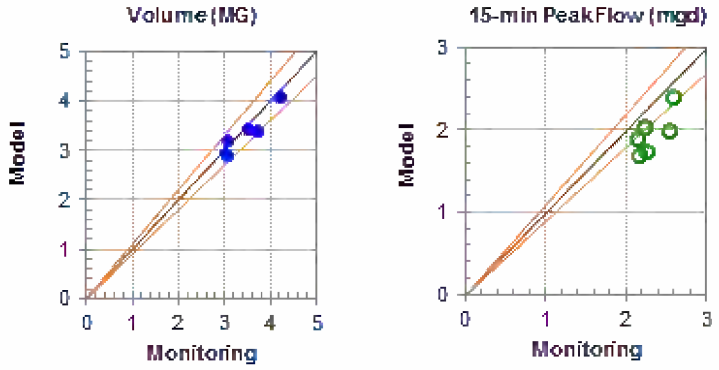
RC MH-26 Model Calibration Results (Metered and Modeled Flow)



RC MH-26 Model Validation Results (Metered and Modeled Flow)



RC MH-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



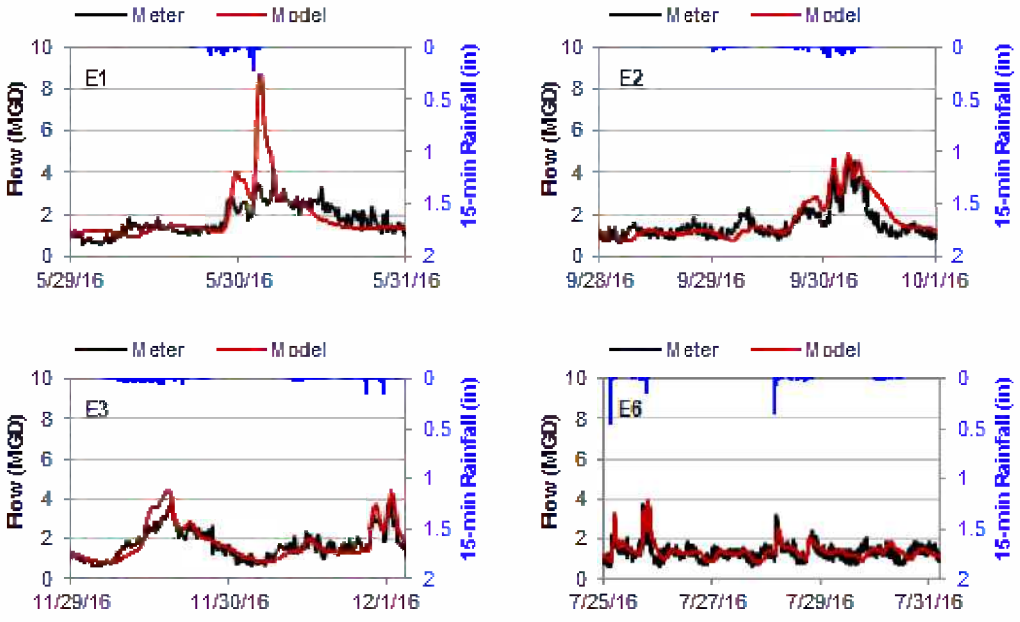
RC MH-26 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	2.23	2.04	-10% to +10%	-8%	3.49	3.44	-10% to +10%	-1%
E2	2.25	1.74	-10% to +10%	-23%	3.04	2.90	-10% to +10%	-5%
E3	2.14	1.91	-10% to +10%	-11%	3.04	3.21	-10% to +10%	6%
E4	2.58	2.40	-10% to +10%	-7%	4.20	4.09	-10% to +10%	-3%
E5	2.53	2.00	-10% to +10%	-21%	3.70	3.41	-10% to +10%	-8%
E6	2.15	1.71	-10% to +10%	-21%	3.02	2.94	-10% to +10%	-3%

RC MH-26 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	6.14	9.50	-15% to +25%	55%	3.08	3.89	-10% to +20%	26%
E2	6.76	7.46	-15% to +25%	10%	5.99	7.22	-10% to +20%	21%
E3	6.07	6.93	-15% to +25%	14%	5.85	6.18	-10% to +20%	6%
E4	6.64	8.33	-15% to +25%	25%	15.34	15.43	-10% to +20%	1%
E5	6.48	7.02	-15% to +25%	8%	7.01	6.25	-10% to +20%	-11%
E6	5.39	4.72	-15% to +25%	-12%	2.64	3.24	-10% to +20%	23%

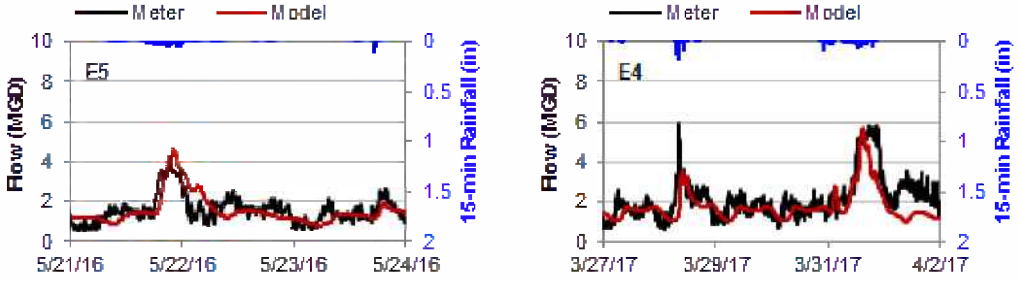
Note: All the six wet weather events are calibrated well within the industry criteria except Event E1. Flow meter data recorded for E1 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER RC MH-30 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

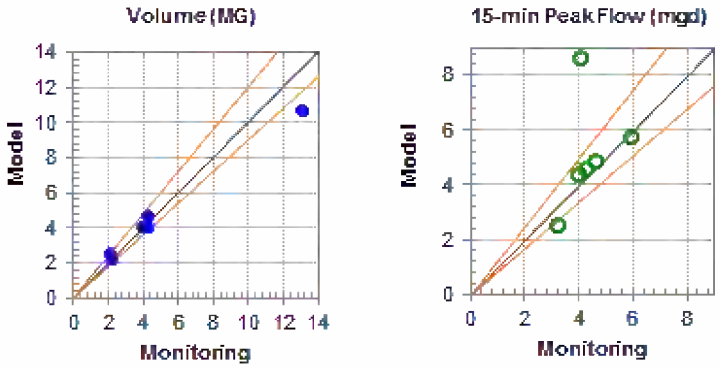
RC MH-30 Model Calibration Results (Metered and Modeled Flow)



RC MH-30 Model Validation Results (Metered and Modeled Flow)

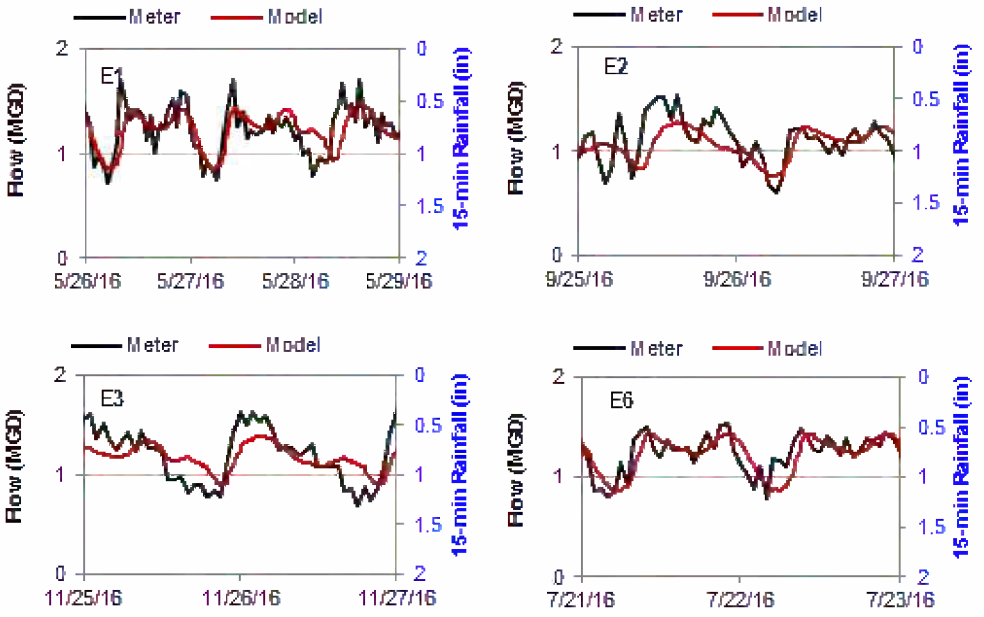


RC MH-30 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

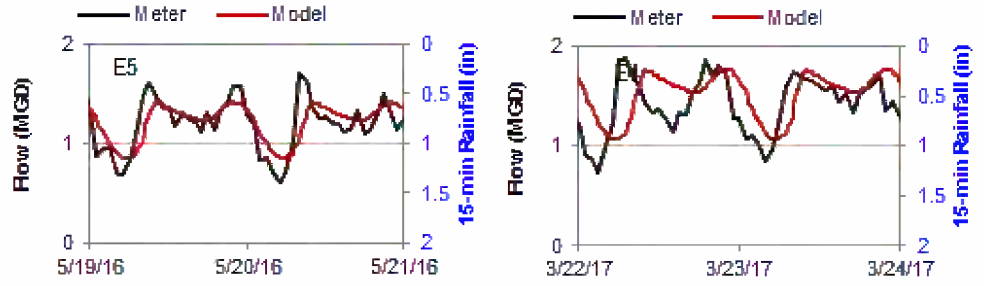


FLOW METER RC MH-30 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

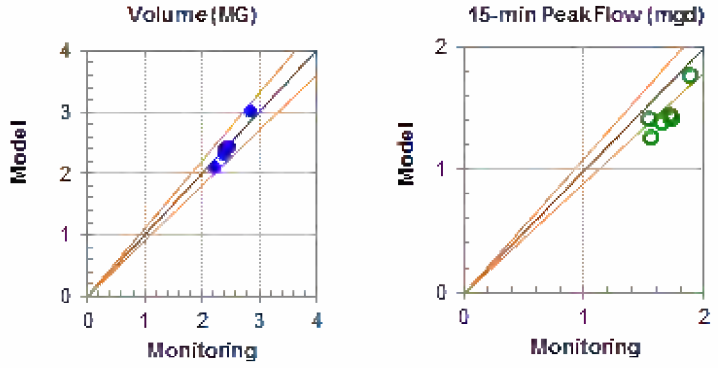
RC MH-30 Model Calibration Results (Metered and Modeled Flow)



RC MH-30 Model Validation Results (Metered and Modeled Flow)



RC MH-30 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



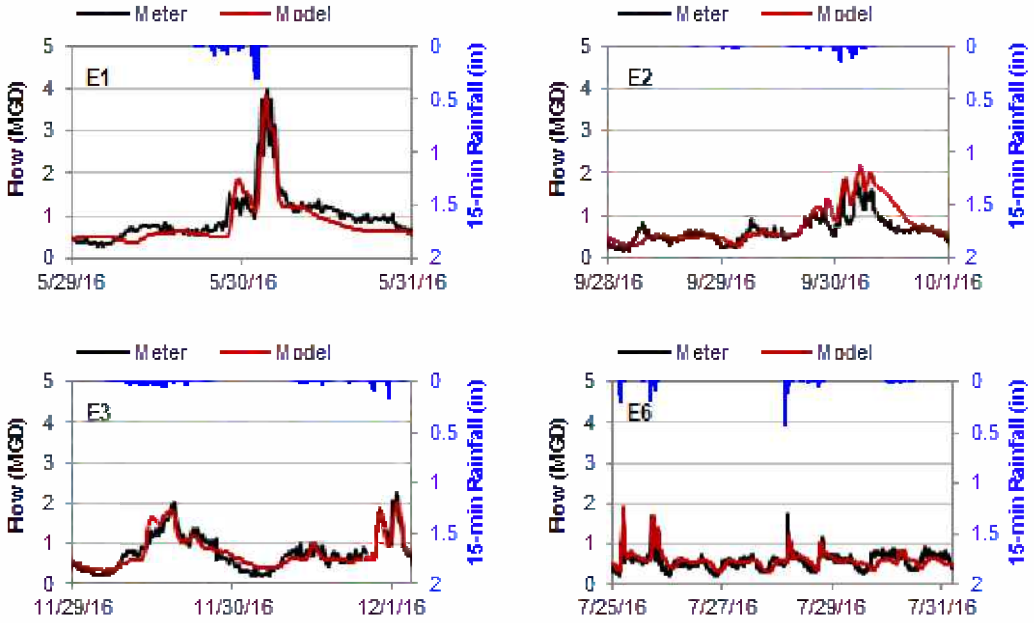
RC MH-30 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.71	1.46	-10% to +10%	-15%	2.41	2.44	-10% to +10%	2%
E2	1.54	1.28	-10% to +10%	-17%	2.23	2.13	-10% to +10%	-4%
E3	1.65	1.39	-10% to +10%	-16%	2.38	2.34	-10% to +10%	-2%
E4	1.88	1.77	-10% to +10%	-6%	2.84	3.03	-10% to +10%	7%
E5	1.71	1.42	-10% to +10%	-17%	2.38	2.43	-10% to +10%	2%
E6	1.53	1.43	-10% to +10%	-7%	2.48	2.45	-10% to +10%	-1%

RC MH-30 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	4.04	8.67	-15% to +25%	114%	2.11	2.59	-10% to +20%	23%
E2	4.57	4.88	-15% to +25%	7%	4.17	4.73	-10% to +20%	13%
E3	3.97	4.44	-15% to +25%	12%	3.91	4.05	-10% to +20%	4%
E4	5.94	5.77	-15% to +25%	-3%	13.02	10.72	-10% to +20%	-18%
E5	4.24	4.63	-15% to +25%	9%	4.24	4.13	-10% to +20%	-3%
E6	3.23	2.55	-15% to +25%	-21%	2.15	2.27	-10% to +20%	6%

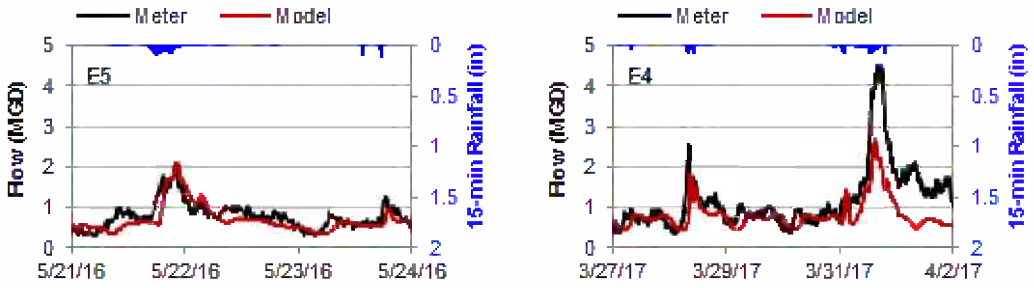
Note: All the six wet weather events are calibrated well within or close to the industry criteria except peak flow for Event E1. Flow meter data recorded for E1 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER RC MH-32 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

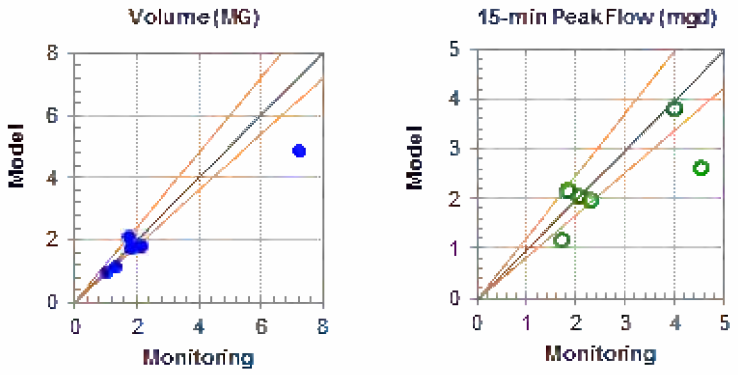
RC MH-32 Model Calibration Results (Metered and Modeled Flow)



RC MH-32 Model Validation Results (Metered and Modeled Flow)

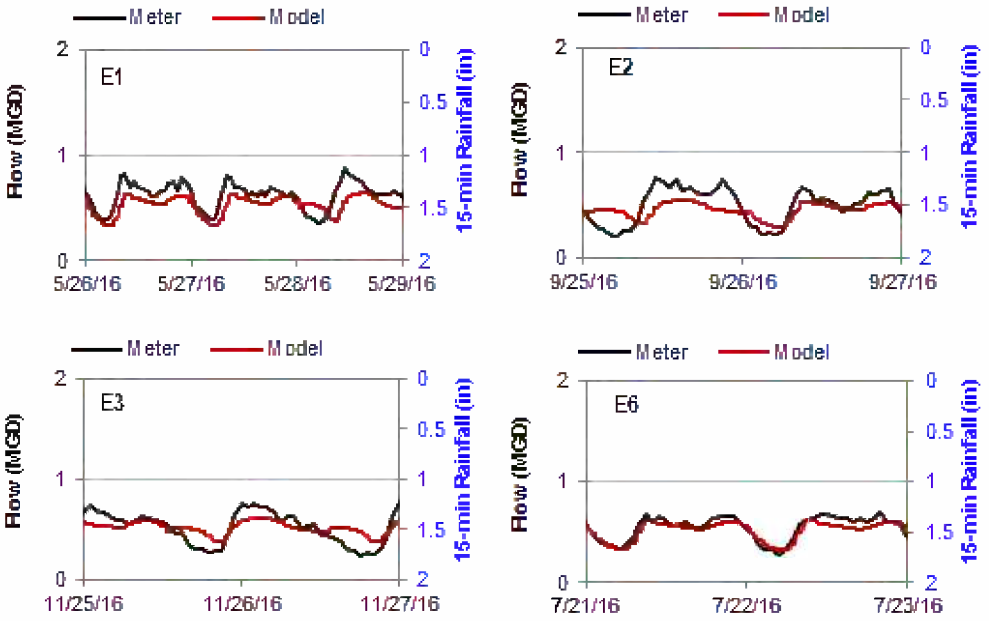


RC MH-32 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

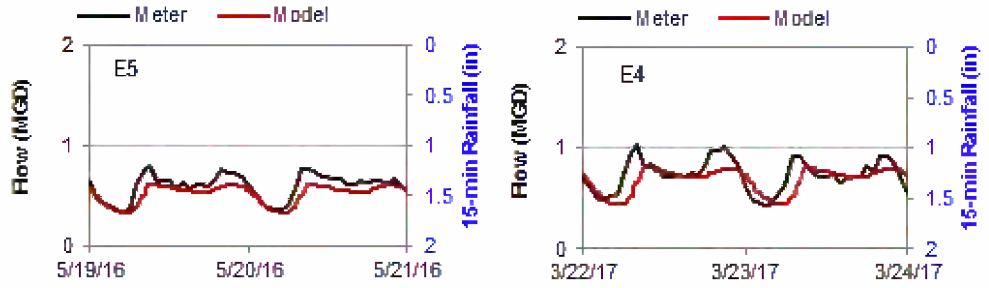


FLOW METER RC MH-32 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

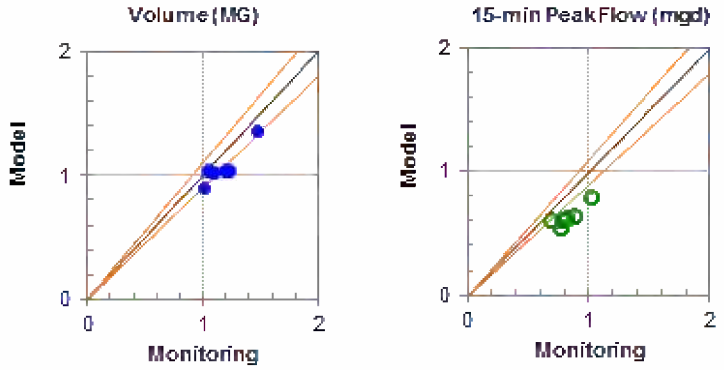
RC MH-32 Model Calibration Results (Metered and Modeled Flow)



RC MH-32 Model Validation Results (Metered and Modeled Flow)



RC MH-32 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



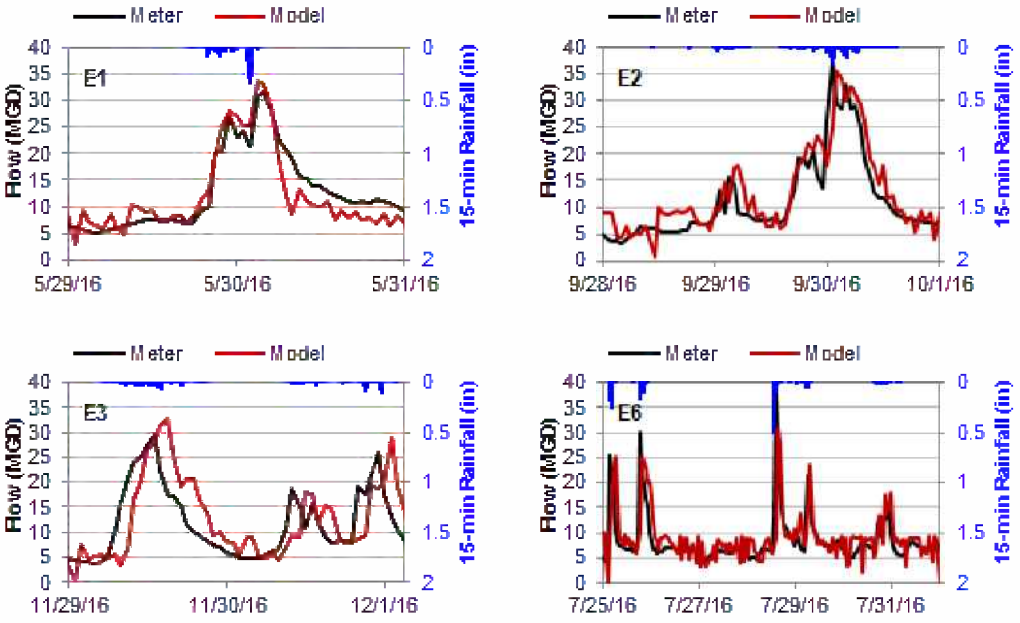
RC MH-32 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.88	0.64	-10% to +10%	-28%	1.22	1.05	-10% to +10%	-14%
E2	0.76	0.55	-10% to +10%	-28%	1.00	0.91	-10% to +10%	-9%
E3	0.77	0.62	-10% to +10%	-20%	1.04	1.04	-10% to +10%	0%
E4	1.02	0.80	-10% to +10%	-22%	1.47	1.36	-10% to +10%	-8%
E5	0.81	0.62	-10% to +10%	-23%	1.19	1.04	-10% to +10%	-13%
E6	0.69	0.61	-10% to +10%	-11%	1.09	1.03	-10% to +10%	-5%

RC MH-32 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	3.98	3.83	-15% to +25%	-4%	1.27	1.19	-10% to +20%	-7%
E2	1.80	2.20	-15% to +25%	22%	1.75	2.13	-10% to +20%	22%
E3	2.27	1.99	-15% to +25%	-12%	1.78	1.79	-10% to +20%	0%
E4	4.52	2.65	-15% to +25%	-41%	7.18	4.89	-10% to +20%	-32%
E5	2.04	2.08	-15% to +25%	2%	2.07	1.85	-10% to +20%	-11%
E6	1.72	1.19	-15% to +25%	-30%	0.98	0.98	-10% to +20%	0%

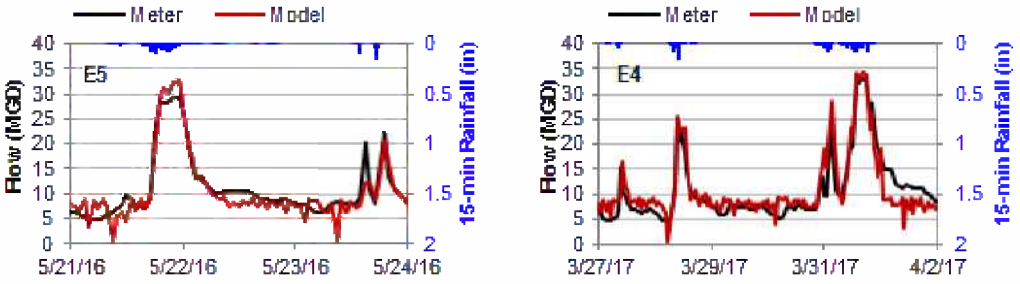
Note: All the six wet weather events are calibrated well within or close to the industry criteria except Event E4. Flow meter data recorded for E4 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CPS MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

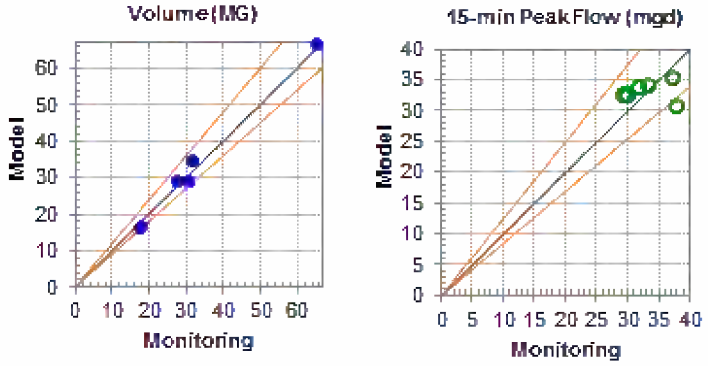
CPS Model Calibration Results (Metered and Modeled Flow)



CPS Model Validation Results (Metered and Modeled Flow)

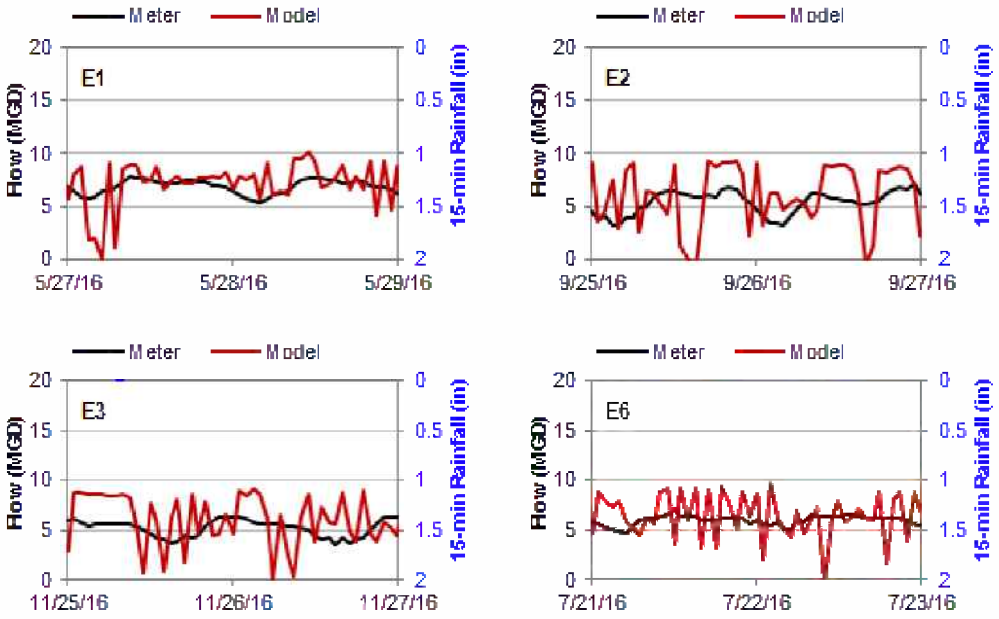


CPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

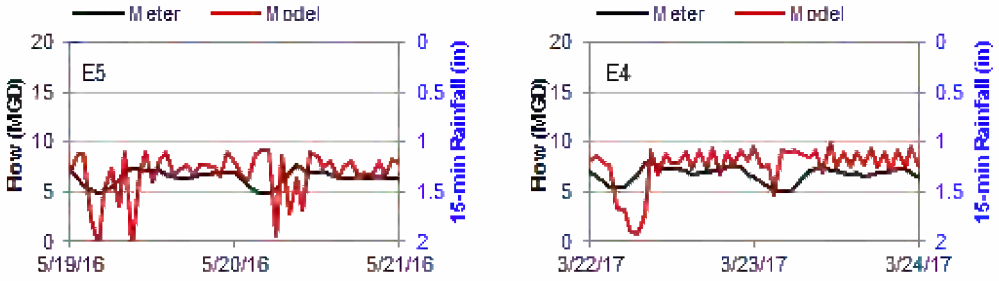


FLOW METER CPS MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

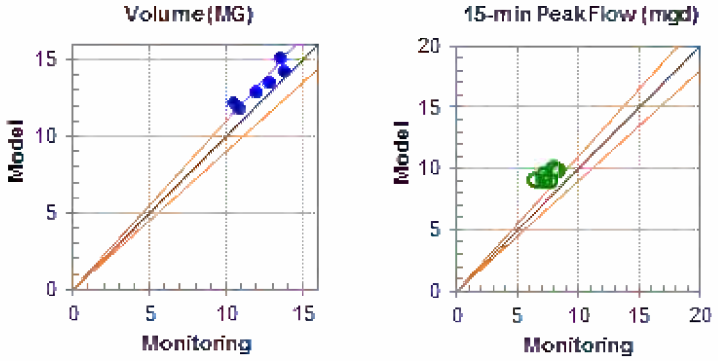
CPS Model Calibration Results (Metered and Modeled Flow)



CPS Model Validation Results (Metered and Modeled Flow)



CPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



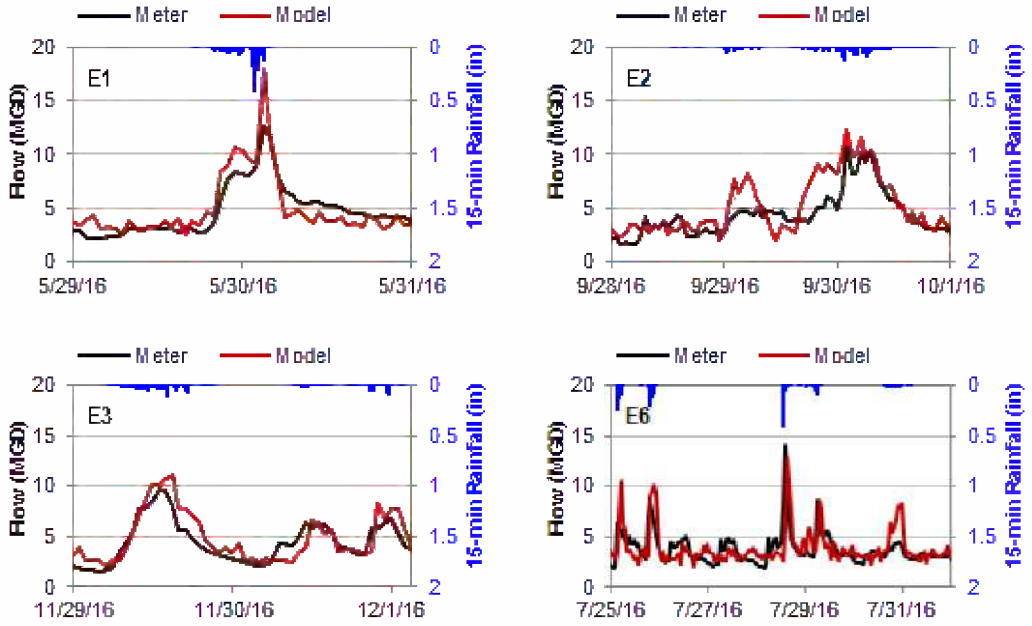
CPS Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	7.93	10.12	-10% to +10%	28%	13.69	14.37	-10% to +10%	5%
E2	7.16	9.19	-10% to +10%	28%	10.80	11.93	-10% to +10%	10%
E3	6.41	9.17	-10% to +10%	43%	10.42	12.30	-10% to +10%	18%
E4	8.12	9.96	-10% to +10%	23%	13.45	15.24	-10% to +10%	13%
E5	7.62	9.23	-10% to +10%	21%	12.79	13.56	-10% to +10%	6%
E6	7.11	9.69	-10% to +10%	36%	11.93	12.99	-10% to +10%	9%

CPS Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	31.54	33.89	-15% to +25%	7%	17.67	17.16	-10% to +20%	-3%
E2	37.19	35.56	-15% to +25%	-4%	31.53	35.06	-10% to +20%	11%
E3	29.85	32.57	-15% to +25%	9%	27.12	29.09	-10% to +20%	7%
E4	33.24	34.24	-15% to +25%	3%	64.77	66.78	-10% to +20%	3%
E5	29.39	32.86	-15% to +25%	12%	30.35	29.10	-10% to +20%	-4%
E6	37.62	30.86	-15% to +25%	-18%	16.98	16.47	-10% to +20%	-3%

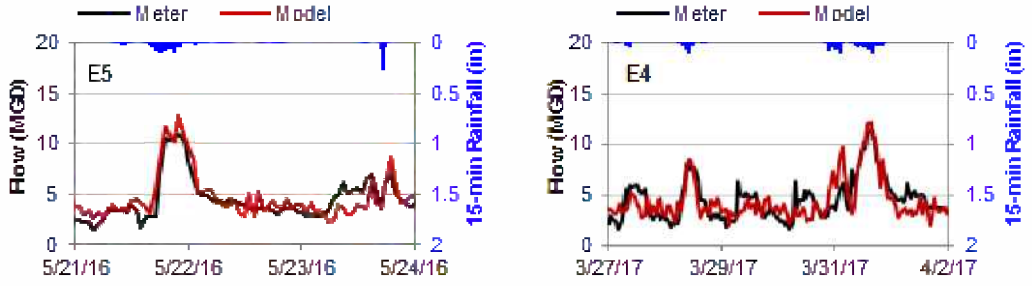
Note: All the six wet weather events are calibrated well within the industry criteria.

FLOW METER EPS-1 MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

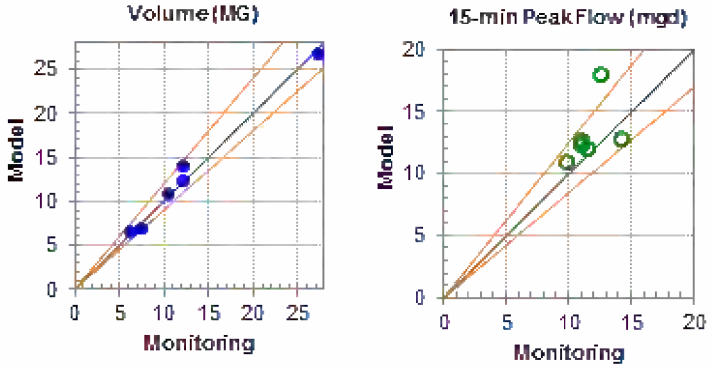
EPS-1 Model Calibration Results (Metered and Modeled Flow)



EPS-1 Model Validation Results (Metered and Modeled Flow)

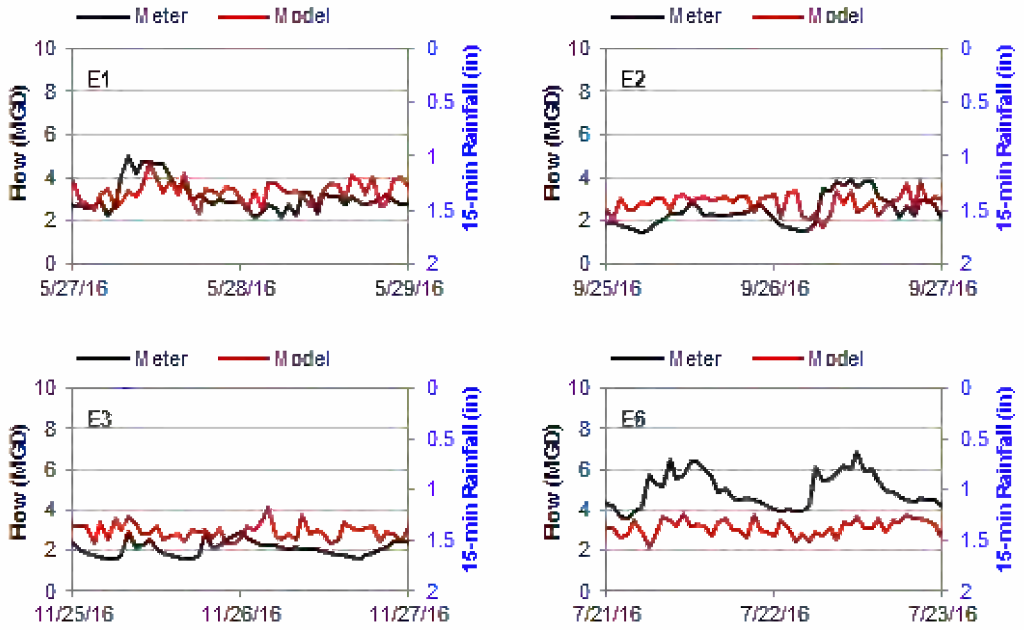


EPS-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

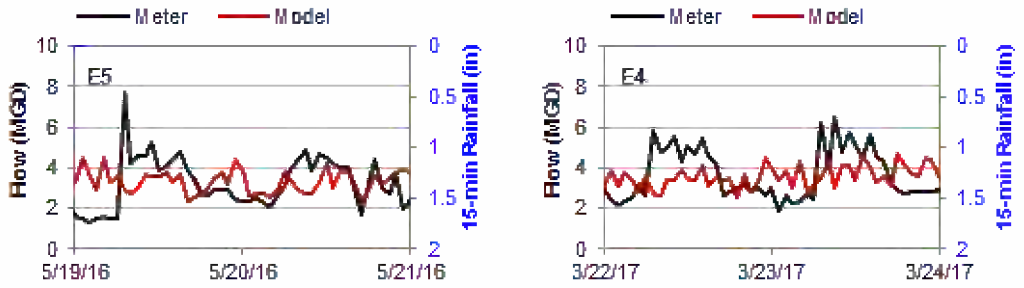


FLOW METER EPS-1 MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

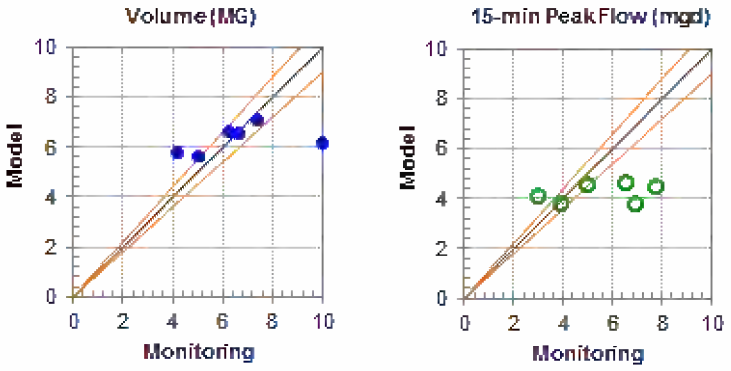
EPS-1 Model Calibration Results (Metered and Modeled Flow)



EPS-1 Model Validation Results (Metered and Modeled Flow)



EPS-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



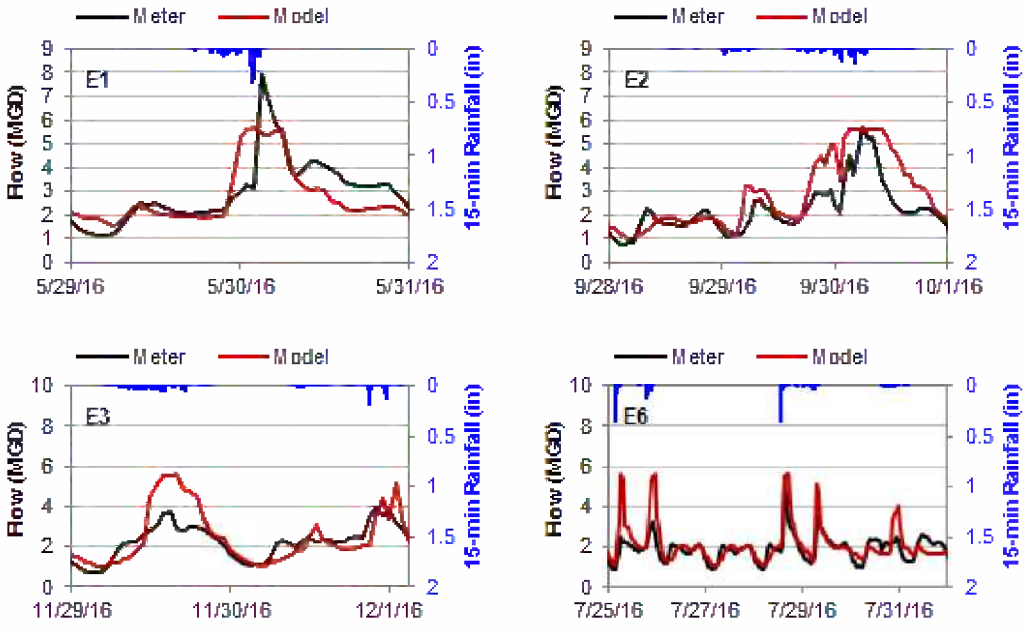
EPS-1 Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	4.95	4.61	-10% to +10%	-7%	6.25	6.65	-10% to +10%	7%
E2	3.88	3.81	-10% to +10%	-2%	4.96	5.69	-10% to +10%	15%
E3	2.90	4.11	-10% to +10%	42%	4.15	5.83	-10% to +10%	40%
E4	6.51	4.67	-10% to +10%	-28%	7.34	7.14	-10% to +10%	-3%
E5	7.72	4.50	-10% to +10%	-42%	6.57	6.62	-10% to +10%	1%
E6	6.83	3.86	-10% to +10%	-43%	9.97	6.23	-10% to +10%	-38%

EPS-1 Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	12.57	18.03	-15% to +25%	43%	6.19	6.60	-10% to +20%	6%
E2	10.94	12.32	-15% to +25%	13%	11.99	14.22	-10% to +20%	19%
E3	9.79	11.08	-15% to +25%	13%	10.30	10.88	-10% to +20%	6%
E4	11.50	12.12	-15% to +25%	5%	27.24	26.82	-10% to +20%	-2%
E5	10.92	12.74	-15% to +25%	17%	12.06	12.37	-10% to +20%	3%
E6	14.11	12.83	-15% to +25%	-9%	7.32	7.02	-10% to +20%	-4%

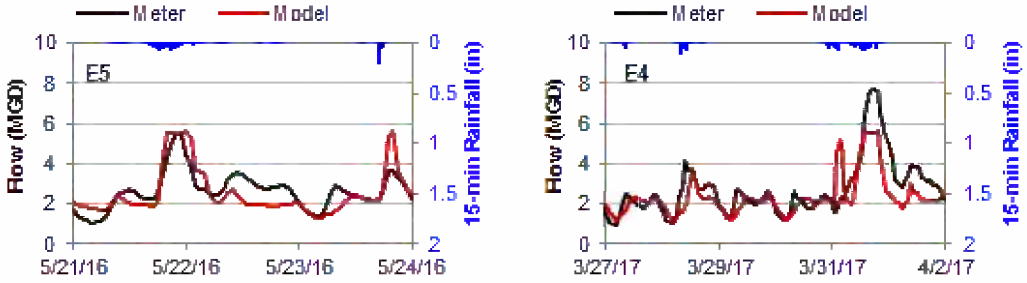
Note: All the six wet weather events are calibrated well within the industry criteria except peak flow for Event E1. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER NCPS MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

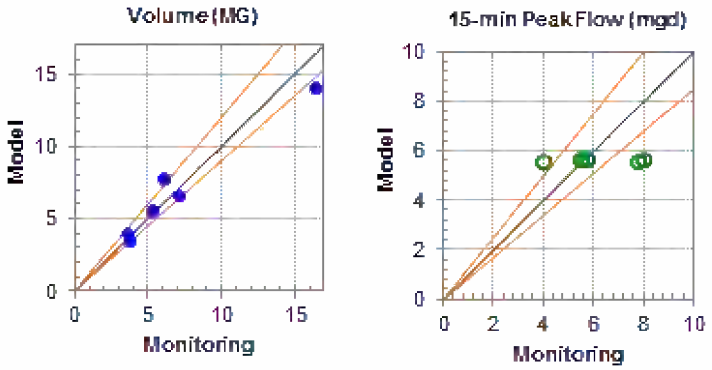
NCPS Model Calibration Results (Metered and Modeled Flow)



NCPS Model Validation Results (Metered and Modeled Flow)

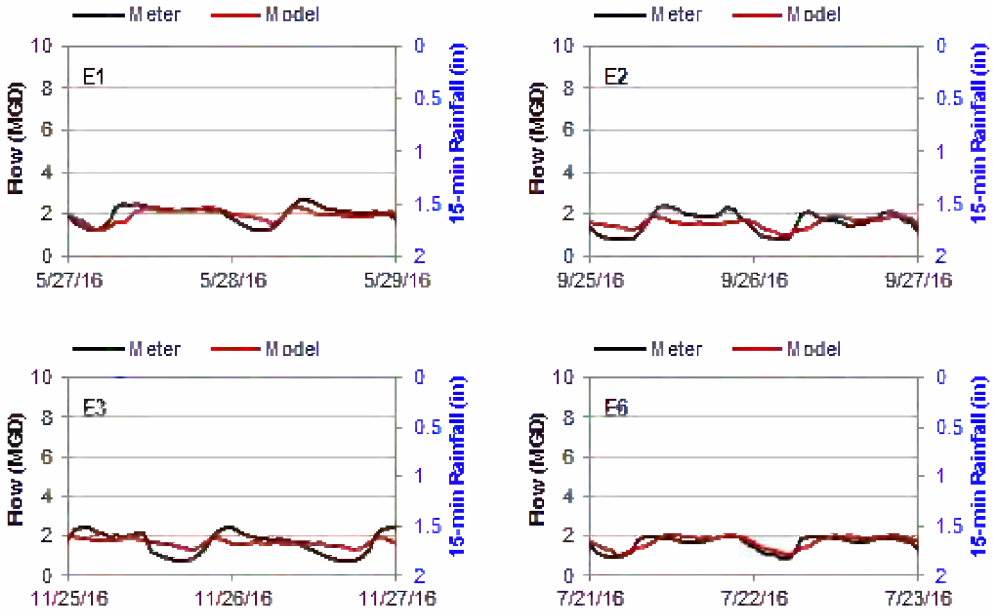


NCPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

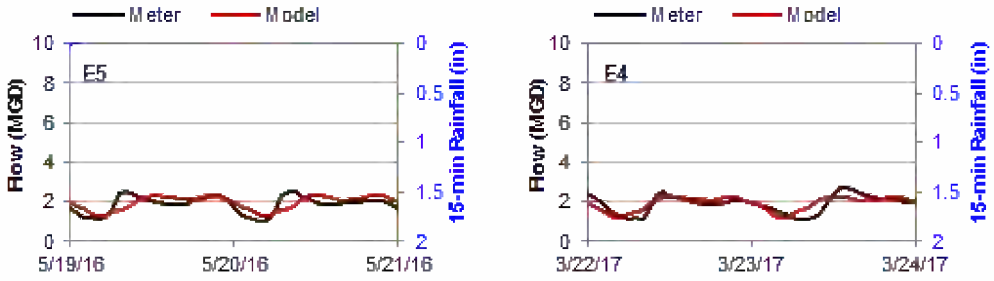


FLOW METER NCPS MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

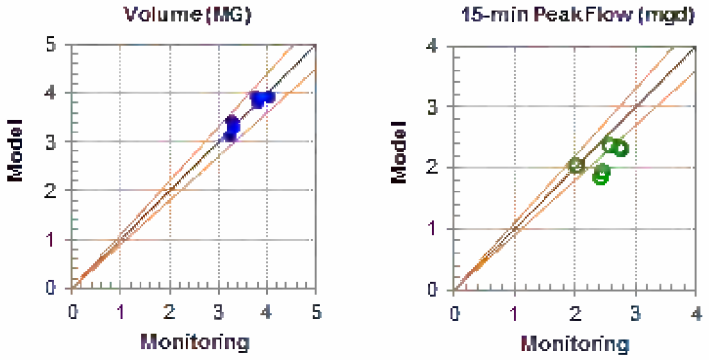
NCPS Model Calibration Results (Metered and Modeled Flow)



NCPS Model Validation Results (Metered and Modeled Flow)



NCPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



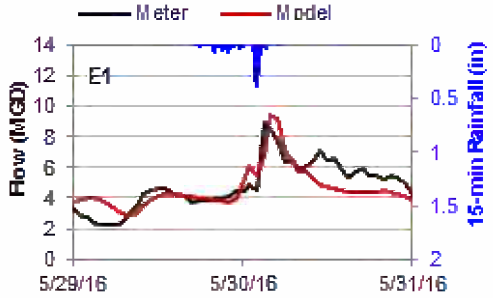
NCPS Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	2.72	2.36	-10% to +10%	-13%	4.02	3.93	-10% to +10%	-2%
E2	2.41	1.86	-10% to +10%	-23%	3.22	3.14	-10% to +10%	-2%
E3	2.45	1.94	-10% to +10%	-21%	3.31	3.33	-10% to +10%	1%
E4	2.74	2.31	-10% to +10%	-16%	3.78	3.84	-10% to +10%	2%
E5	2.55	2.38	-10% to +10%	-7%	3.77	3.95	-10% to +10%	5%
E6	1.99	2.05	-10% to +10%	3%	3.25	3.44	-10% to +10%	6%

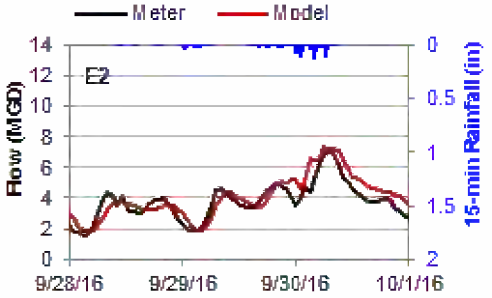
NCPS Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	7.95	5.65	-15% to +25%	-29%	3.67	3.51	-10% to +20%	-4%
E2	5.71	5.63	-15% to +25%	-1%	6.02	7.83	-10% to +20%	30%
E3	3.95	5.62	-15% to +25%	42%	5.29	5.61	-10% to +20%	6%
E4	7.75	5.61	-15% to +25%	-28%	16.38	14.07	-10% to +20%	-14%
E5	5.51	5.66	-15% to +25%	3%	7.07	6.64	-10% to +20%	-6%
E6	5.51	5.67	-15% to +25%	3%	3.53	4.03	-10% to +20%	14%

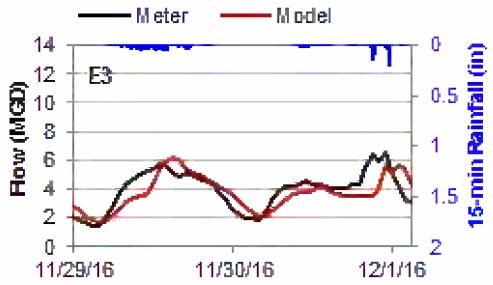
Note: Four of the six wet weather events are calibrated well within the industry criteria. The under-predicted peak flow for E1 and E4 is probably due to the pump capacity limit put in the model based on received pump curves. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

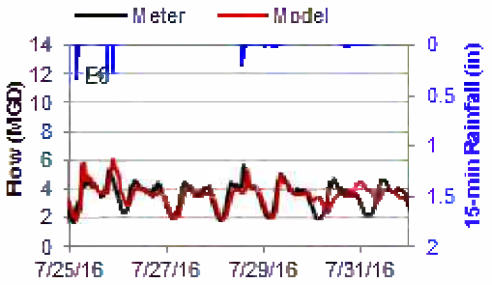
FLOW METER CRPS MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

CRPS Model Calibration Results (Metered and Modeled Flow)

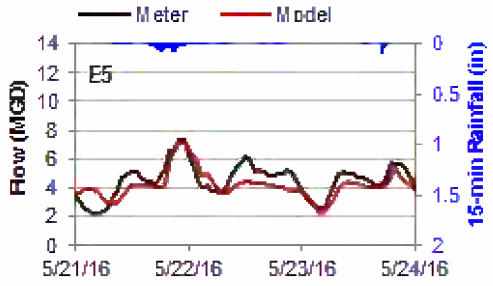


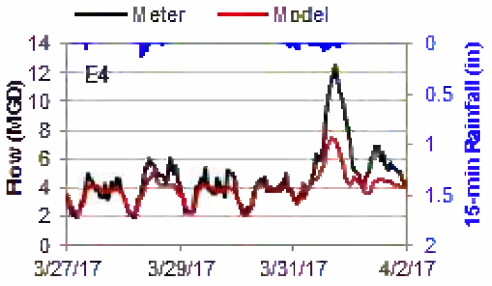




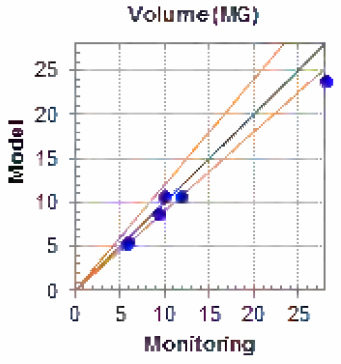


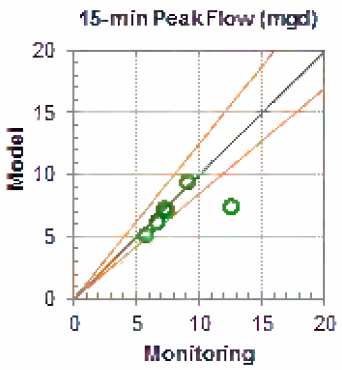
CRPS Model Validation Results (Metered and Modeled Flow)





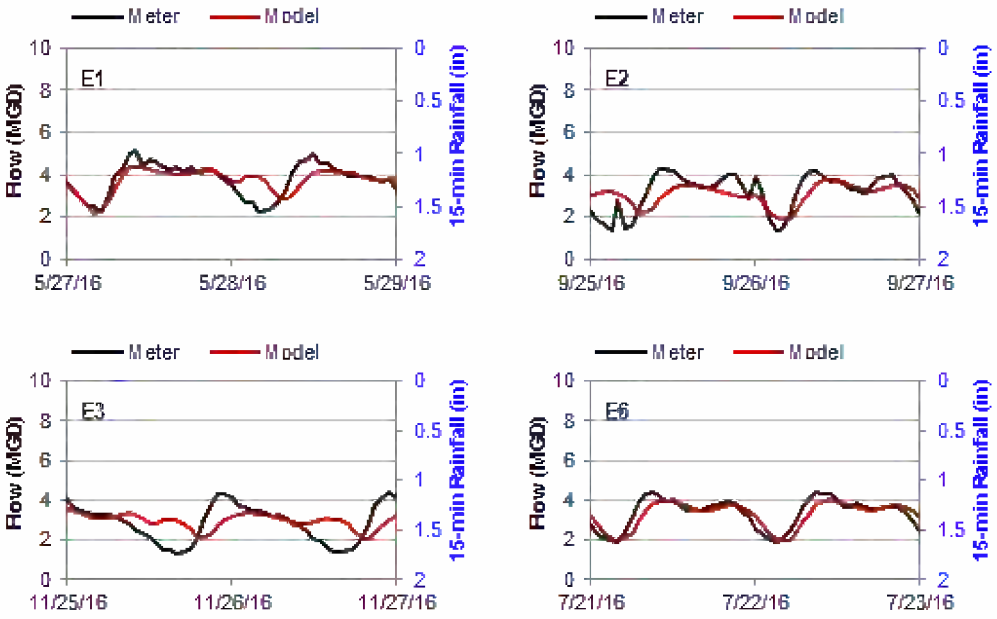
CRPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



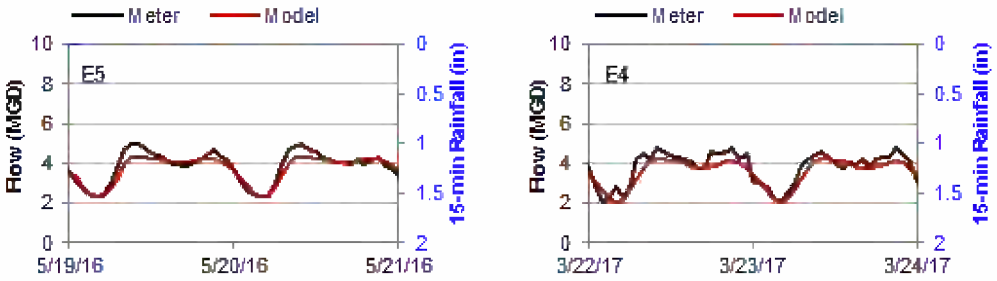


FLOW METER CRPS MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

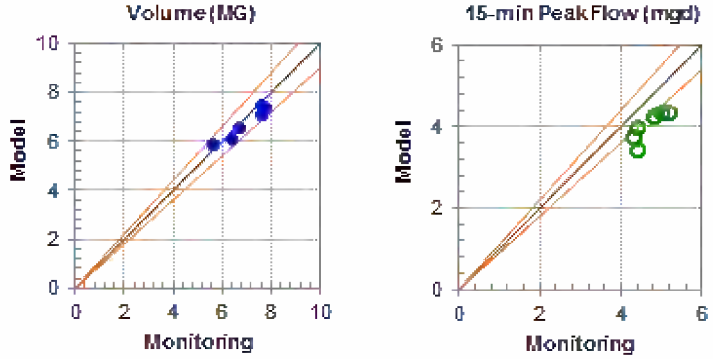
CRPS Model Calibration Results (Metered and Modeled Flow)



CRPS Model Validation Results (Metered and Modeled Flow)



CRPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



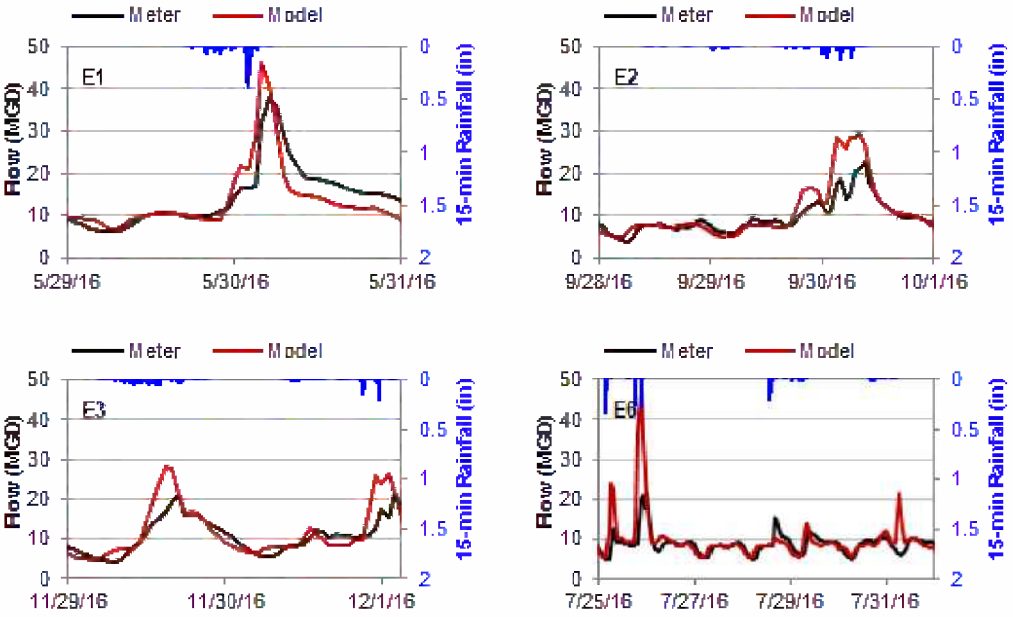
CRPS Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	5.18	4.36	-10% to +10%	-16%	7.58	7.49	-10% to +10%	-1%
E2	4.30	3.75	-10% to +10%	-13%	6.36	6.13	-10% to +10%	-4%
E3	4.38	3.44	-10% to +10%	-21%	5.64	5.87	-10% to +10%	4%
E4	4.81	4.26	-10% to +10%	-12%	7.59	7.10	-10% to +10%	-6%
E5	4.97	4.36	-10% to +10%	-12%	7.71	7.45	-10% to +10%	-3%
E6	4.42	3.99	-10% to +10%	-10%	6.71	6.56	-10% to +10%	-2%

CRPS Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	8.96	9.48	-15% to +25%	6%	5.67	5.45	-10% to +20%	-4%
E2	7.22	7.29	-15% to +25%	1%	10.03	10.80	-10% to +20%	8%
E3	6.54	6.21	-15% to +25%	-5%	9.27	8.75	-10% to +20%	-6%
E4	12.48	7.48	-15% to +25%	-40%	27.92	23.89	-10% to +20%	-14%
E5	7.40	7.17	-15% to +25%	-3%	11.95	10.82	-10% to +20%	-9%
E6	5.64	5.18	-15% to +25%	-8%	5.84	5.64	-10% to +20%	-3%

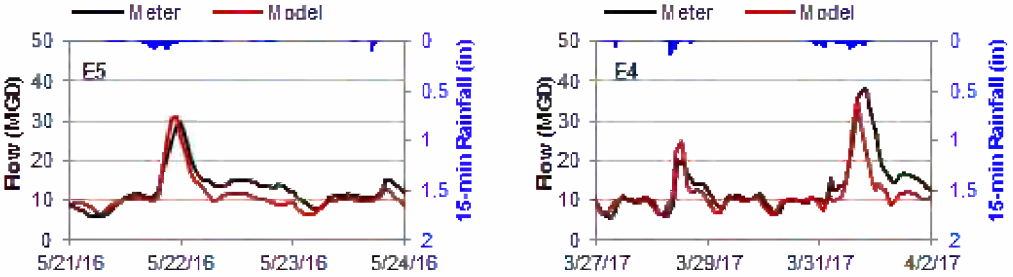
Note: All the six wet weather events are calibrated well within the industry criteria except peak flow for Event E4. Flow meter data recorded for E4 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER CDPS TOTAL MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

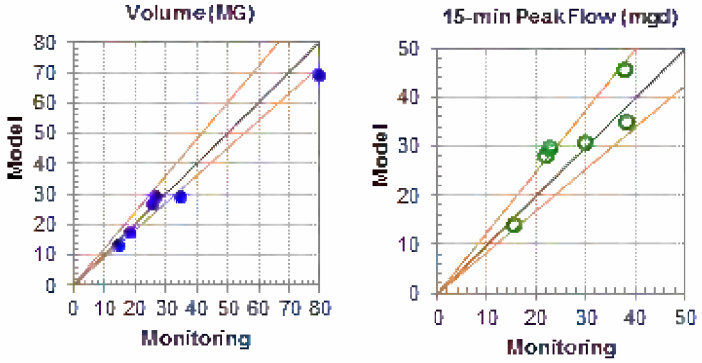
CDPS Total Model Calibration Results (Metered and Modeled Flow)



CDPS Total Model Validation Results (Metered and Modeled Flow)

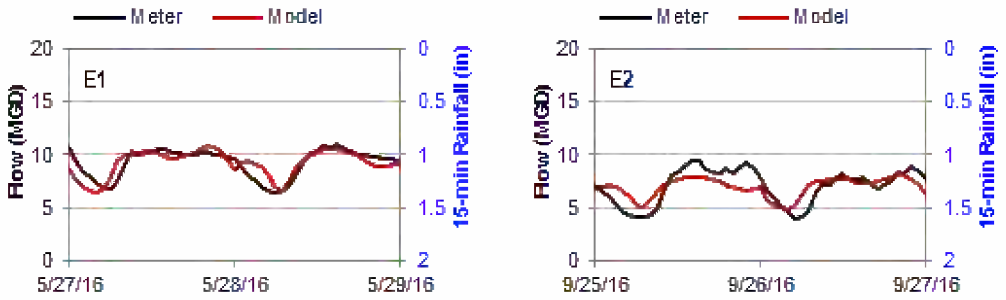


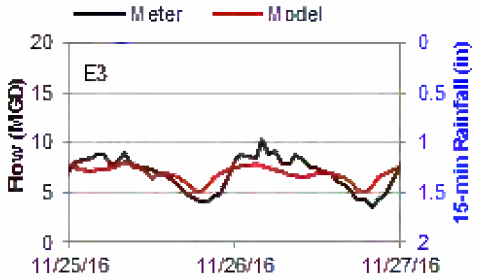
CDPS Total Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

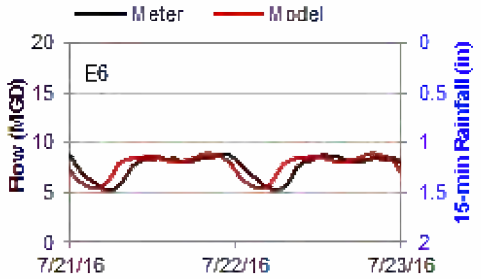


FLOW METER CDPS TOTAL MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

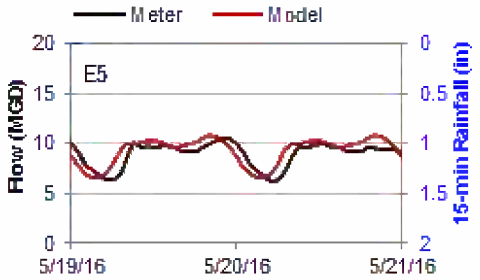
CDPS Total Model Calibration Results (Metered and Modeled Flow)

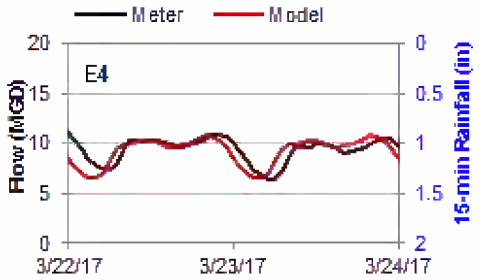




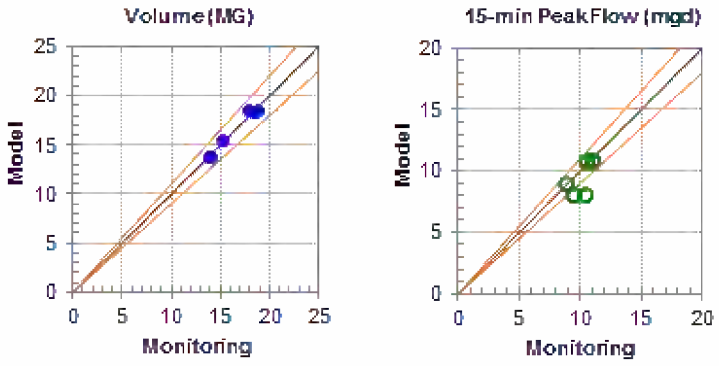


CDPS Total Model Validation Results (Metered and Modeled Flow)





CDPS Total Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



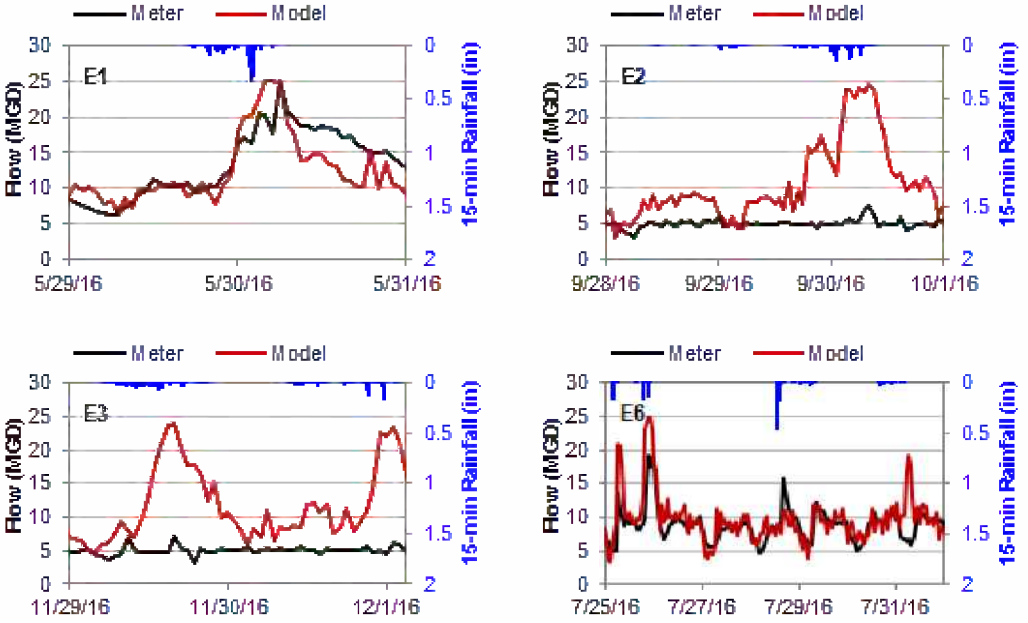
CDPS Total Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	10.96	10.82	-10% to +10%	-1%	18.43	18.45	-10% to +10%	0%
E2	9.44	8.14	-10% to +10%	-14%	14.04	13.87	-10% to +10%	-1%
E3	10.39	8.04	-10% to +10%	-23%	13.84	13.76	-10% to +10%	-1%
E4	10.97	10.82	-10% to +10%	-1%	18.70	18.50	-10% to +10%	-1%
E5	10.52	10.82	-10% to +10%	3%	17.77	18.50	-10% to +10%	4%
E6	8.81	9.06	-10% to +10%	3%	15.18	15.50	-10% to +10%	2%

CDPS Total Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	37.59	46.03	-15% to +25%	22%	18.12	17.80	-10% to +20%	-2%
E2	22.62	29.77	-15% to +25%	32%	26.28	29.53	-10% to +20%	12%
E3	21.62	28.12	-15% to +25%	30%	25.07	27.13	-10% to +20%	8%
E4	38.01	35.13	-15% to +25%	-8%	79.48	69.36	-10% to +20%	-13%
E5	29.79	31.11	-15% to +25%	4%	34.43	29.65	-10% to +20%	-14%
E6	15.30	14.01	-15% to +25%	-8%	14.43	13.30	-10% to +20%	-8%

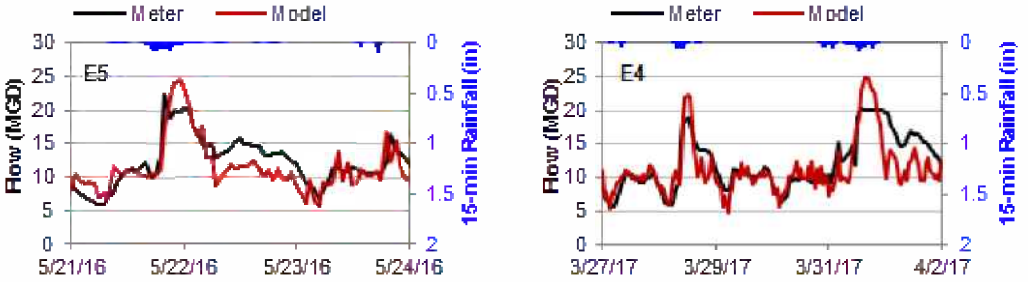
Note: All the six wet weather events are calibrated well within or close to the industry criteria.

FLOW METER CDPS TO WRTP MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

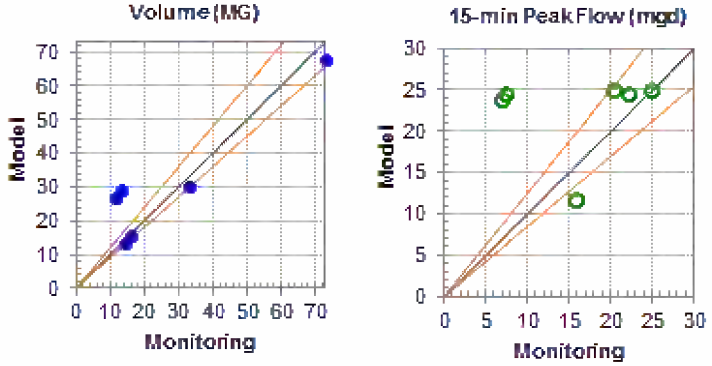
CDPS to WRTP Model Calibration Results (Metered and Modeled Flow)



CDPS to WRTP Model Validation Results (Metered and Modeled Flow)

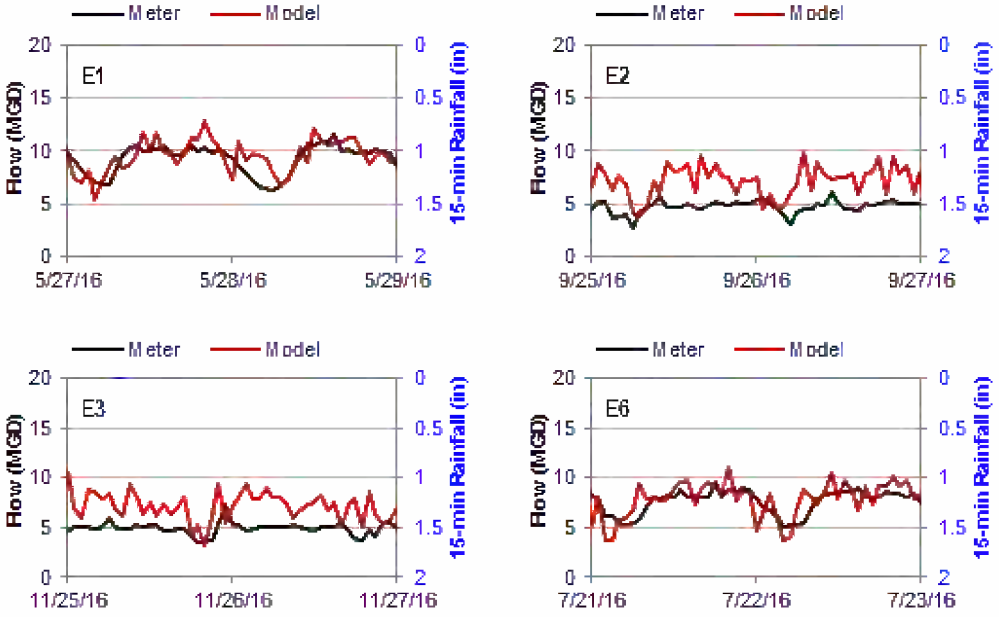


CDPS to WRTP Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

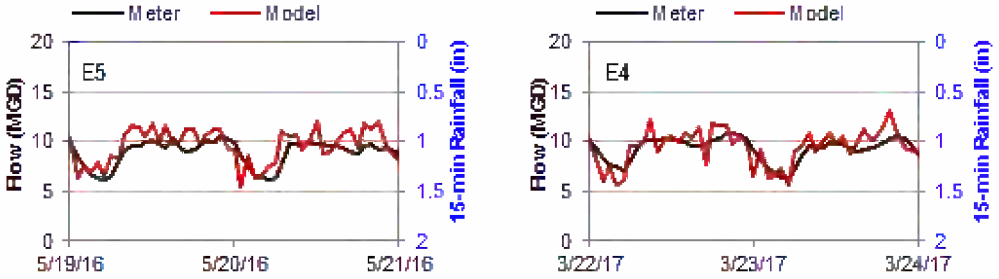


FLOW METER CDPS TO WRTP MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

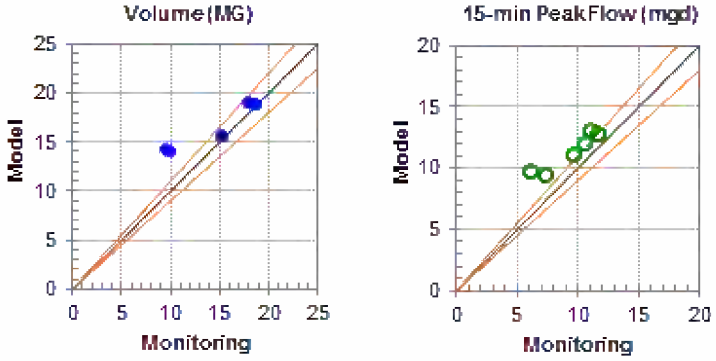
CDPS to WRTP Model Calibration Results (Metered and Modeled Flow)



CDPS to WRTP Model Validation Results (Metered and Modeled Flow)



CDPS to WRTP Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



CDPS to WRTP Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	11.51	12.85	-10% to +10%	12%	18.39	19.01	-10% to +10%	3%
E2	6.00	9.79	-10% to +10%	63%	9.45	14.29	-10% to +10%	51%
E3	7.22	9.46	-10% to +10%	31%	9.83	14.19	-10% to +10%	44%
E4	10.89	13.14	-10% to +10%	21%	18.50	18.96	-10% to +10%	2%
E5	10.44	12.10	-10% to +10%	16%	17.76	19.21	-10% to +10%	8%
E6	9.56	11.13	-10% to +10%	16%	15.20	15.76	-10% to +10%	4%

CDPS to WRTP Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	24.93	24.93	-15% to +25%	0%	15.92	15.55	-10% to +20%	-2%
E2	7.41	24.61	-15% to +25%	232%	12.92	29.02	-10% to +20%	125%
E3	6.95	23.88	-15% to +25%	243%	11.69	26.99	-10% to +20%	131%
E4	20.25	24.89	-15% to +25%	23%	72.78	68.00	-10% to +20%	-7%
E5	22.24	24.53	-15% to +25%	10%	33.04	30.02	-10% to +20%	-9%
E6	15.80	11.79	-15% to +25%	-25%	14.31	13.26	-10% to +20%	-7%

Note: During Rainfall Events E2 and E3, CDPS flow to the WRTP was capped due to the aeration replacement project at WRTP.

All the remaining four wet weather events are calibrated well within the industry criteria.

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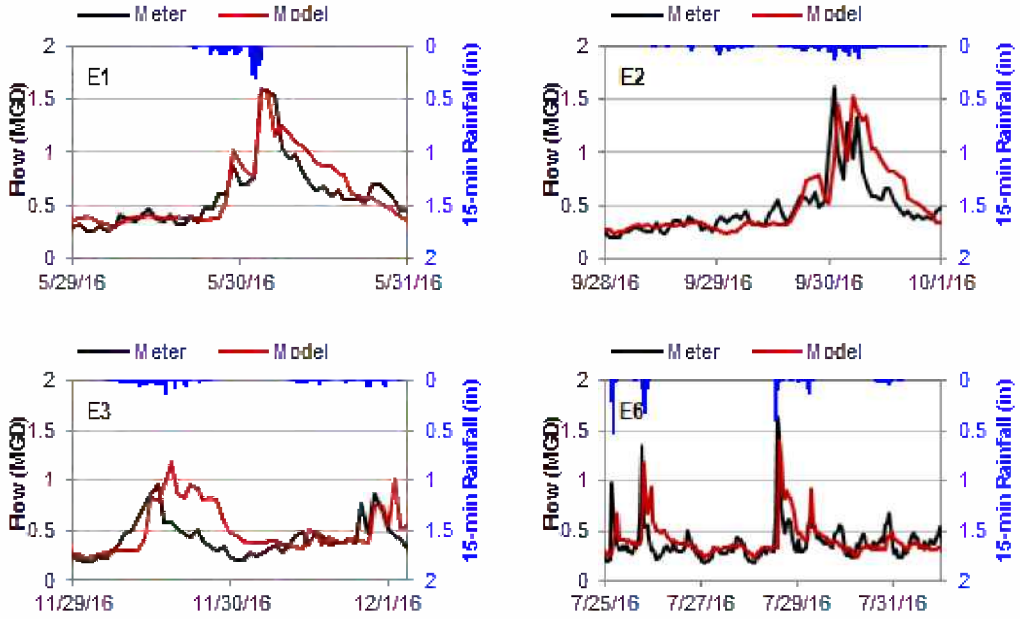
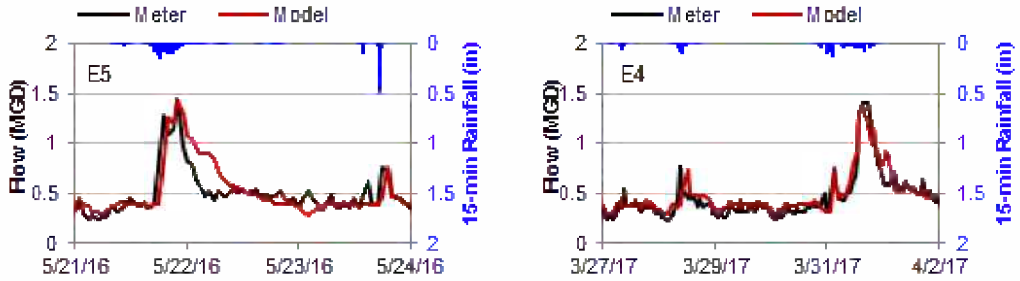
FLOW METER EDPS MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

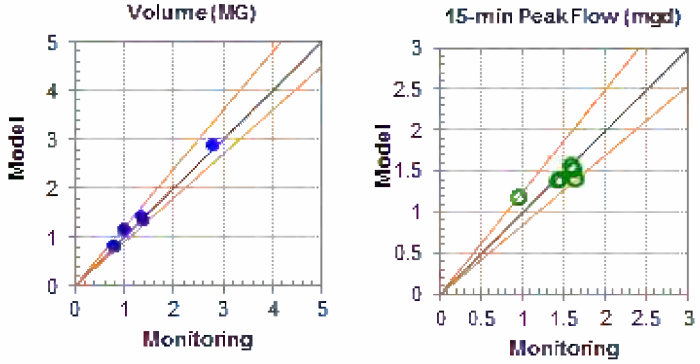
EDPS Model Calibration Results (Metered and Modeled Flow)



EDPS Model Validation Results (Metered and Modeled Flow)

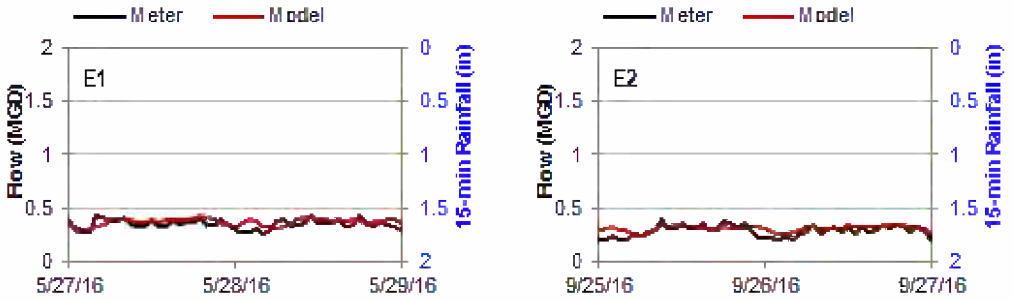


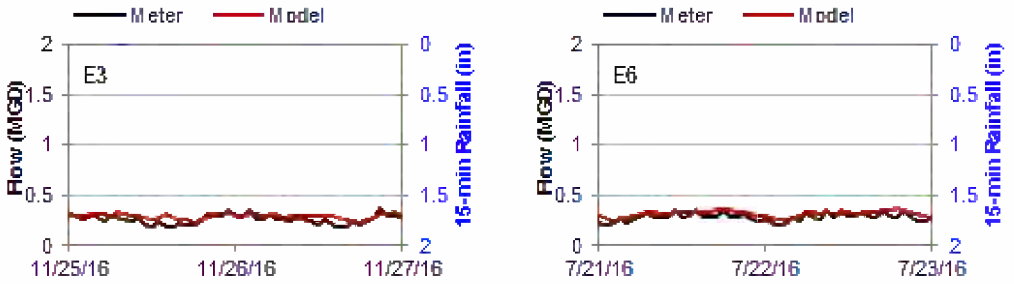
EDPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



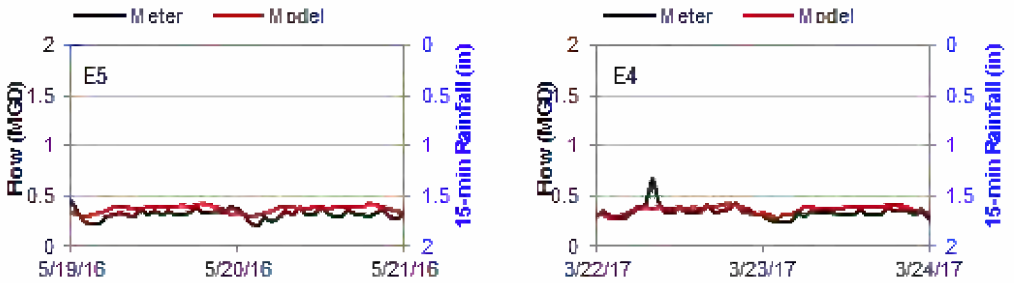
FLOW METER EDPS MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

EDPS Model Calibration Results (Metered and Modeled Flow)

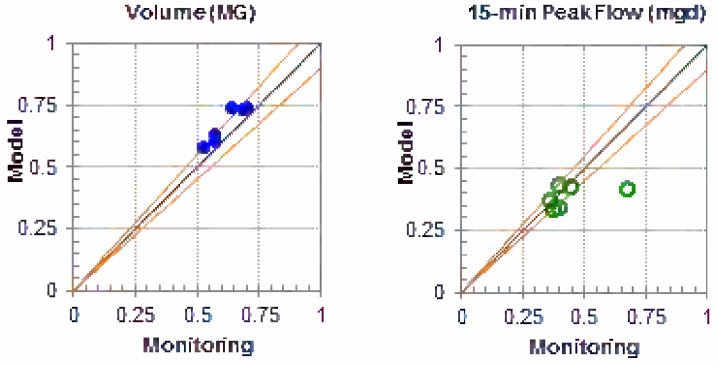




EDPS Model Validation Results (Metered and Modeled Flow)



EDPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



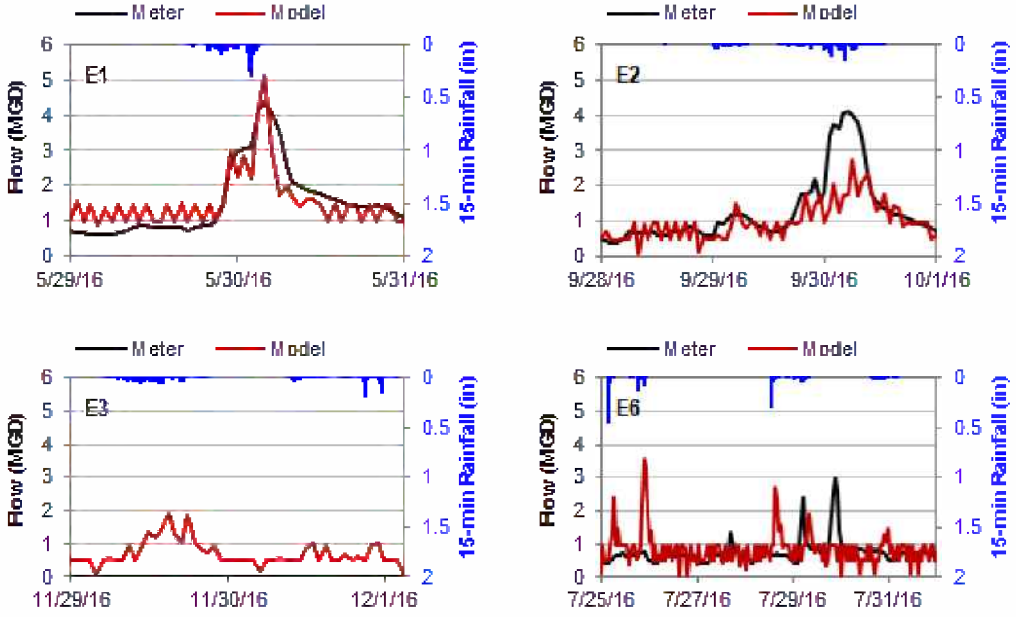
EDPS Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.44	0.43	-10% to +10%	-2%	0.70	0.74	-10% to +10%	6%
E2	0.39	0.35	-10% to +10%	-12%	0.57	0.61	-10% to +10%	7%
E3	0.37	0.34	-10% to +10%	-8%	0.52	0.58	-10% to +10%	12%
E4	0.67	0.42	-10% to +10%	-37%	0.68	0.74	-10% to +10%	8%
E5	0.40	0.43	-10% to +10%	10%	0.64	0.74	-10% to +10%	17%
E6	0.36	0.37	-10% to +10%	5%	0.57	0.64	-10% to +10%	12%

EDPS Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	1.59	1.59	-15% to +25%	0%	0.77	0.83	-10% to +20%	8%
E2	1.61	1.53	-15% to +25%	-5%	1.32	1.44	-10% to +20%	9%
E3	0.95	1.19	-15% to +25%	25%	0.98	1.20	-10% to +20%	23%
E4	1.41	1.40	-15% to +25%	-1%	2.76	2.92	-10% to +20%	6%
E5	1.44	1.42	-15% to +25%	-2%	1.35	1.39	-10% to +20%	3%
E6	1.63	1.42	-15% to +25%	-13%	0.77	0.85	-10% to +20%	11%

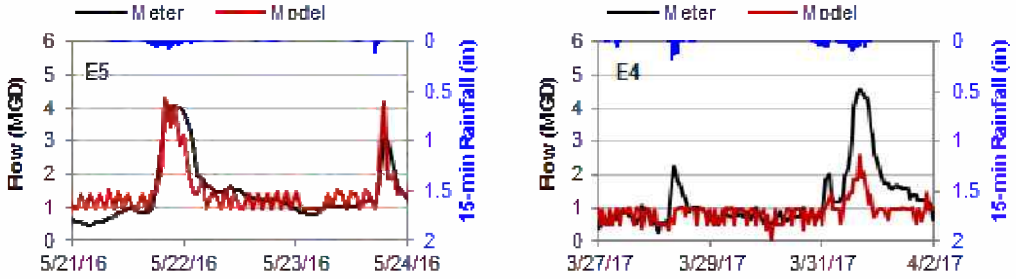
Note: All the six wet weather events are calibrated well within or close to the industry criteria.

FLOW METER MHPS MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

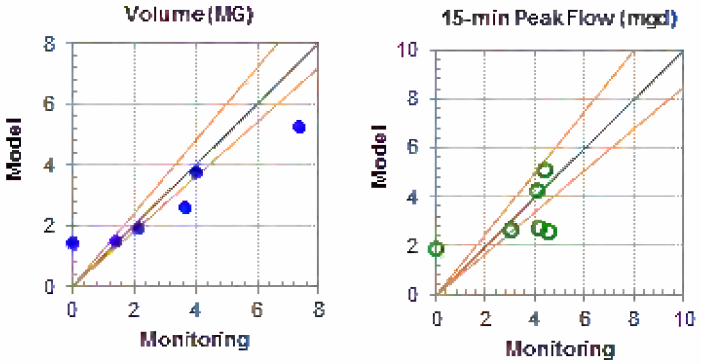
MHPS Model Calibration Results (Metered and Modeled Flow)



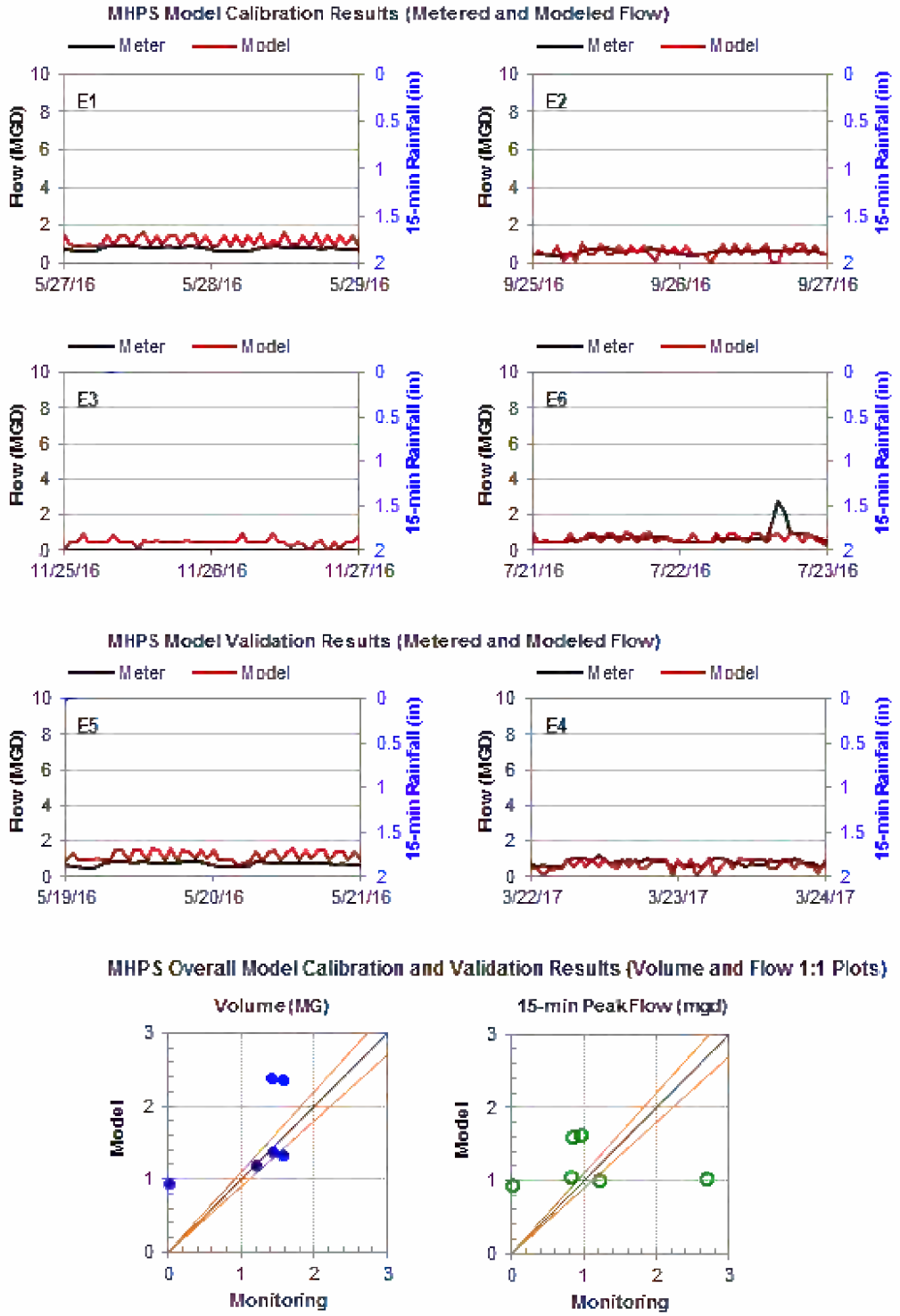
MHPS Model Validation Results (Metered and Modeled Flow)



MHPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER MHPS MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events

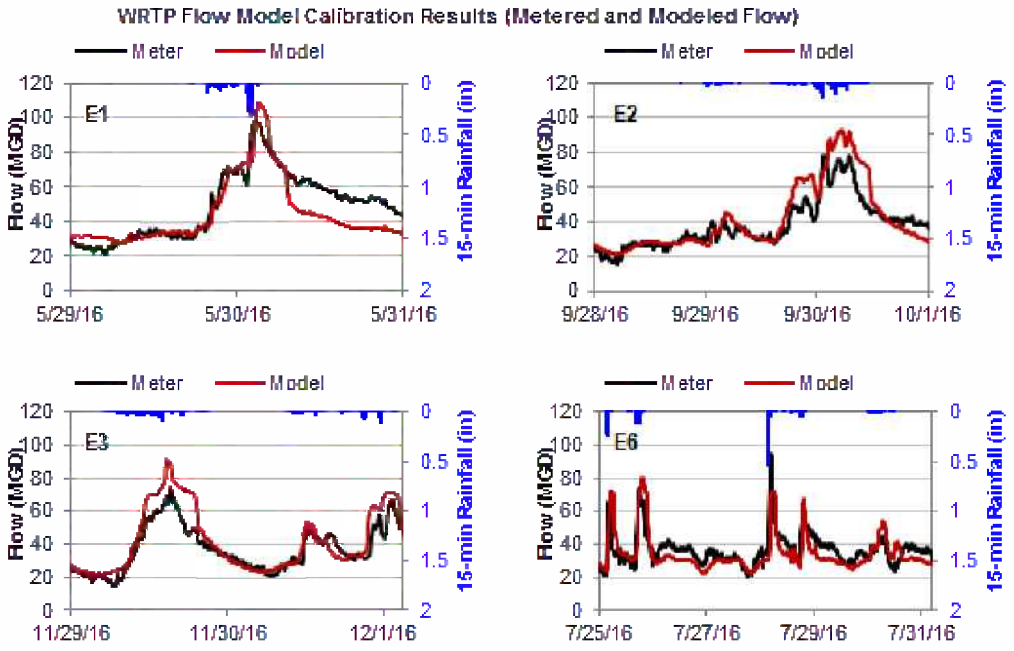


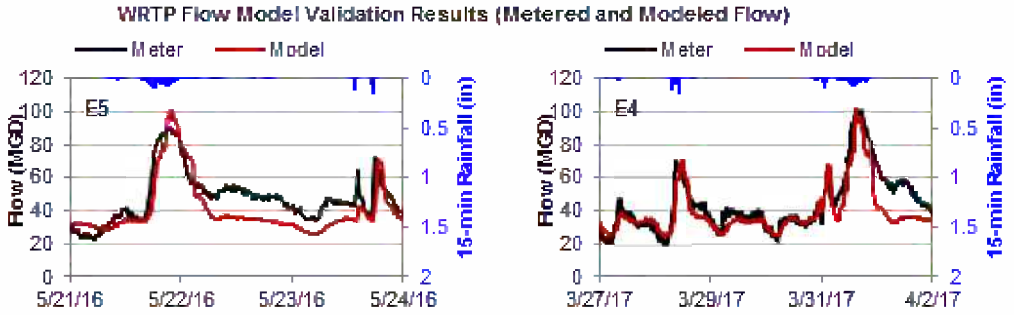
MHPS Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	0.94	1.63	-10% to +10%	73%	1.58	2.36	-10% to +10%	50%
E2	0.81	1.06	-10% to +10%	32%	1.20	1.20	-10% to +10%	1%
E3	0.00	0.95	-10% to +10%	See Note Below	0.00	0.93	-10% to +10%	See Note Below
E4	1.20	1.02	-10% to +10%	-15%	1.58	1.33	-10% to +10%	-16%
E5	0.83	1.60	-10% to +10%	93%	1.40	2.38	-10% to +10%	70%
E6	2.68	1.04	-10% to +10%	-61%	1.43	1.38	-10% to +10%	-4%

MHPS Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	4.39	5.09	-15% to +25%	16%	2.11	1.95	-10% to +20%	-8%
E2	4.12	2.73	-15% to +25%	-34%	3.62	2.65	-10% to +20%	-27%
E3	0.00	1.91	-15% to +25%	See Note Below	0.00	1.46	-10% to +20%	See Note Below
E4	4.54	2.61	-15% to +25%	-43%	7.36	5.28	-10% to +20%	-28%
E5	4.05	4.27	-15% to +25%	5%	4.00	3.81	-10% to +20%	-5%
E6	2.99	2.70	-15% to +25%	-10%	1.39	1.50	-10% to +20%	8%

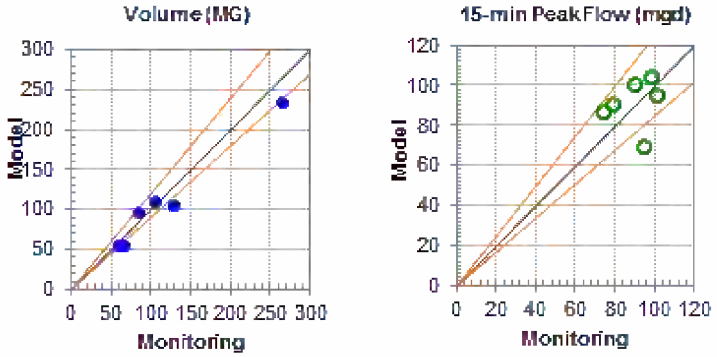
Note: Flow meter data not available for Event E3. Three of the remaining five wet weather events are calibrated well within the industry criteria. Flow meter data recorded for E2 and E4 is not consistent with the recorded rainfall intensity. Based on the calibration results of the overall model, the model calibration is adequate for purposes of long term control planning.

FLOW METER WRTP FLOW MODEL CALIBRATION AND VALIDATION RESULTS_Wet Weather Events

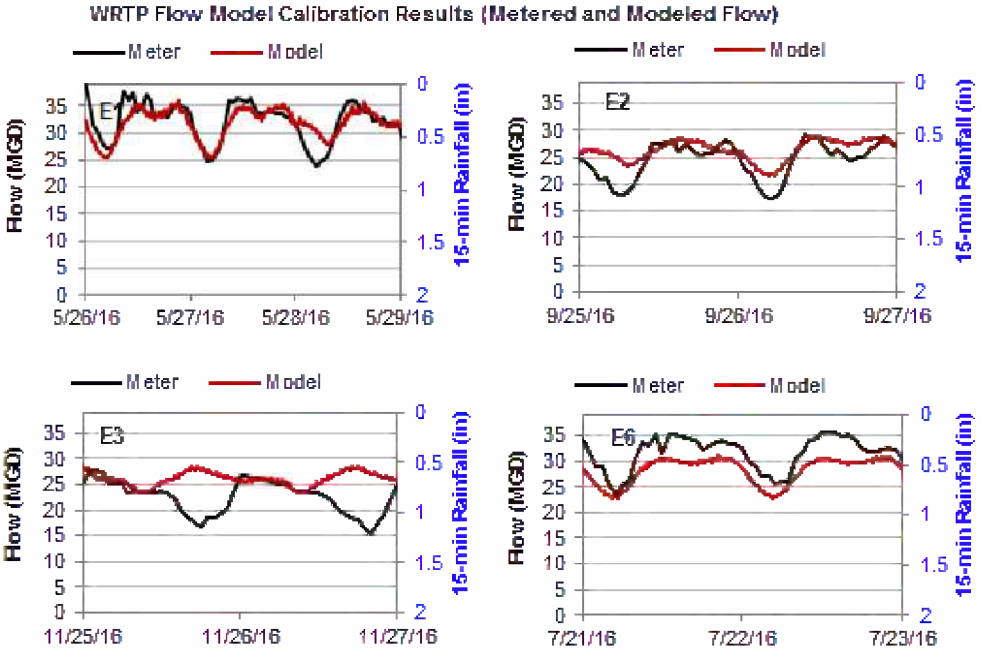


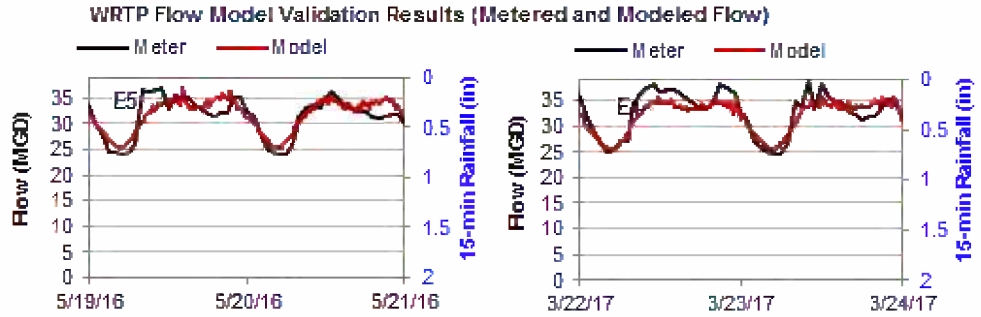


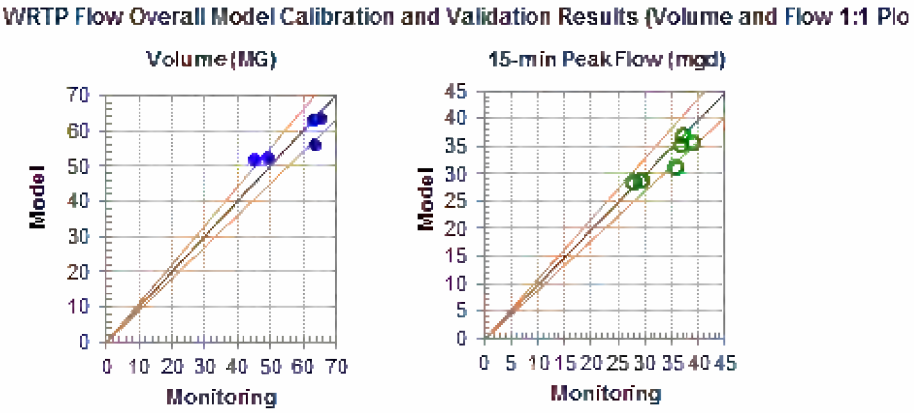
WRTP Flow Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)



FLOW METER WRTP FLOW MODEL CALIBRATION AND VALIDATION RESULTS_Dry Weather Events







WRTP Flow Model Dry Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	36.45	38.89	-10% to +10%	7%	62.91	63.52	-10% to +10%	1%
E2	29.28	29.03	-10% to +10%	-1%	49.02	52.61	-10% to +10%	7%
E3	27.68	28.79	-10% to +10%	4%	45.05	52.52	-10% to +10%	17%
E4	38.76	36.21	-10% to +10%	-7%	65.29	63.80	-10% to +10%	-2%
E5	36.88	36.10	-10% to +10%	-2%	62.75	63.47	-10% to +10%	1%
E6	35.61	31.18	-10% to +10%	-12%	63.12	56.27	-10% to +10%	-11%

WRTP Flow Model Wet Weather Calibration and Validation Summary								
Event	Peak Flow (MGD)				Volume (MG)			
	Monitored	Model	Criteria	Achieved	Monitored	Model	Criteria	Achieved
E1	97.94	108.55	-15% to +25%	11%	59.32	56.46	-10% to +20%	-5%
E2	78.26	93.19	-15% to +25%	19%	104.19	113.52	-10% to +20%	9%
E3	74.21	91.44	-15% to +25%	23%	85.10	95.25	-10% to +20%	12%
E4	100.93	101.13	-15% to +25%	0%	263.84	235.90	-10% to +20%	-11%
E5	89.95	100.49	-15% to +25%	12%	127.56	106.30	-10% to +20%	-17%
E6	94.40	72.14	-15% to +25%	-24%	66.96	57.10	-10% to +20%	-15%

Note: All the six wet weather events are calibrated well within or close to the industry criteria.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Greg. McDiSantis

RECEIVED
APR 19 2018
By 2018-0505

4/17/2018

Mr. Michael DiSantis, Director of Operations & Maintenance
Delaware County Regional Water Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. DiSantis:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Regional Water Quality Control Authority (DELCORA) Sewer System Hydrologic and Hydraulic Model Report Revised Appendix C dated March 1, 2018. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA accepts and approves the subject report.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: P. Yeany, EPA
Tom Magee, PaDEP, SERO
C. Hurst, DELCORA

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APPENDIX G

Rainfall and Flow Monitoring Quarterly Report

- DELCORA Rainfall and Flow Monitoring Quarterly Report No. 1 dated July 2016
- DELCORA Rainfall and Flow Monitoring Quarterly Report No. 2 (July 1, 2016 to September 30, 2016) (Final) dated October 2016
- DELCORA Rainfall and Flow Monitoring Quarterly Report No. 3 (October 1, 2016 to December 31, 2016) (Final) dated January 2017
- DELCORA Rainfall and Flow Monitoring Quarterly Report No. 4 (January 1, 2017 to April 1, 2017) - Final dated April 2017
- DELCORA Transmittal Letter of Rainfall and Flow Monitoring Quarterly Report No. 1 dated July 29, 2016
- DELCORA Transmittal Letter of Rainfall and Flow Monitoring Quarterly Report No. 2 dated October 25, 2016
- DELCORA Transmittal Letter of Rainfall and Flow Monitoring Quarterly Report No. 3 dated January 26, 2017
- DELCORA Transmittal Letter of Rainfall and Flow Monitoring Quarterly Report No. 4 dated April 28, 2017

Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Rainfall and Flow Monitoring Quarterly Report No. 1

~~(Draft)~~ (FINAL)

July 2016

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Rainfall and Flow Monitoring Report No. 1.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	*Signature*	7/24/16 *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	7/26/16 *Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	7/26/16 *Date*

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) entered into a Consent Decree (CD) with the United States Government in August 2015. The purpose of the Consent Decree is to establish a schedule for implementation of Long Term Control Plan Update (LTCPU) to achieve full compliance with the Clean Water Act and the regulations and Clean Streams Law and regulations. The lodging of this Consent Decree was entered by the court on August 17, 2015, it was signed and filed on November 10, 2015 by the United States District Court for the Eastern District of Pennsylvania.

According to the Consent Decree, DELCORA's Hydrologic and Hydraulic Model (H&H Model) must be updated to meet the requirements in Section V.A.14 of the Consent Decree. A detailed plan to update, calibrate and validate the H&H model has been submitted and approved by the USEPA on March 1, 2016. Additional rainfall and flow monitoring is required to calibrate and validate the H&H model. Requirements of rainfall and flow monitoring are detailed in the Consent Decree Section V.A.14.d and e, which is included in the following:

> "*d.* *Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve* ***(12) months****, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*
>
> *e.* *For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data."*

In summary, rainfall and flow monitoring shall be conducted for at least 12 months, and quarterly technical memoranda shall be submitted to Plaintiffs for review.

To satisfy the above mentioned rainfall and flow monitoring requirements, and in accordance with the submitted DELCORA H&H Model Update and Calibration Plan, DELCORA has installed 5 new rain gauges and 38 new flow meters in its sewer collection system. Starting from March 18, 2016, most of the newly installed rain gauges and flow meters were in service and began generating data.

This report is a summary of the first quarter reporting for Rainfall and Flow Monitoring during March 18, 2016 to June 30, 2016.

Section 2 Rainfall Monitoring

2.1 Rainfall Monitoring Locations

The site locations of the four existing and five newly installed rain gauges are shown in **Figure 1**. These rain gauges provide an effective spatial coverage of the entire WRTP's service area.

The four (4) existing rainfall gauges are in Delaware County that record precipitation in 15-minute increments. The gauges are located at the following DELCORA owned facilities:

- Western Regional Treatment Plant (WRTP, will be used for model calibration)
- Central Delaware County Pump Station (CDPS, will be used for model calibration)
- Muckinipates Pump Station (MPS, will be used for model calibration)
- Darby Creek Pump Station (DCPS, will NOT be used for model calibration)

The five (5) newly installed rain gauges are listed in **Table 1** with detail information of rain gauge location, service starting date, and data recording interval.

Table 1: Newly Installed Rain Gauges

	Rain Gauge ID	Location	Service Start Date	Data Interval
1	RG_Rose Valley	18 N. Longpoint Lane, Media, PA	3/05/16	5-minute
2	RG_Chester-PS	55 East 2nd Street, Chester, PA	3/05/16	5-minute
3	RG_NCPS	1628 Naamans Creek Rd., Marcus Hook, PA	3/05/16	5-minute
4	RG_Springfield	217 Saxer Avenue, Springfield, PA	4/03/16	5-minute
5	RG_UCT	1671 N. Upper Providence Road, Media, PA	4/16/16	5-minute

2.2 Rain Gauge Calibration/Verification Procedure

Rain Gauge calibrations were performed during the rain gauge installation. Additional calibrations will be performed to the manufacturer's specifications on a bi-annual basis or as needed if irregular data is observed. Rain gauges are routinely checked for debris, and cleared after snow/ice storms.

Each "tip" of the rain gauge bucket should correspond with 0.01" of rain. To ensure the modem is reading the tipping bucket pulse accurately, the tech will tip the bucket 10 times in rapid succession. The tech should see that 0.1" of rain is recorded.

2.3 Rainfall Event Summary

Rainfall events were analyzed for each individual rain gauge based on the inter-event time of 12 hours. In total there were 31 rainfall events during reporting period. **Table 2** lists rainfall events with total precipitation greater than 0.1 inch.

Figure 1: Rain Gauge Locations

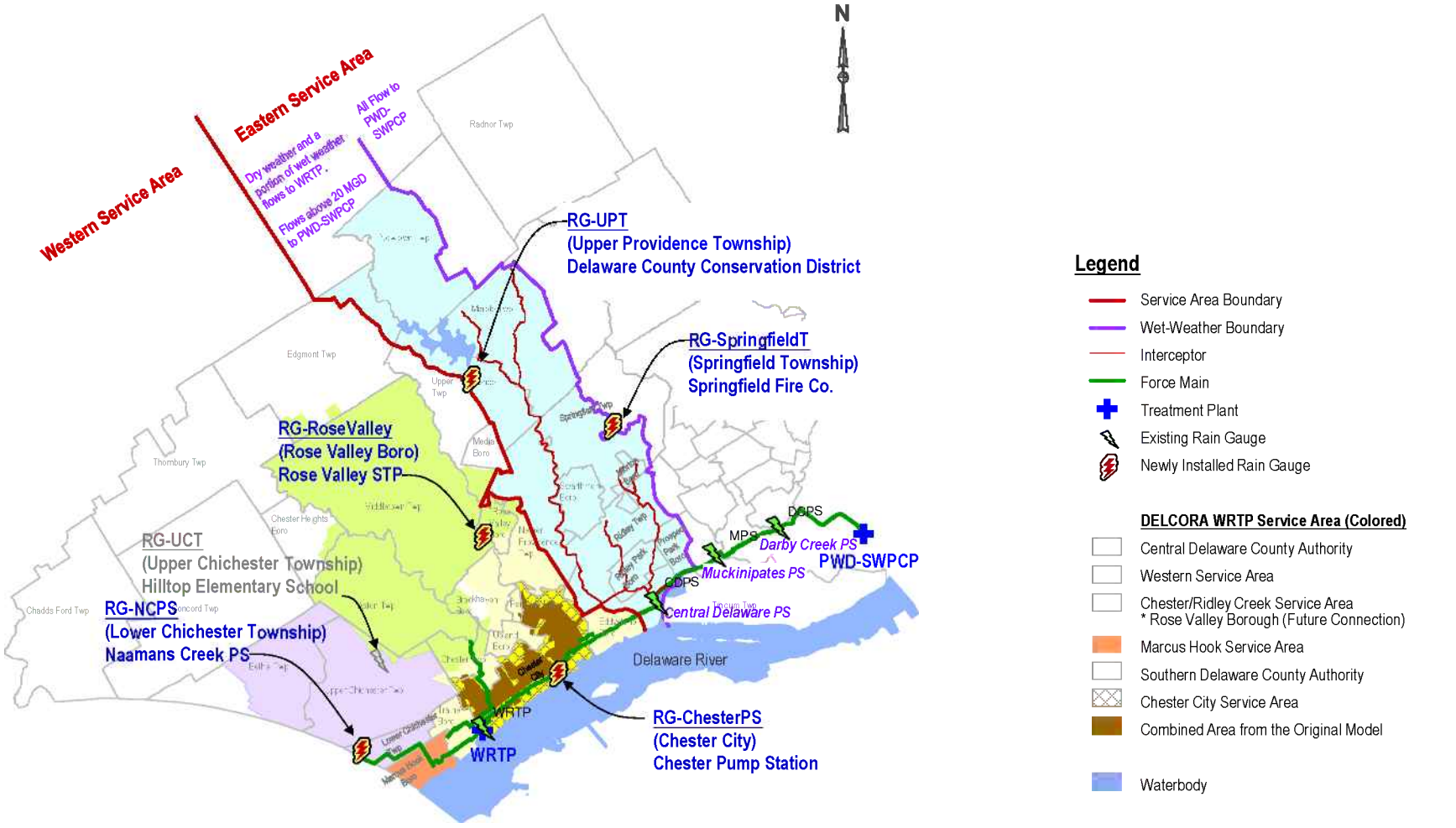


Figure 2 shows rainfall amounts at each rain gauge in each month for April (includes March data), May and June. It is obvious that rainfall in the area has significant spatial and temporal variance. As an example, during this reporting period, the rain gauge at the Chester Pump Station (Chester PS) recorded a total rainfall of 9.1 inches while the gauge at the Naamans Creek Pump Station (NCPS) recorded 13.39 inches. **Figure 3** shows the 1-hour rainfall profile for all of the 5 new rain gauges.

Table 2: Rainfall Event Summary, 3/18/16 - 6/30/16

	Rain Event Starting Time	Rose Valley	Chester-PS	NCPS	Springfield	UCT
1	3/28/2016 0:25	0.42	0.31	0.37	See Note	See Note
2	4/1/2016 10:35	0.23	0.23	0.28	See Note	See Note
3	4/4/2016 7:35	0.24	0.24	0.26	See Note	See Note
4	4/7/2016 11:45	0.26	0.09	0.23	0.02	See Note
5	4/9/2016 8:10	0.67	0.56	0.56	0.53	See Note
6	4/12/2016 6:40	0.39	0.35	0.31	0.35	See Note
7	4/23/2016 1:00	0.36	0.07	0.21	0.34	0.49
8	4/26/2016 0:35	0.42	0.29	0.2	0.22	0.56
9	4/28/2016 13:00	0.15	0.08	0.16	0.12	0.2
10	5/1/2016 2:05	0.82	0.47	0.65	0.51	0.66
11	5/2/2016 22:00	0.61	0.55	0.9	0.53	0.84
12	5/6/2016 3:00	1.47	1.18	2.12	1.4	1.97
13	5/13/2016 12:15	0.12	0.1	0.13	0.09	0.21
14	5/17/2016 11:30	0.14	0.14	0.17	0.1	0.16
15	5/21/2016 10:20	1.5	1.71	2.2	1.26	1.6
16	5/23/2016 14:30	0.23	0.49	0.47	0.38	0.31
17	5/29/2016 18:20	2.17	1.82	2.73	2.06	2.41
18	6/3/2016 4:35	0.22	0.15	0.24	0.24	0.48
19	6/5/2016 3:35	0.4	0.57	0.79	0.33	0.88
20	6/7/2016 15:45	0.01	0.01	0.18	0	0
21	6/8/2016 11:35	0.07	0.09	0.24	0.14	0.25
22	6/16/2016 0:20	0.44	0.44	0.65	0.31	0.49
23	6/23/2016 8:20	0.2	0.35	0.85	0.15	0.36
24	6/27/2016 18:35	0.89	0.59	0.5	1.24	1.25
	Subtotal (4/16-6/30)	10.22	9.1	13.39	9.42	13.12

Note: Meter not in service. See Table 1 above.

Figure 2: Rainfall Event Summary, 3/18/16 – 6/30/16

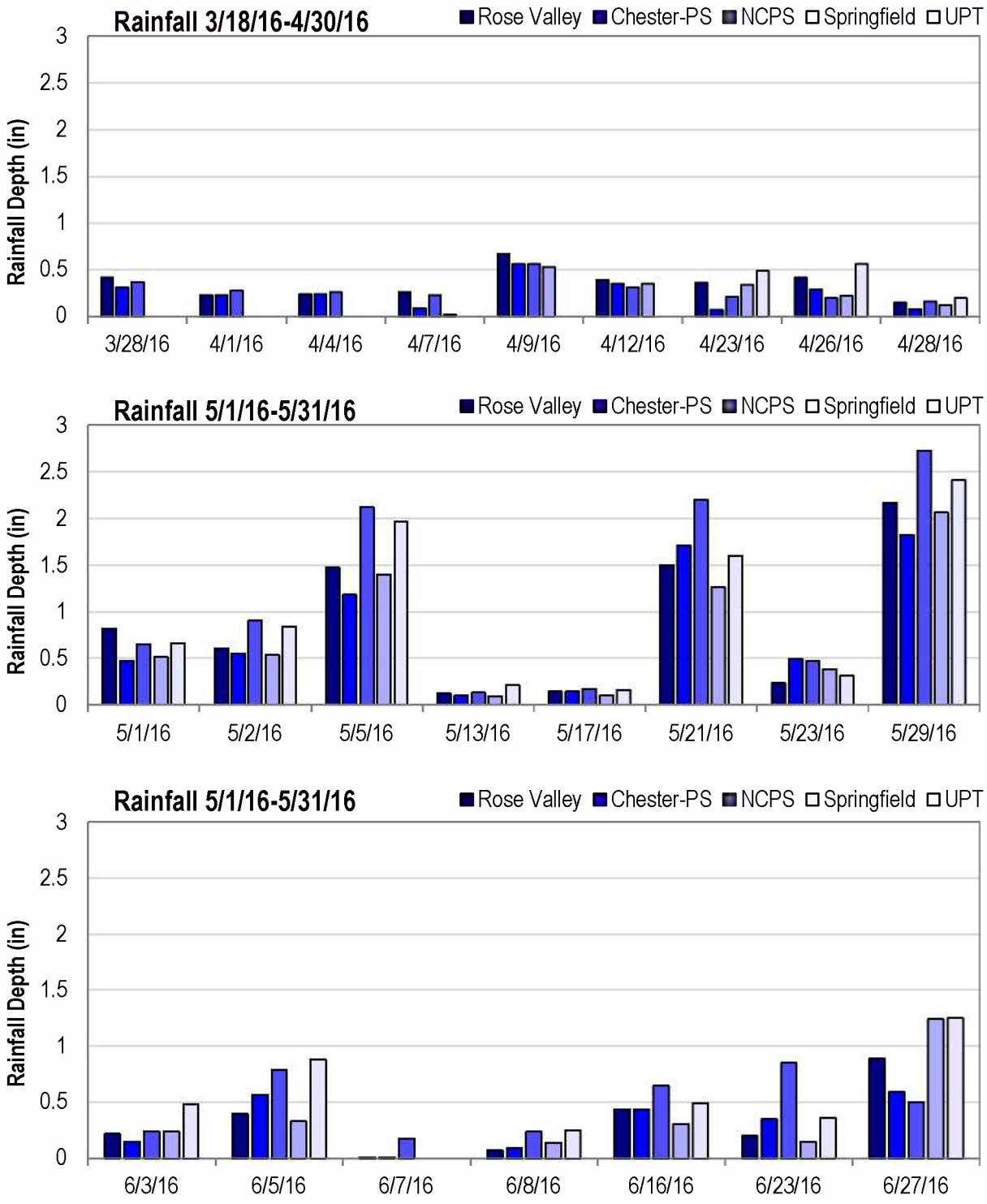
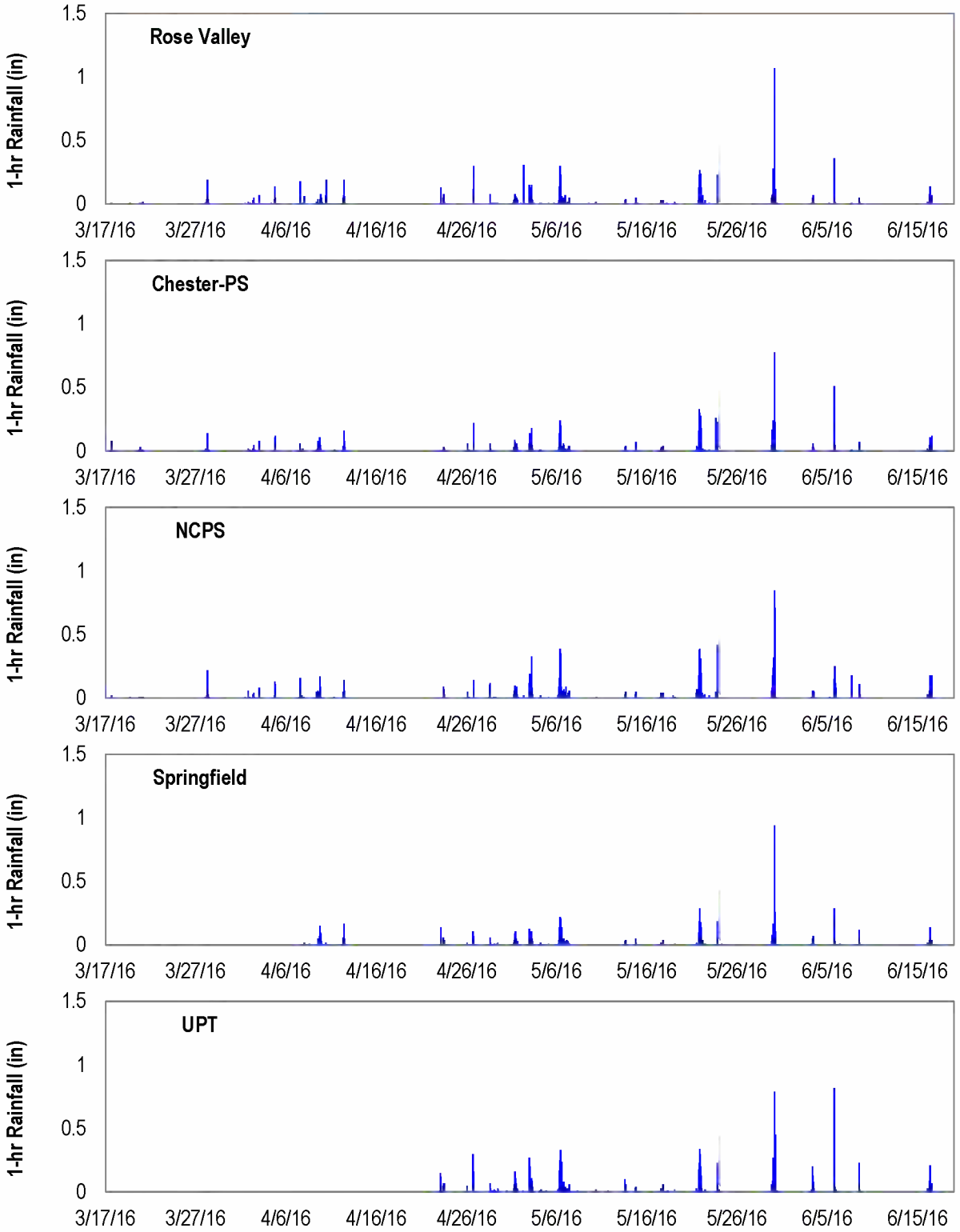


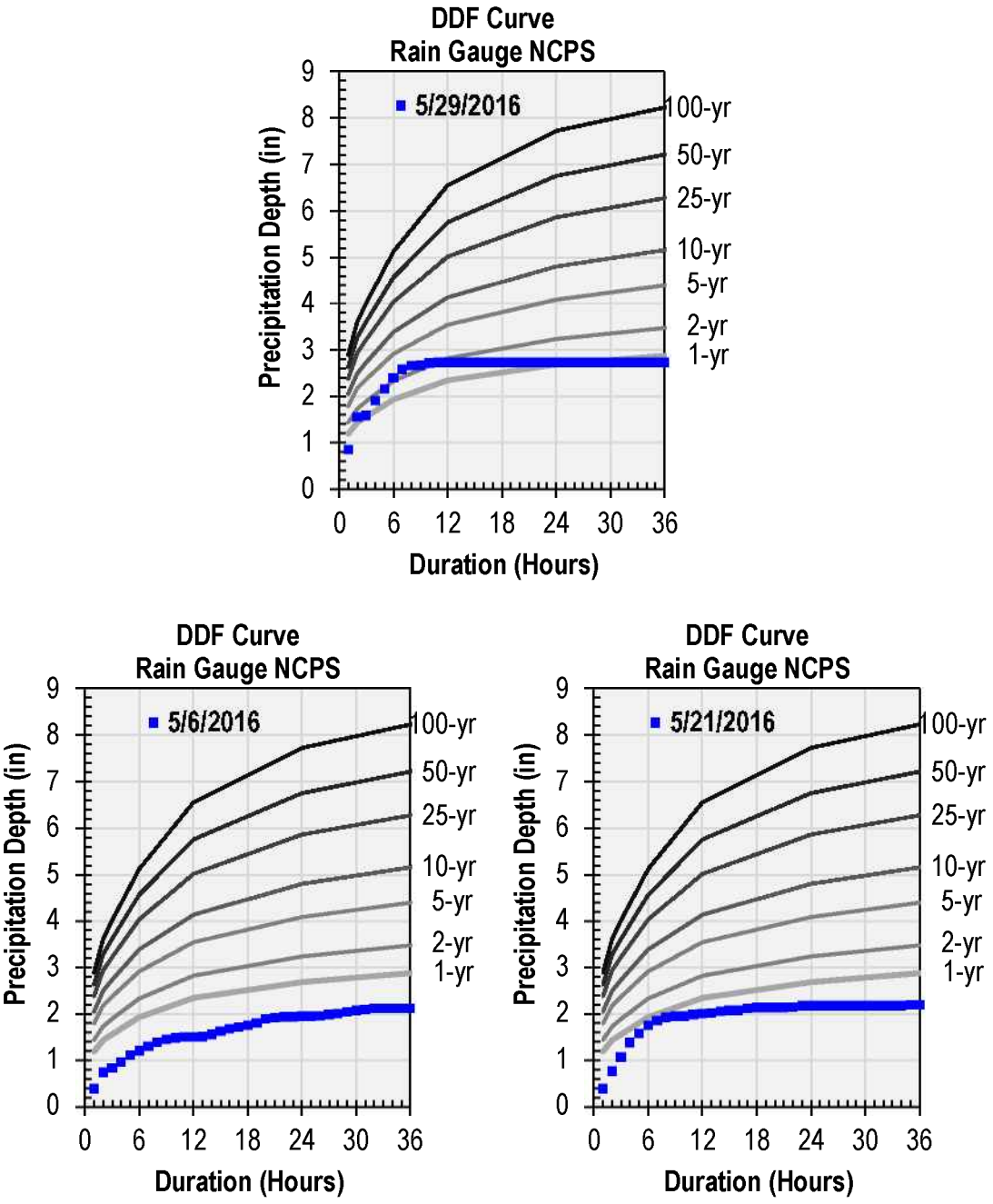
Figure 3: Hourly Rainfall Profile



2.3.1 Rainfall Return Frequency

Rain gauge RG_NCPS was selected for return frequency analysis because it recorded the maximum rainfall amount from the five newly installed gauges. For the three storm events greater than 1 inch, the 5/29/16 storm has a return frequency of 2-years, the 5/21/16 storm is close to 1-year, and the 5/6/16 storm is less than 1-year event (**Figure 4**).

Figure 4: Duration-Depth-Frequency (DDF) Plot



Section 3 Flow Meter Monitoring

3.1 Flow Monitoring Program

The site locations of the existing and newly installed flow meters are shown in **Figure 5**. **Figure 6** shows the newly installed flow meters on a larger scale, mostly in the combined area. These new meters were installed to investigate surface runoff from the combined area and CSO discharges, rainfall-derived inflow and infiltration (RDII) from the separated area, and system response to the wet weather conditions. The schematic of the newly installed flow meters is included in **Figure 7**.

The newly installed flow meter locations are categorized into the following four types:

- Category 1: Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
- Category 2: Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
- Category 3: Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.
- Category 4: Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
- Category 5: Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

In total, 38 additional flow meters have been installed. Details of the newly installed flow meters are included in **Table 3**.

3.2 Flow Meters Field Calibration/Verification Procedures

As part of the operation of flow meters, verifications of meter accuracy are performed on a regular basis. Calibrations are performed at a minimum every eight weeks, or more as needed.

The procedure used for performing meter calibrations is outlined below. This procedure only defines the required result. Any specific equipment function issues should be referred to the equipment manual or the manufacturer's technical support department.

Table 3: Details of the Newly Installed Flow Meters

Meter ID	GIS ID	Location	Pipe Size (in)	Material	Evidence of Surcharge	Category
CSO 02	3462	DS	36	Brick	Yes	2
CSO 03	2726	DS	38	Brick	Yes	2
CSO 05	2634	DS	48	Concrete	Yes	2
CSO 08	3463	DS	60	Concrete	Yes	2
CSO 14	3481	DS	45"x53"	Brick	Yes	2
CSO 19	690	DS	42"x43"	Concrete	Yes	2
Eff-02	3460	US	8	Clay	Yes	2
Eff-03	3454	DS	14.25	Concrete	Yes	2
Eff-05	2635	DS	12	Concrete	Yes	2
Eff-08	2246	DS	18.2	PVC	Yes	2
Eff-14	3482	DS	18	Concrete	Yes	2
Eff-19	***	DS	36	Concrete	Yes	2
In-03	2721	US	36	Brick	Yes	1
In-05	2634	US	28	Brick	Yes	1
In-08	3463	US	60	Concrete	Yes	1
In-09	1987	US	48	Cast Iron	Yes	1
In-10	1670	US	36	Brick	Yes	1
In-11	1770	US	49	Cast Iron	Yes	1
In-13	3479	US	48	Concrete	Yes	1
In-14	3481	DS	43"x47"	Brick	Yes	1
In-16	752	US	60	Concrete	No	1
In-17	691	US	36	Brick	Yes	1
In-18	3033	US	66"x43"	Concrete	Yes	1
In-19-1	625	DS	49"x47.5"	Clay	No	1
In-19-2	688	US	42"	Concrete	Yes	1
In-2	2751	DS	36	Corrugated PVC	No	1
In-25	3502	US	36	Concrete	Yes	1
In-26	1192	US	36	Brick	No	1
INT- 2nd St	1548	DS	40	Concrete	No	5
INT-DRI	2743	US	24	Clay	Yes	5
INT-Ridley 2	1487	US	44	Concrete	Yes	5
INT-Ridley 3	1509	US	48	Concrete	Yes	5
INT-WestEnd	2755	US	53	Concrete	No	5
Sep-1	2135	US	15	Clay	Yes	4
Sep-2	2134	DS	12	Clay	No	4
Sep-3	798	US	24	Clay	No	4
Side-1	1571	US	36	Concrete	No	3
Side-2	2135	US	8	Clay	Yes	3

Figure 5: Existing and Newly Installed Flow Meter Locations

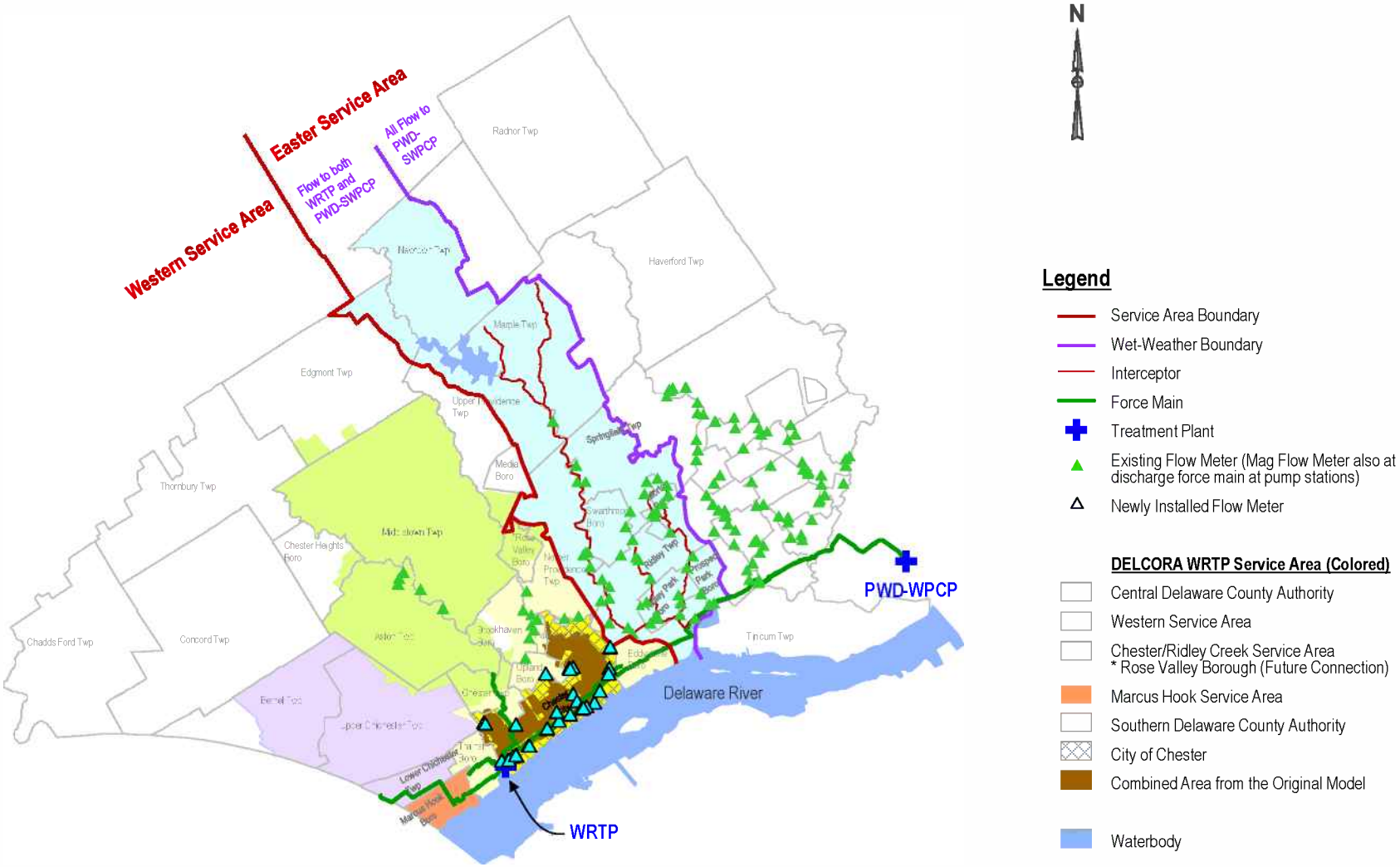


Figure 6: Newly Installed Flow Meter Locations

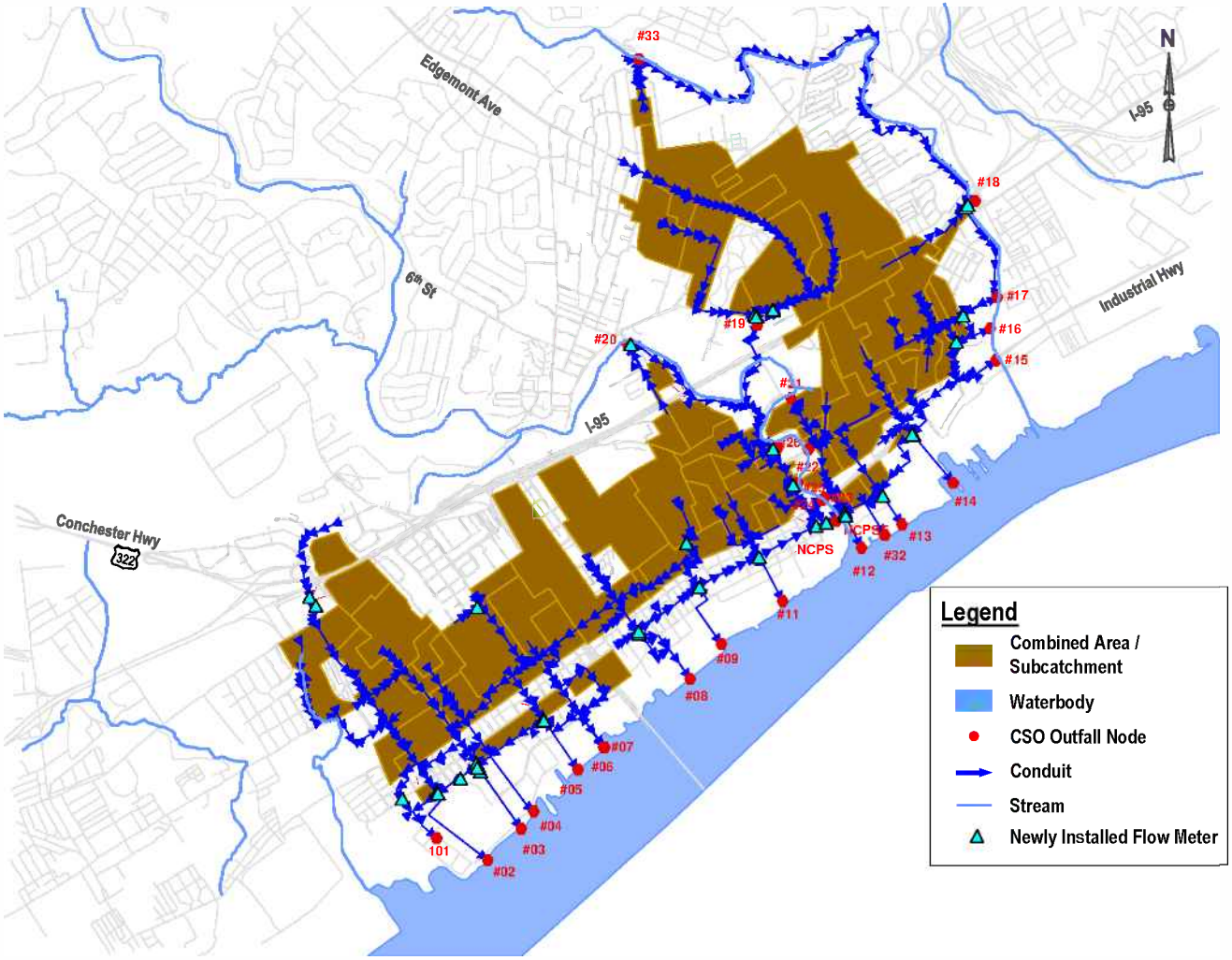
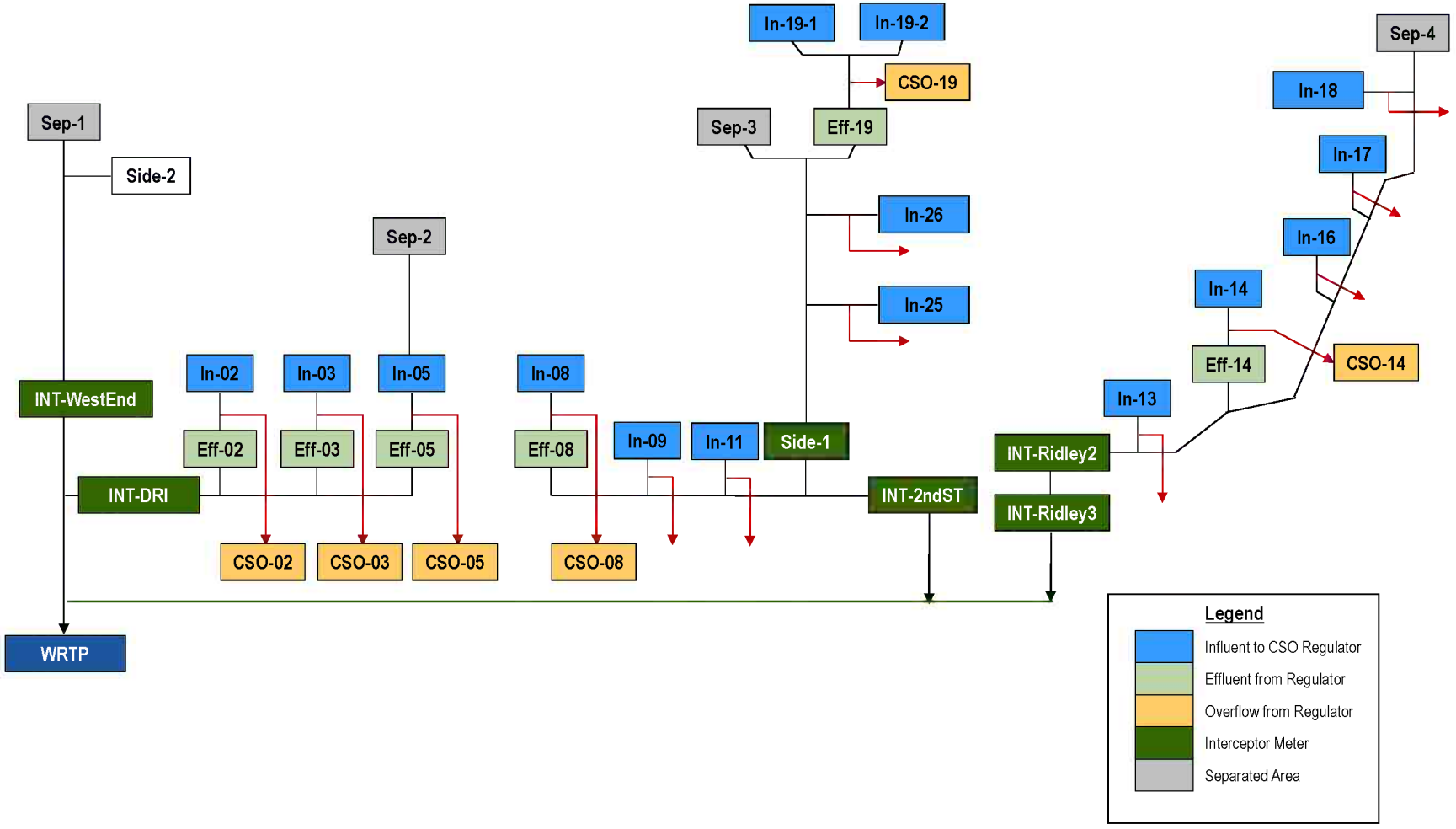


Figure 7: Flow Monitoring Schematic



Manually Downloaded Meters
This method is used for any meter that cannot be interrogated remotely by the data analyst. Field technicians use the *Daily Field Download Sheet* for recording the calibration results.

- Record the date.
- Record the field time, which is the local time.
- Record the meter time.
- Record the instantaneous depth reading from the meter.
- Measure the peak velocity.
- Record the instantaneous average or peak, whichever is applicable.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Remote Connection Meters
This method is used for any meter that can be interrogated remotely. The data analyst uses the *Daily Field Download Sheet* for single depth and velocity meters and the *Multi- Sensor Calibration Sheet* for meter types that record multiple depth and/or velocity readings.

- Fill all site visit information fields on form.
- Have the field tech measure the depth of flow and record with time.
- Record the time and instantaneous depth reading from the meter or the depth sensor, whichever is applicable. All available depth sensors should be activated and compared to the field measurement.
- Have the field tech measure the peak the velocity or have them perform a velocity profile if the depth is sufficient then record with time.
- Record the time and instantaneous velocity reading from the meter or the velocity sensor, whichever is applicable. All available velocity sensors should be activated and compared to the field measurement.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Special Cases

- Blind Verifications: A blind verification occurs when a field technician's only role is to measure the depth and velocity of the flow and report the values to the data analyst. In these cases, the crew is "blind" to what the meter is reading. The data analyst will then compare the readings to current/recent data or live readings. Should the blind verification be out of tolerance, the analyst can direct the crew to perform additional blind verifications or perform a conventional verification and/or troubleshoot as necessary.

- Installations/Removals: When installing or removing meters, the above calibration method should be used for three consecutive verifications, performed at 5 minute intervals.
- Third Party Audit: When performing a calibration at a meter that is not maintained by CSL and where CSL is to verify the meter function, the CSL Audit report should be used.

3.3 Flow Monitoring Data Summary

Flow, level and velocity data are received for each flow monitoring site at 5-minute intervals. Metering data is analyzed for dry weather flows (DWF), hourly peak flows, and hourly peaking factors for each monitoring site. A "dry weather" condition was defined as a period with no precipitation that begins three days after the last wet weather event and lasts until the beginning of the next precipitation event.

Table 4 shows dry weather flow (DWF), hourly peak flow, hourly peaking factor and flow condition observations.

The dry weather flows are also shown in the schematic in **Figure 8**. Generally the downstream dry weather flow is greater than the upstream locations for all of the meters. For meters immediately upstream and downstream of CSO regulators, the upstream and downstream dry weather flows should be similar. **Figure 9** shows the influent and effluent from CSO#08 as an example to indicate that the dry weather of the two are similar.

The hourly peaking factor in the combined area is in the range of 11 to 88 and average at 40. The hourly peaking factor for the interceptor is between 3.8 and 6.8 with an average of 4.4. The hourly peaking factor is between 3.6 and 6.4 for the separated area, with an average of 5.0.

A detailed hydrograph and scattergraph for each flow monitoring site is shown in **Figure 10** to **Figure 47**, each includes:

- The flow hydrographs show hourly flow and rainfall profile. Hourly Rainfall data is included for the convenience of reviewing flow response to the wet weather conditions. Hourly flow and rainfall were calculated from the 5-min interval.
- The scattergraphs (based on 5-min data) are essentially a plotting of flow rate versus depth. This plotting helps to understand the flow patterns and conditions on the individual monitored sewer pipes.
- For CSOs 02, 03, 05, 08, 14, & 19, flows including influent, effluent and overflows were plotted in the same plot.

Table 4: Flow Monitoring Summary

Meter ID	Hourly Peak (MGD)DWF	DWF (MGD)	Hourly Peaking Factor	Comments
In-02	8.13	0.30	27.1	Free flow most of the time
Eff-02	1.70	0.30	5.6	Surcharged under common conditions
CSO-02	8.36	0.00		Free flow most of the time
In-03	9.48	0.24	39.2	Free flow most of the time
Eff-02	2.67	0.23	11.7	Surcharged under large storms
CSO-03	8.00	0.00		Free flow most of the time
In-05	13.01	0.65	20.2	Backwater observed
Eff-05	2.65	0.63	4.2	Severely surcharged under common conditions
CSO-05	11.60	0.00		Free flow most of the time, backwater observed
In-08	34.47	0.74	46.6	Free flow most of the time
Eff-08	8.80	0.85	10.3	Free flow most of the time, backwater during large storms
CSO-08	35.12	0.00		Free flow most of the time
In-09	8.60	0.11	79.6	Free flow most of the time
In-10	6.52	0.18	36.8	Free flow most of the time
In-11	11.75	0.22	53.6	Free flow most of the time
In-13	9.35	0.24	39.7	Free flow most of the time
In-14	13.03	0.28	47.2	Backwater observed
Eff-14	3.69	0.29	12.9	Free flow mostly, backwater and surcharge during large storms
CSO-14	10.53	0.00		Free flow most of the time
In-16	4.38	0.40	10.9	Backwater observed
In-17	3.09	0.12	24.9	Backwater observed
In-18	6.79	0.08	87.3	Free flow most of the time
In-19-1	11.61	0.65	17.8	Free flow most of the time
In-19-2	9.58	0.69	13.9	Free flow most of the time
Eff-19	3.21	1.41	2.3	Free flow most of the time
CSO-19	18.13	0.00		Free flow most of the time
In-25	4.70	0.06	74.8	Free flow mostly, backwater observed
In-26	7.56	0.30	25.4	Free flow mostly
INT-2nd St	13.04	3.76	3.5	Free flow mostly
INT-DRI	4.26	1.40	3.0	Severe surcharge observed
INT-Ridley 2	15.73	3.29	4.8	Free flow mostly, backwater observed
INT-Ridley 3	17.02	3.59	4.7	Free flow mostly, backwater observed
INT-WEI	9.54	1.41	6.8	Free flow mostly, backwater observed
Sep-1	0.73	0.15	5.0	Free flow mostly
Sep-2	0.75	0.12	6.4	Free flow mostly
Sep-3	1.62	0.45	3.6	Free flow mostly
Side-1	11.34	2.42	4.7	Free flow mostly
Side-2	0.72	0.24	3.0	Free flow mostly

Figure 8: Dry Weather Flow Balance Schematic

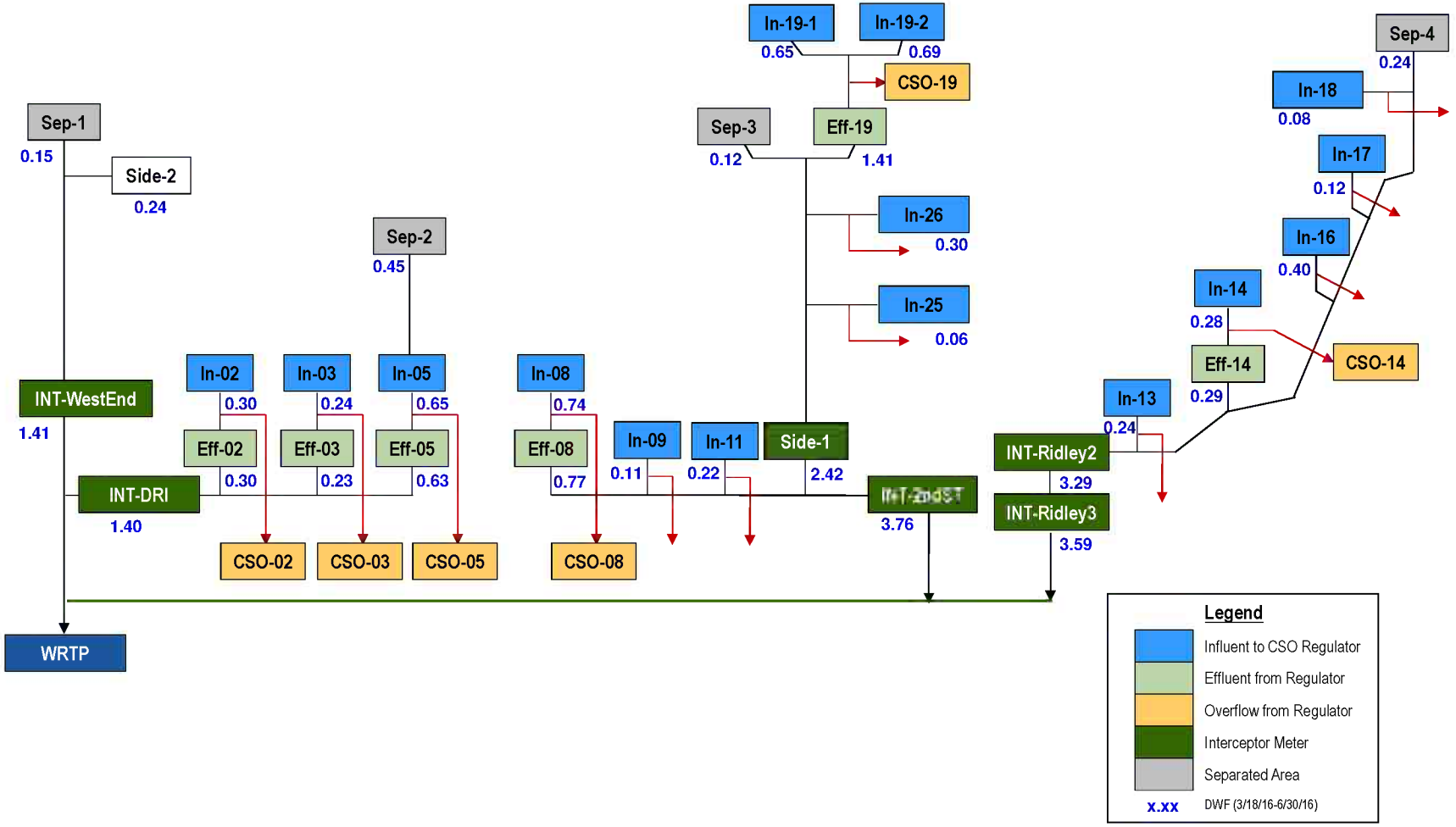


Figure 9: Flow Hydrograph In-08 and Eff-08

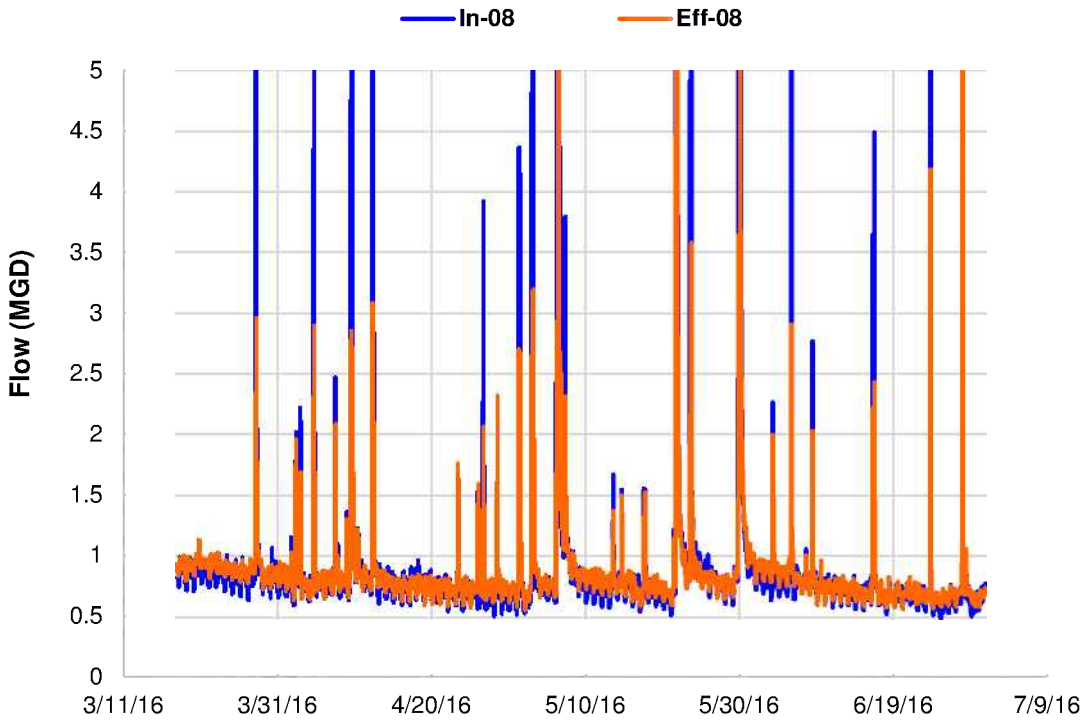
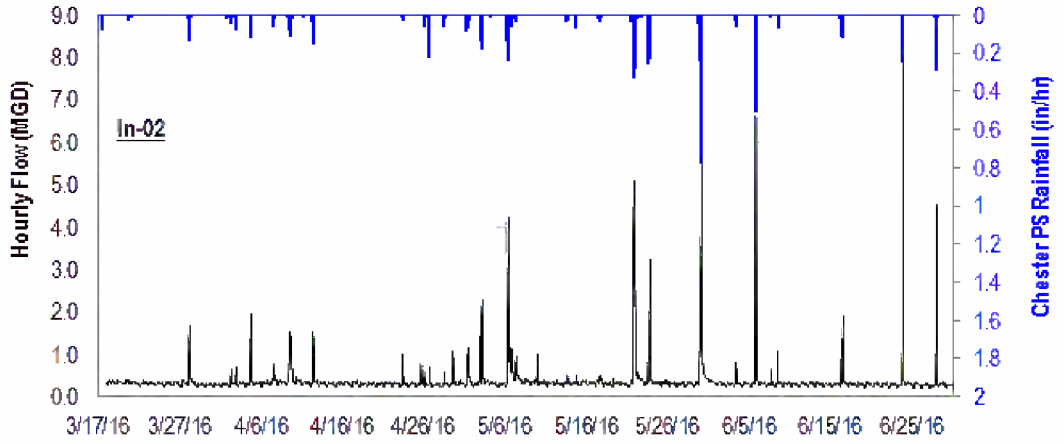
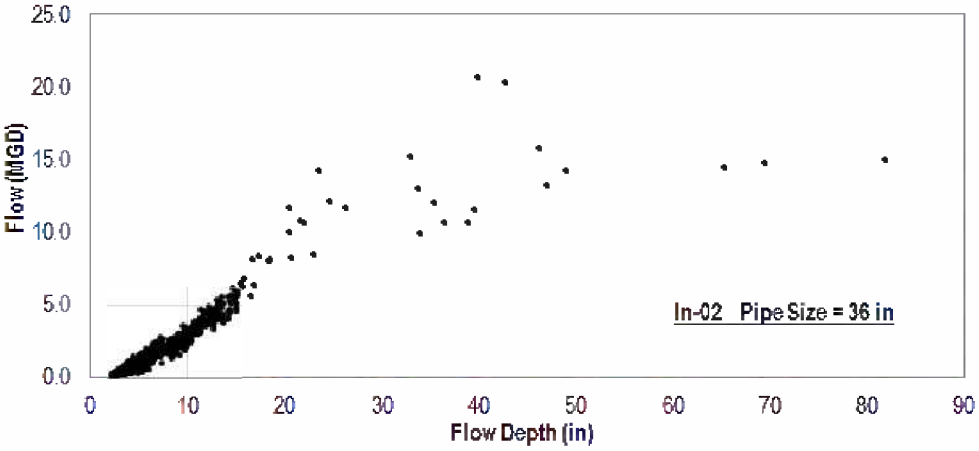


Figure 10: Flow Monitoring Data, In-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#02 Influent , Effluent and Overflow

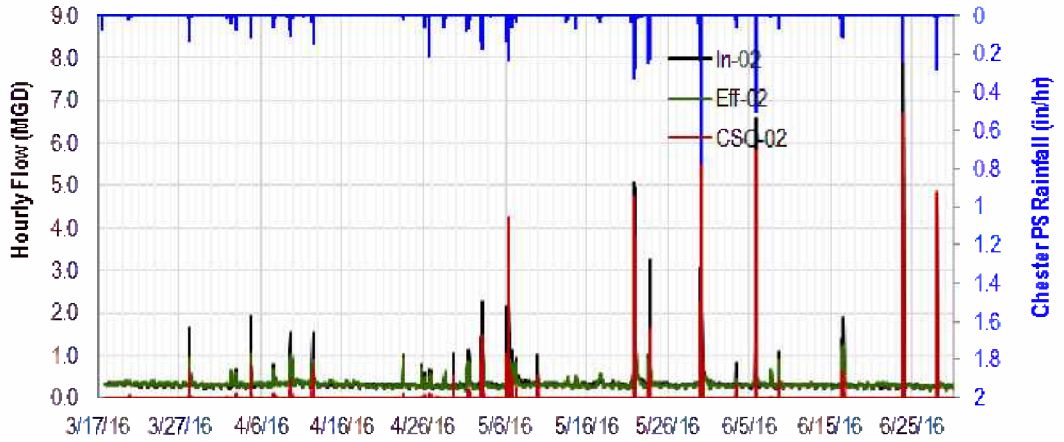


Figure 11: Flow Monitoring Data, EFF-02

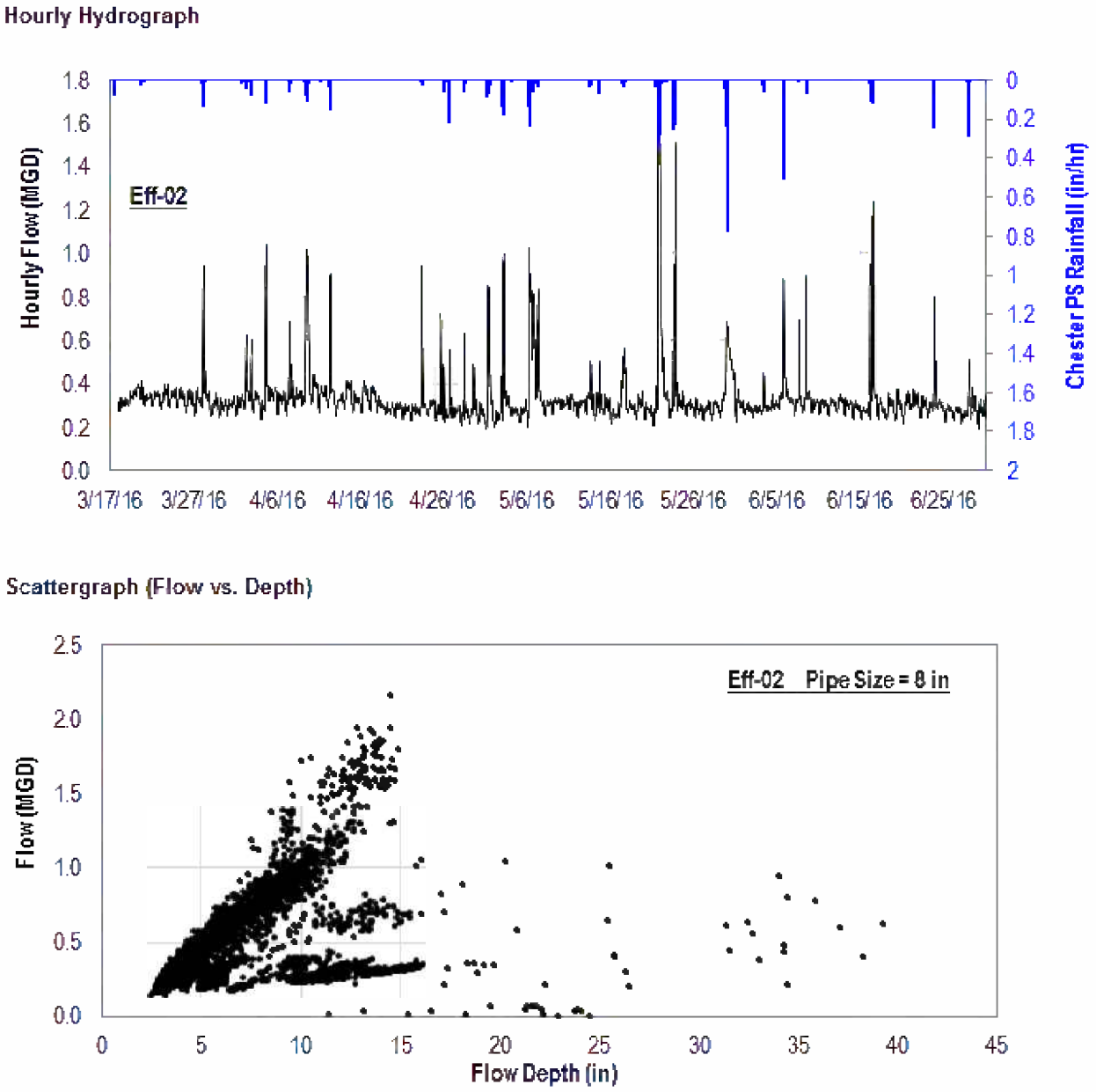
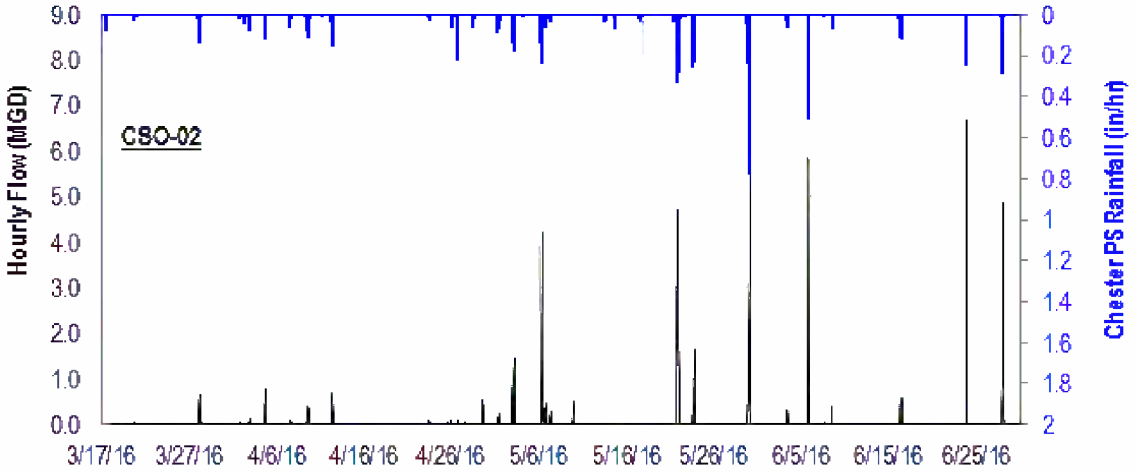


Figure 12: Flow Monitoring Data, CSO-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

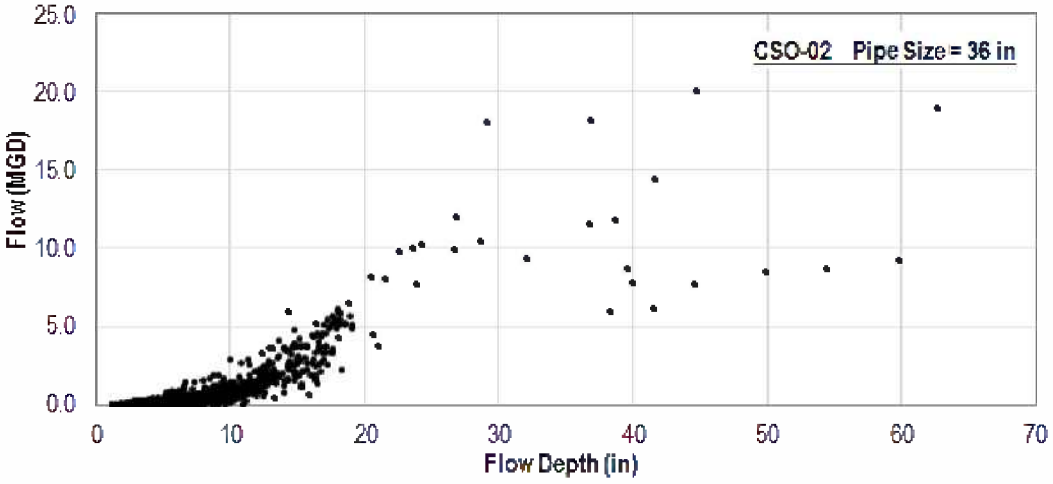
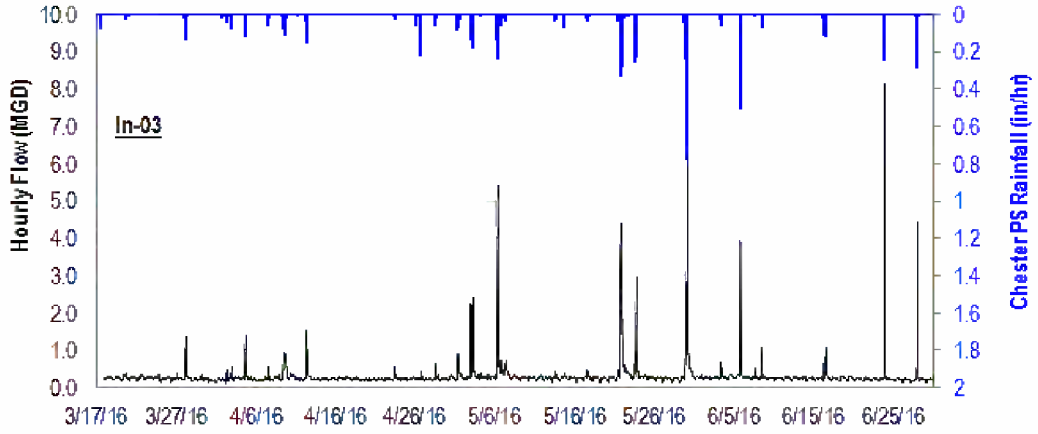
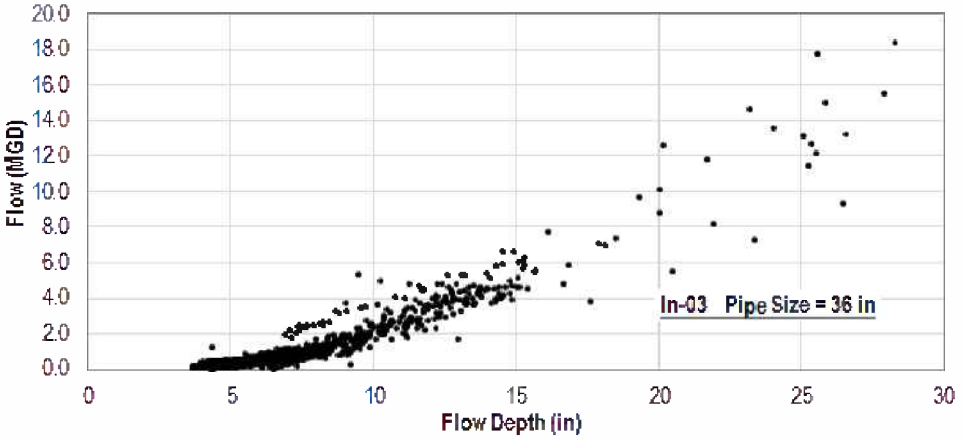


Figure 13: Flow Monitoring Data, IN-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

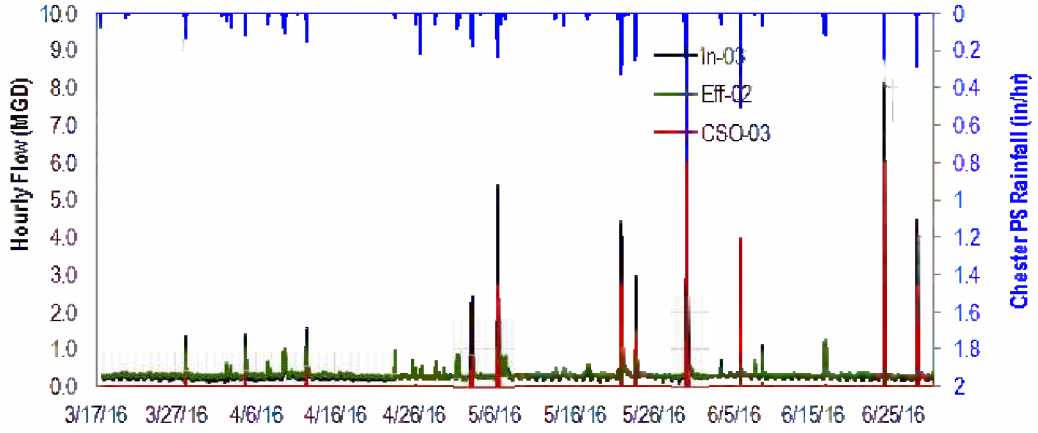
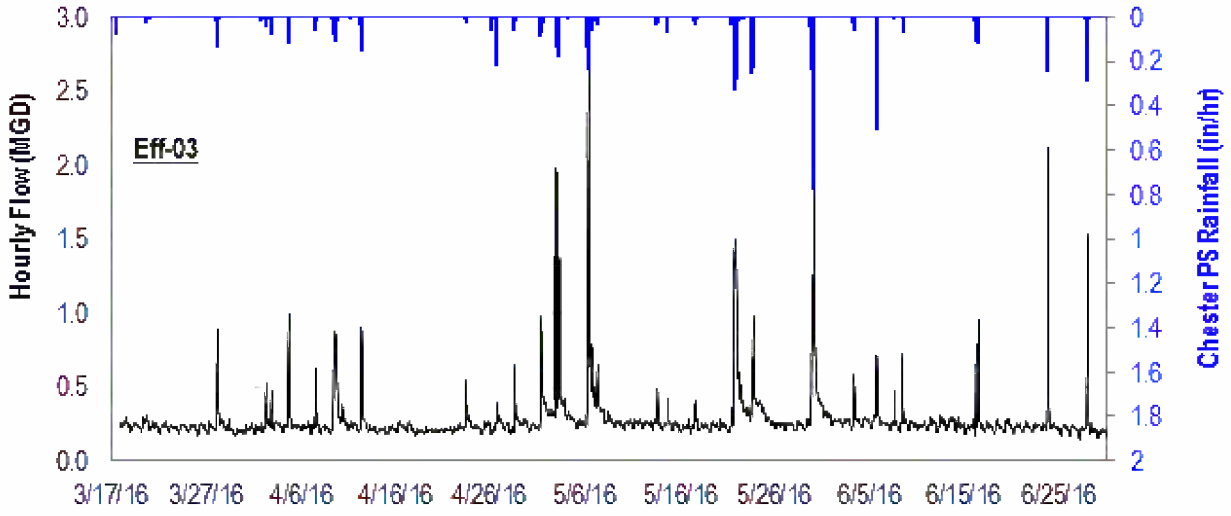


Figure 14: Flow Monitoring Data, Eff-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

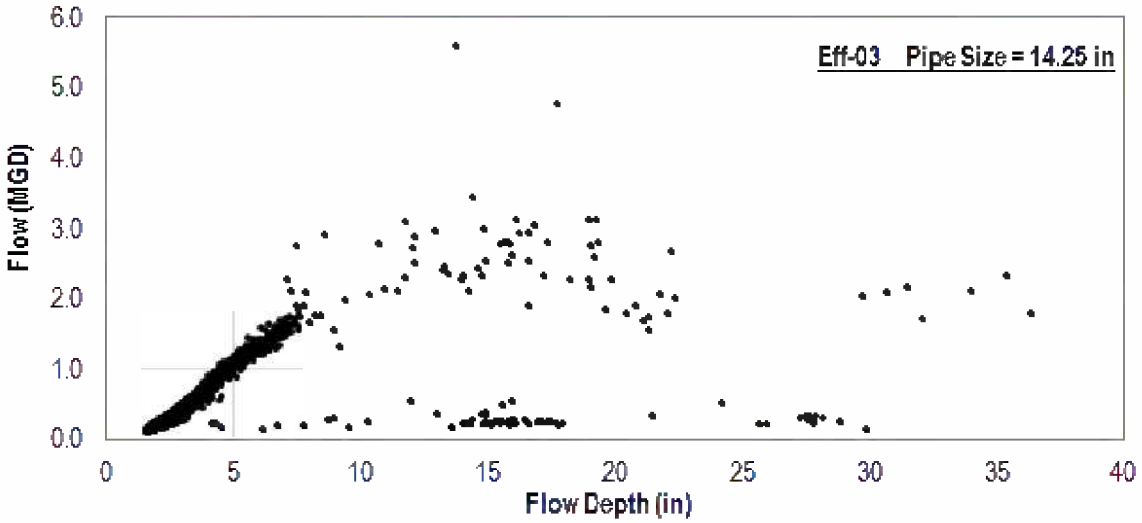
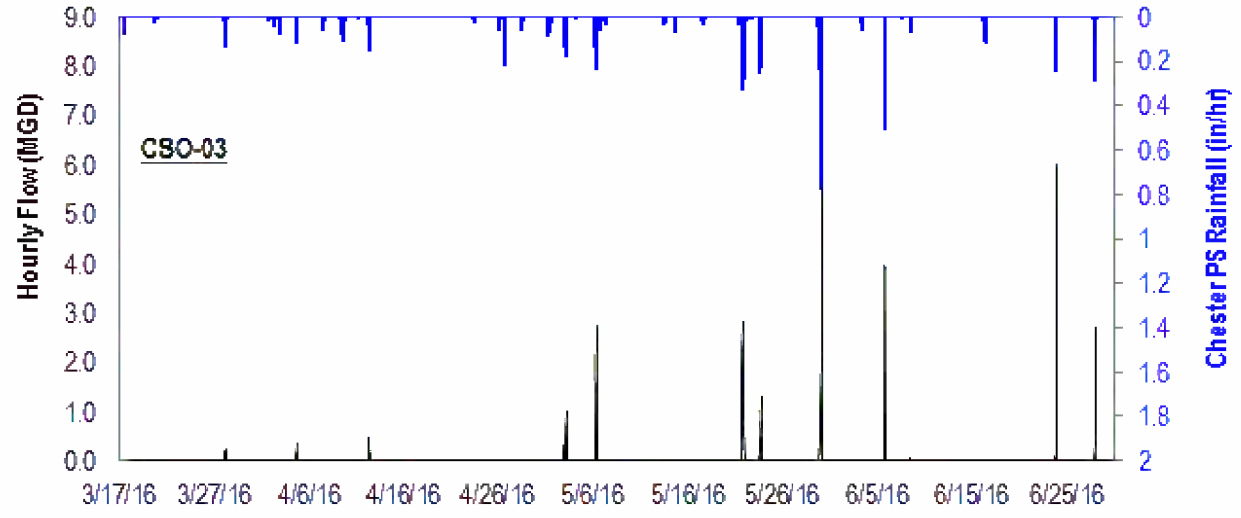


Figure 15: Flow Monitoring Data, CSO-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

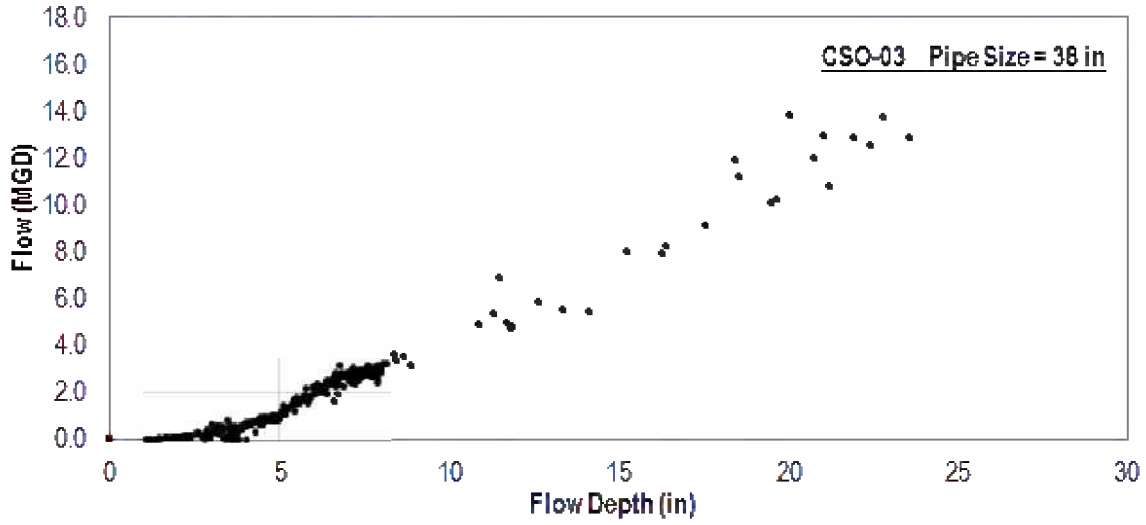
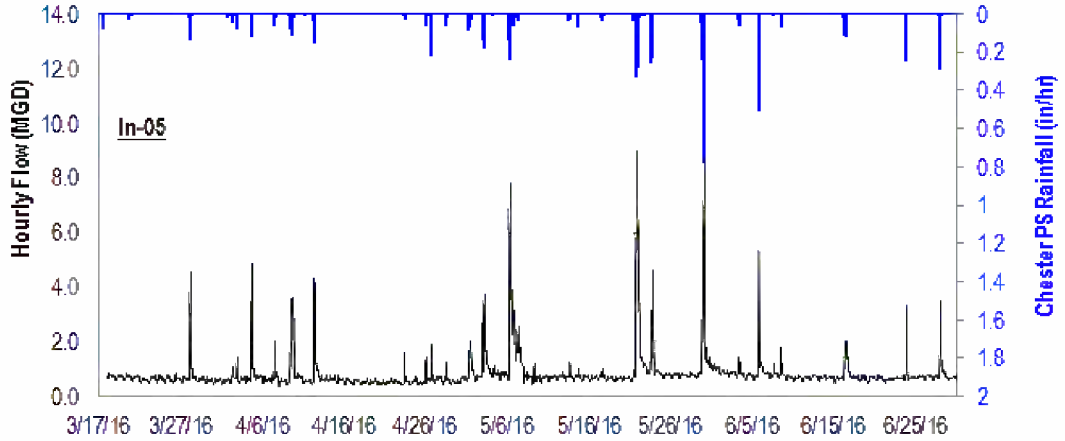
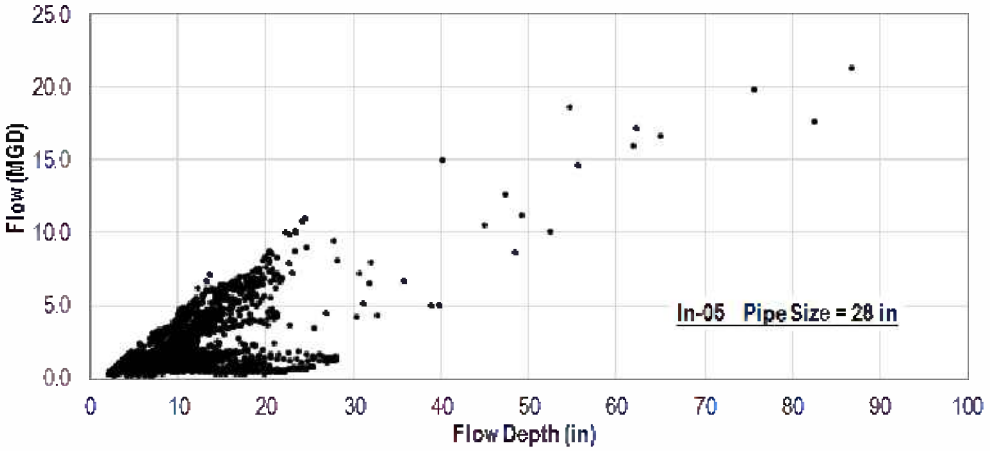


Figure 16: Flow Monitoring Data, IN-05

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

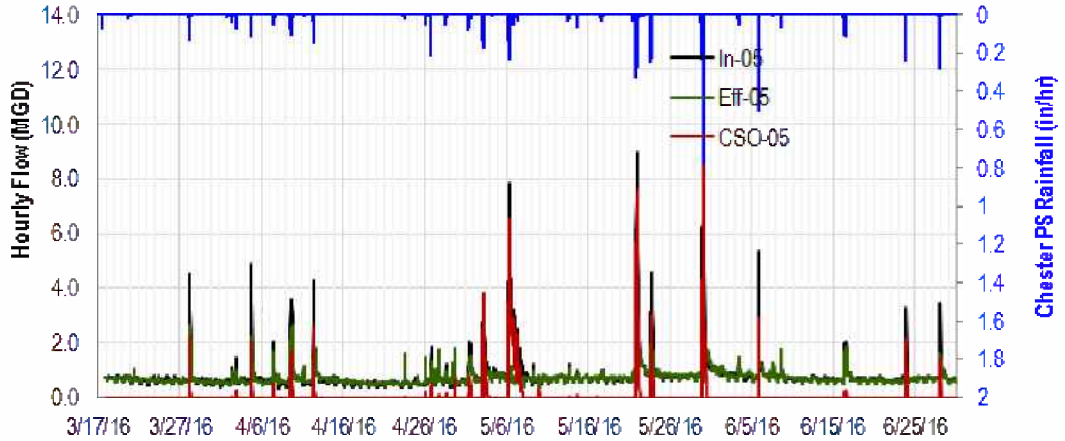
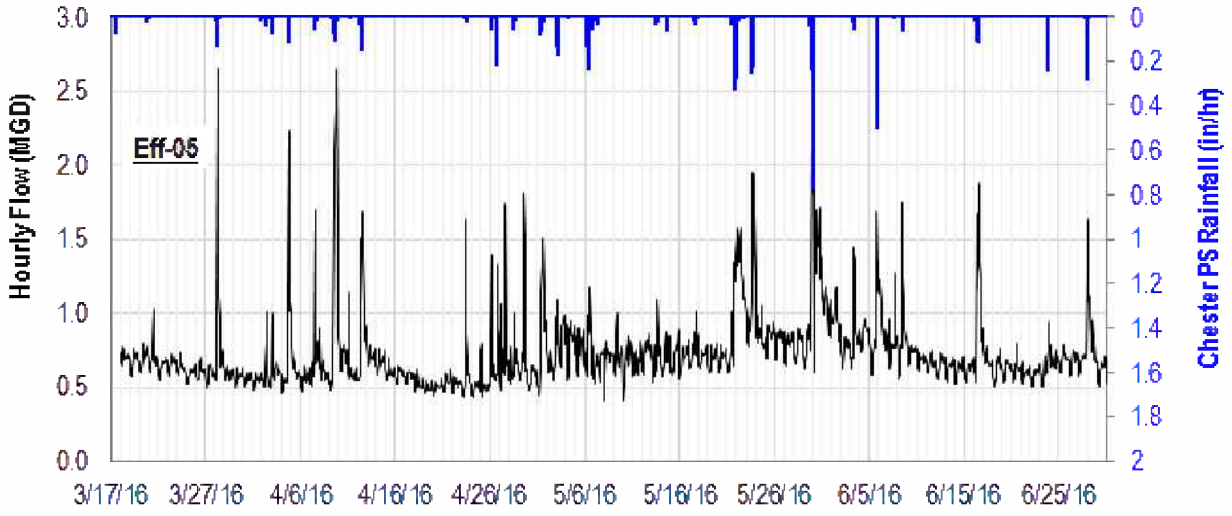


Figure 17: Flow Monitoring Data, Eff-05

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

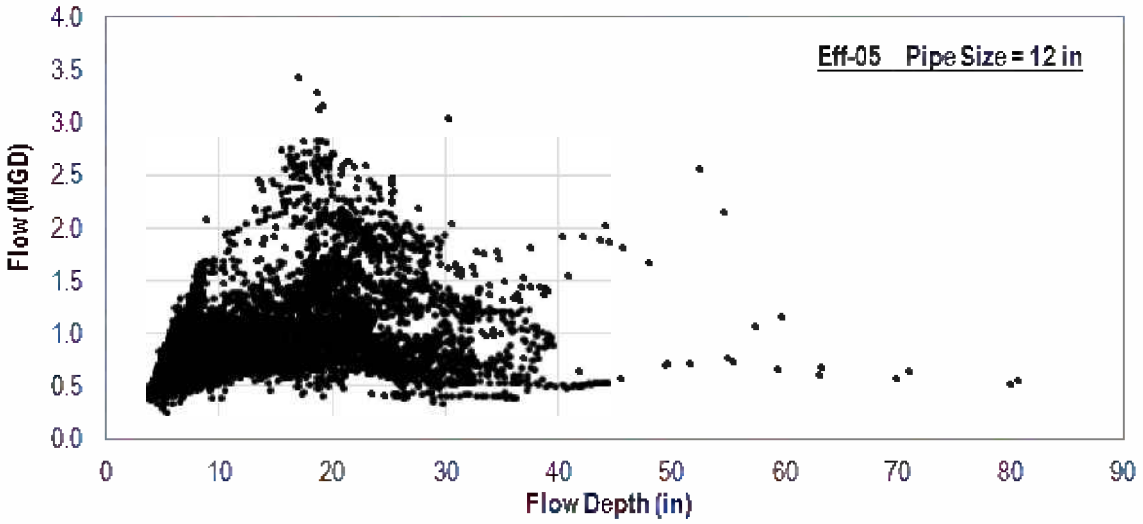


Figure 18: Flow Monitoring Data, CSO-05

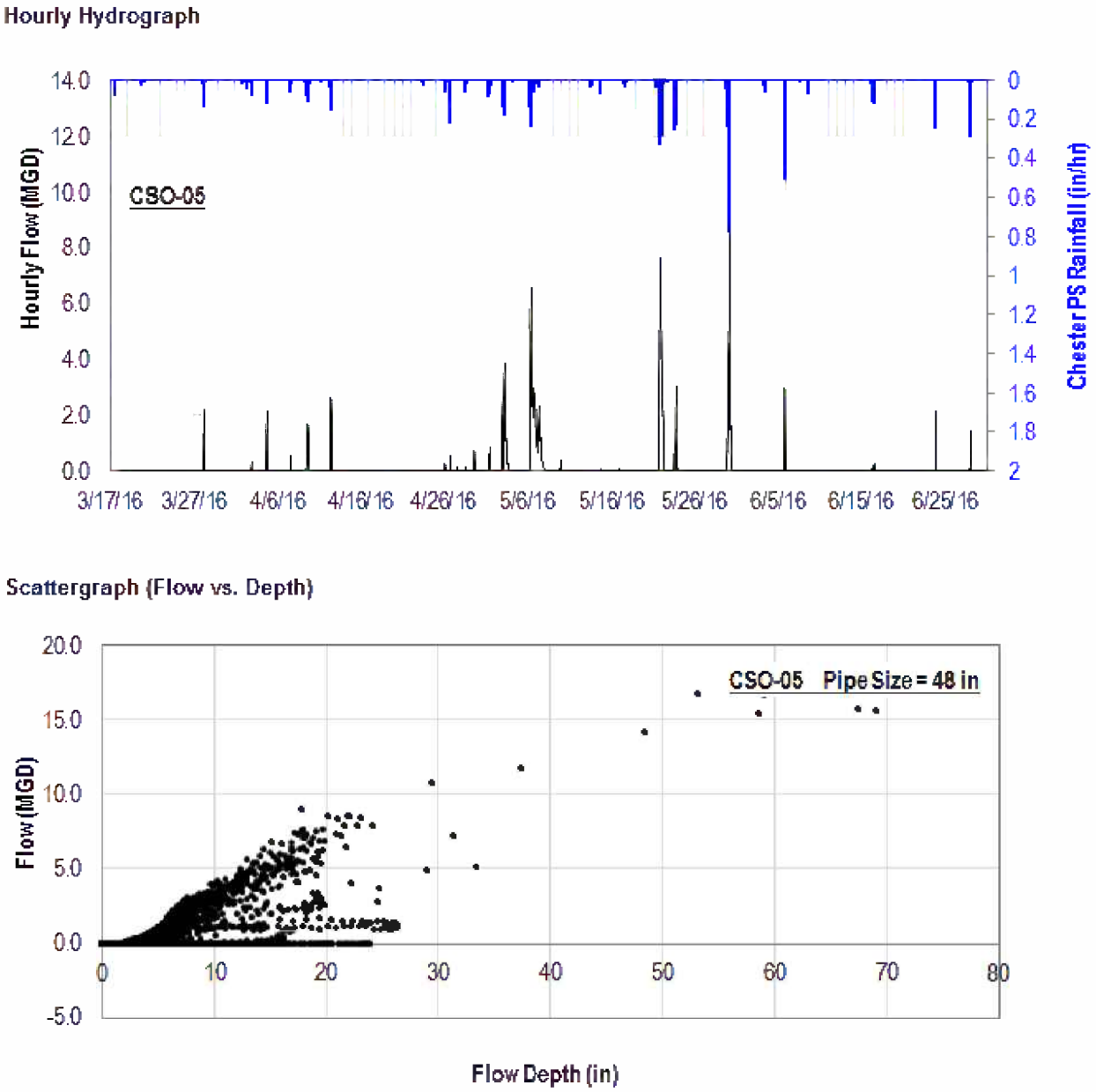
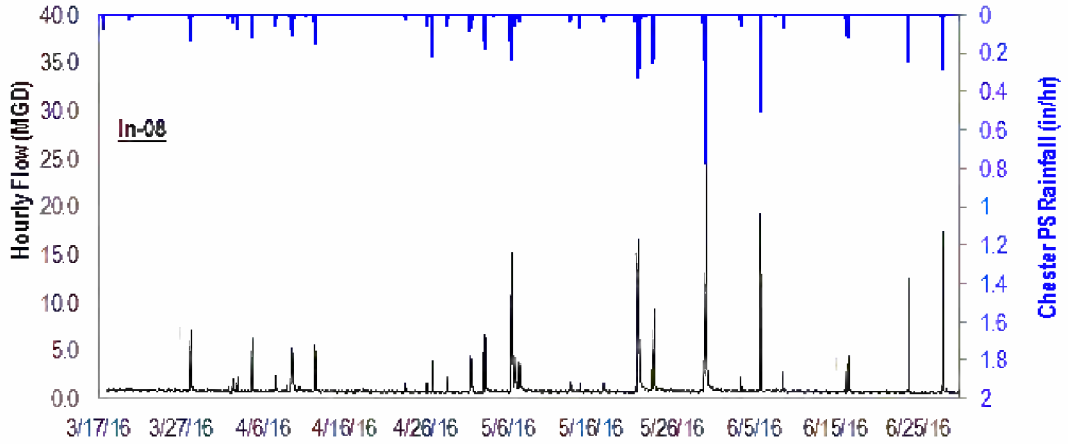
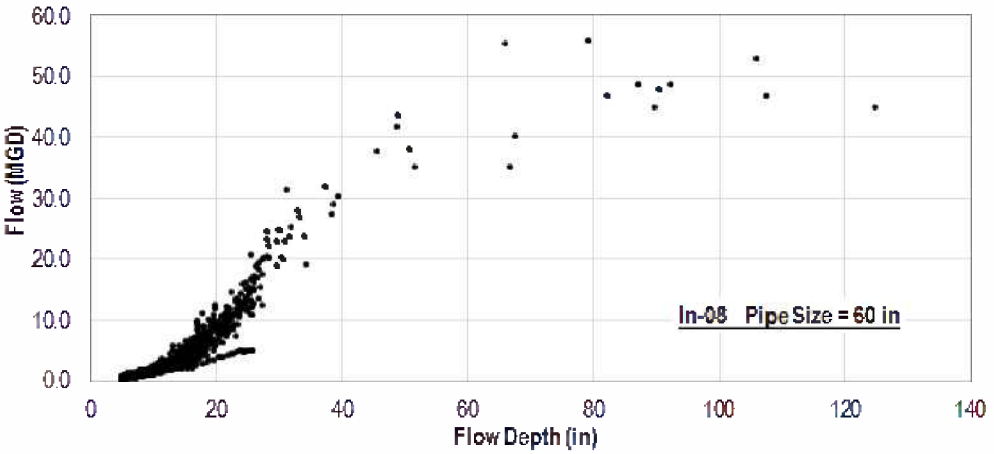


Figure 19: Flow Monitoring Data, IN-08

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

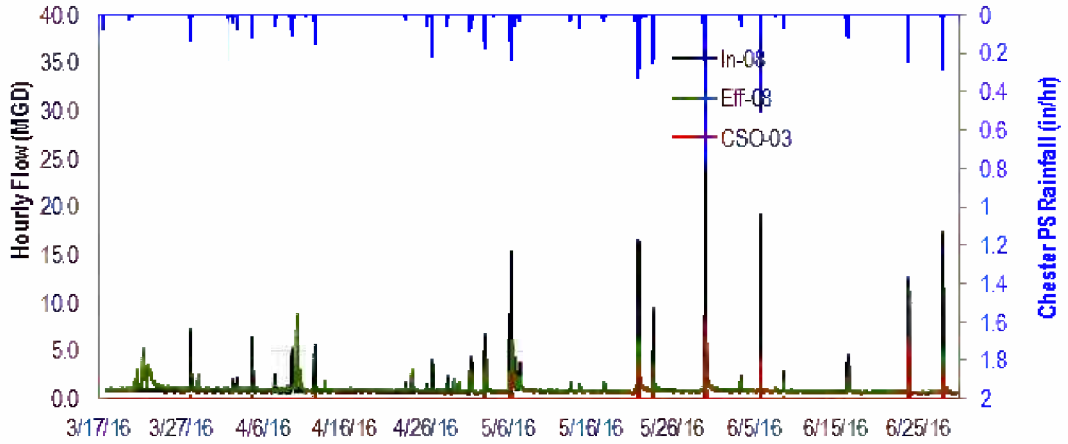
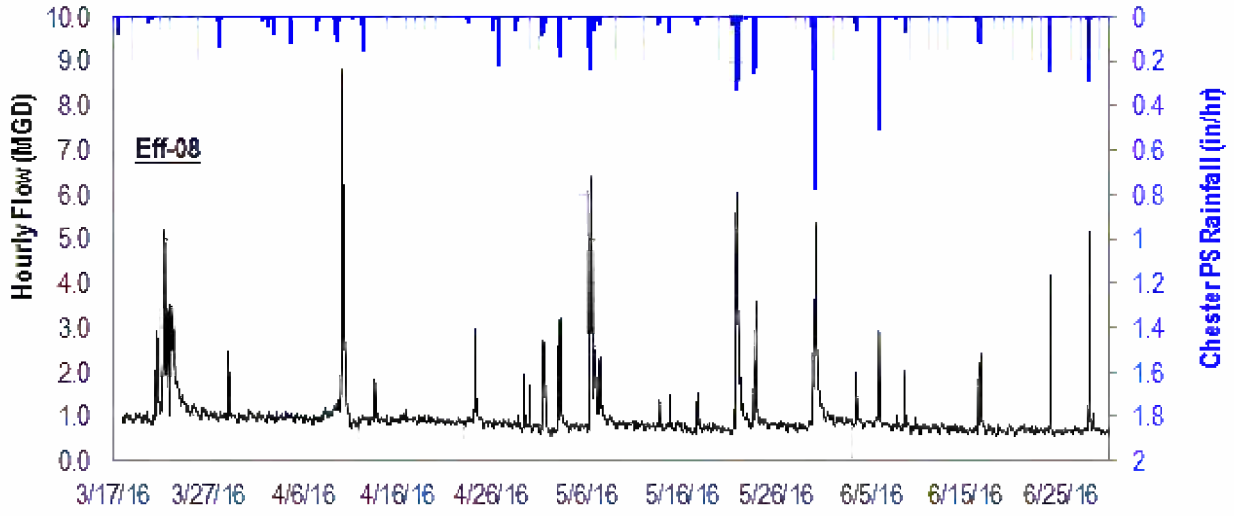


Figure 20: Flow Monitoring Data, Eff-08

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

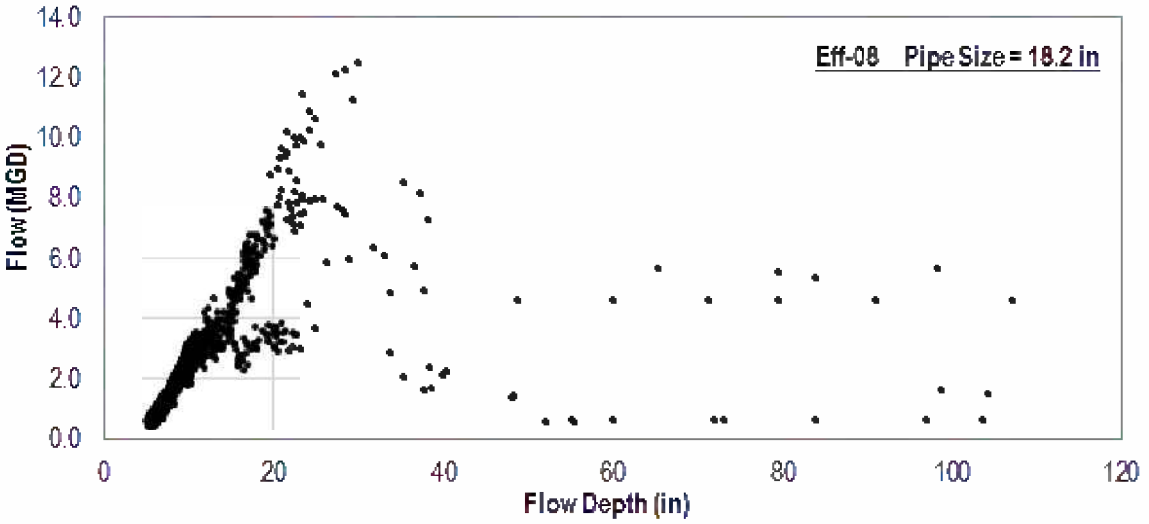


Figure 21: Flow Monitoring Data, CSO-08

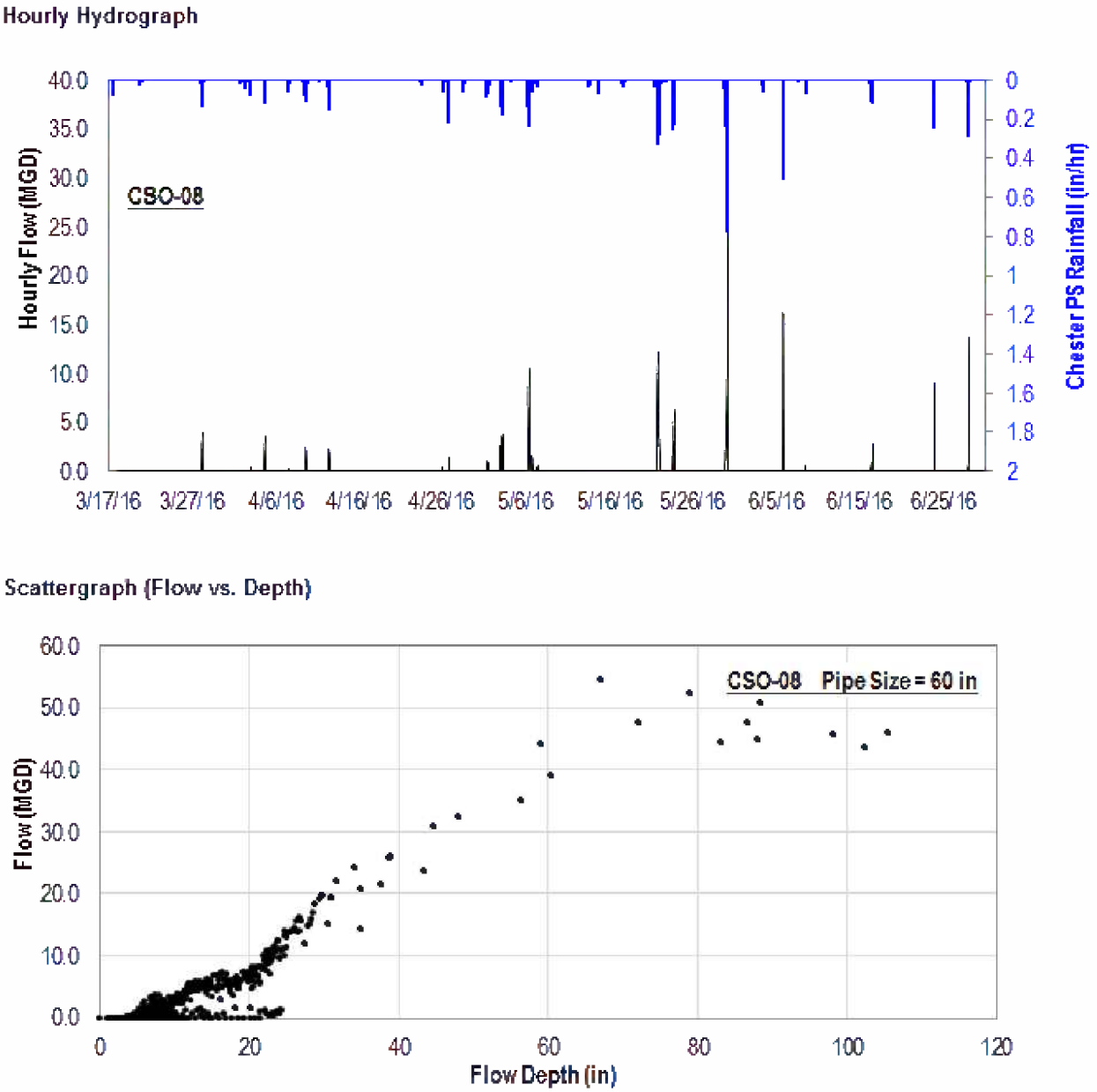
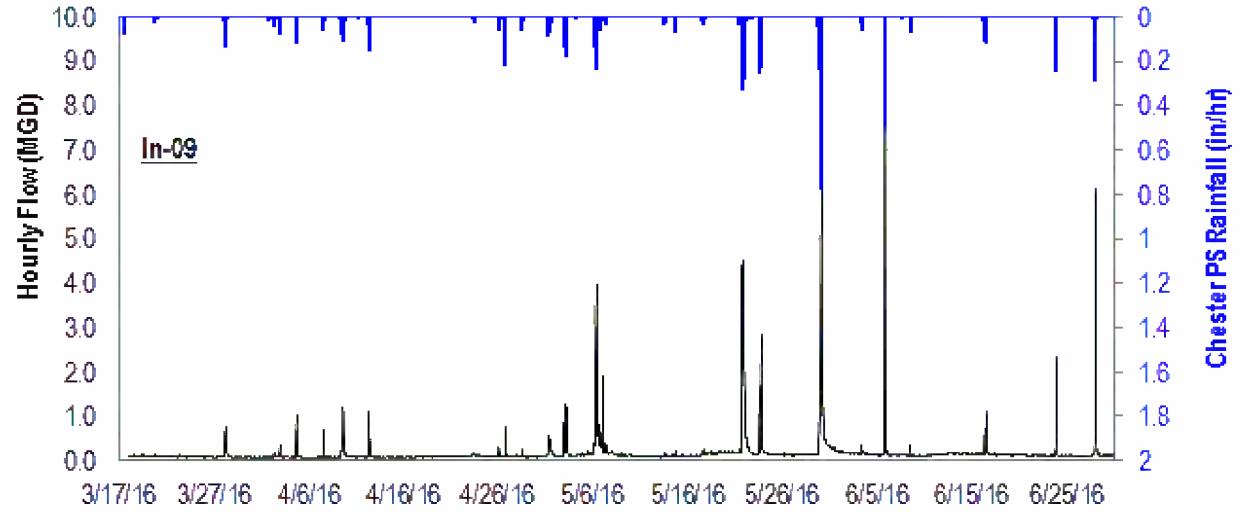


Figure 22: Flow Monitoring Data, In-09

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

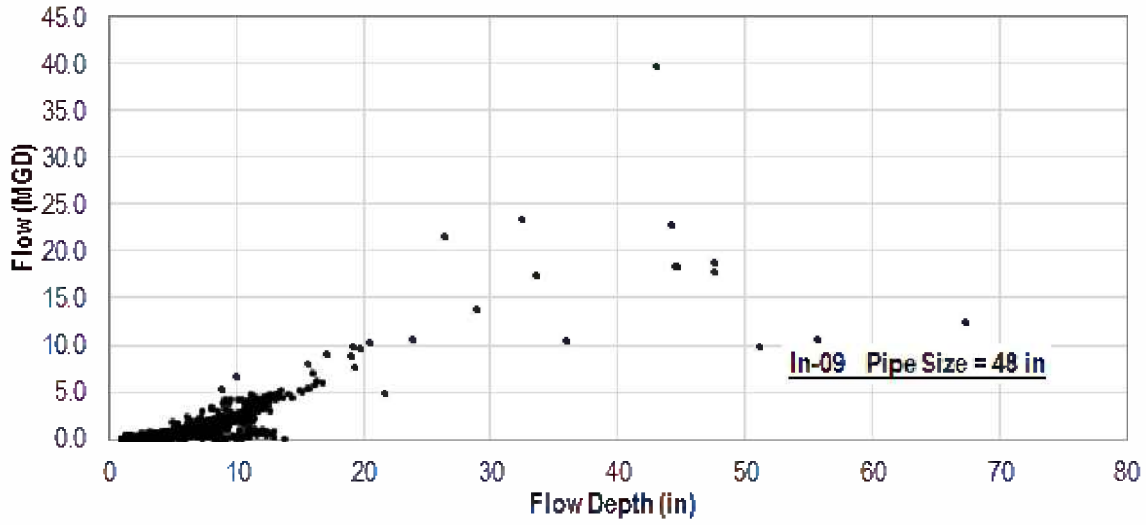


Figure 23: Flow Monitoring Data, In-10

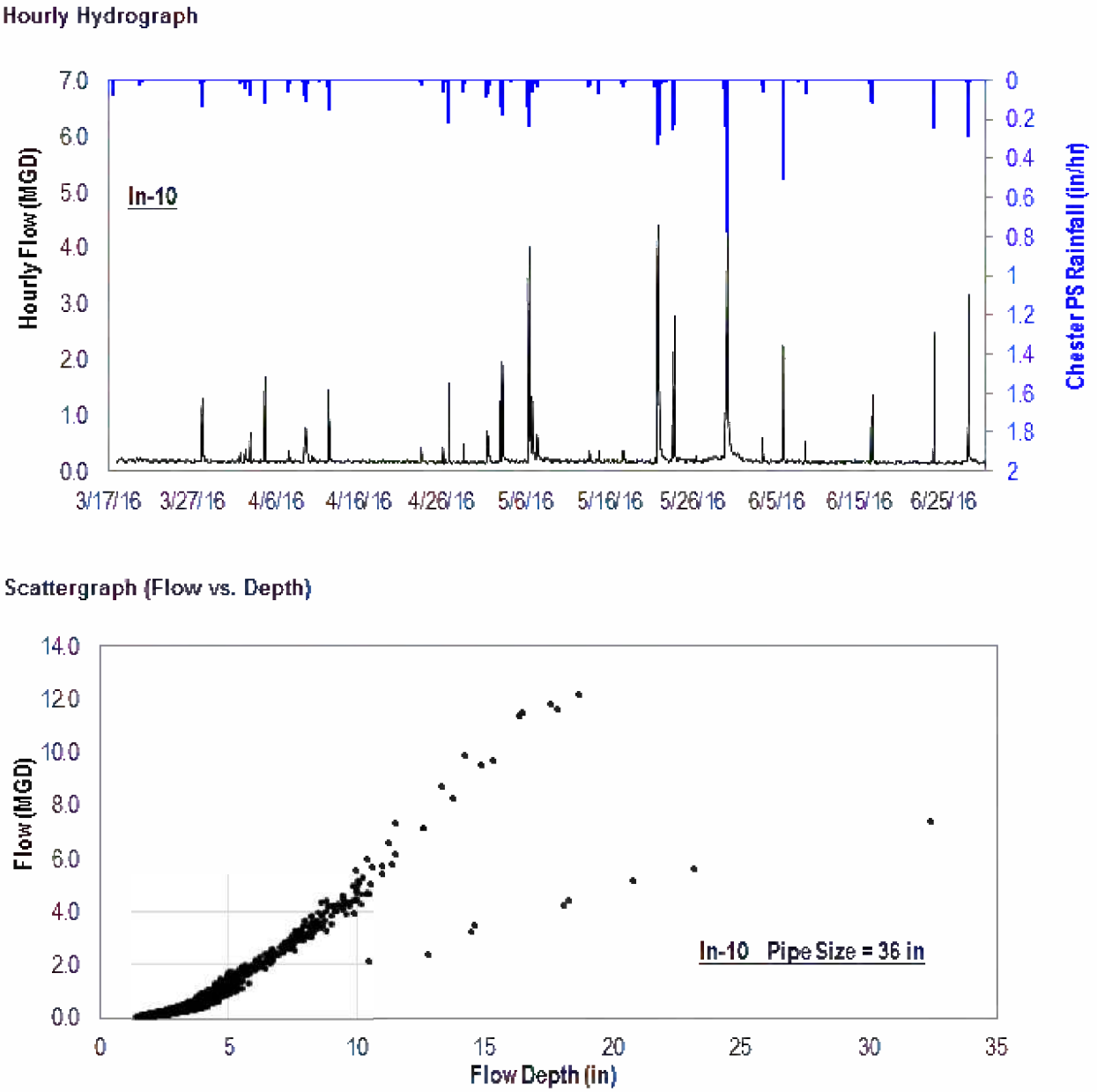


Figure 24: Flow Monitoring Data, In-11

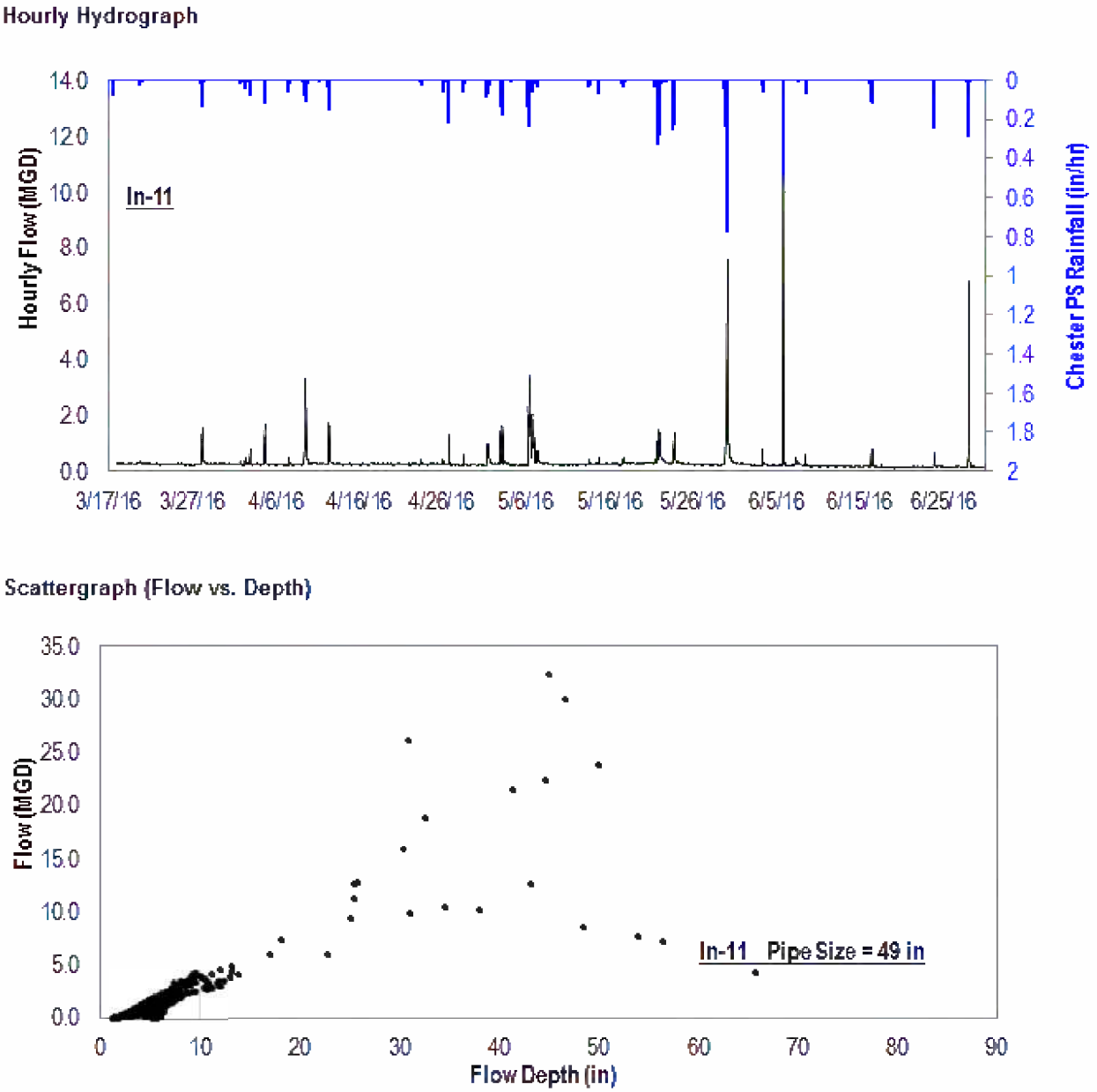
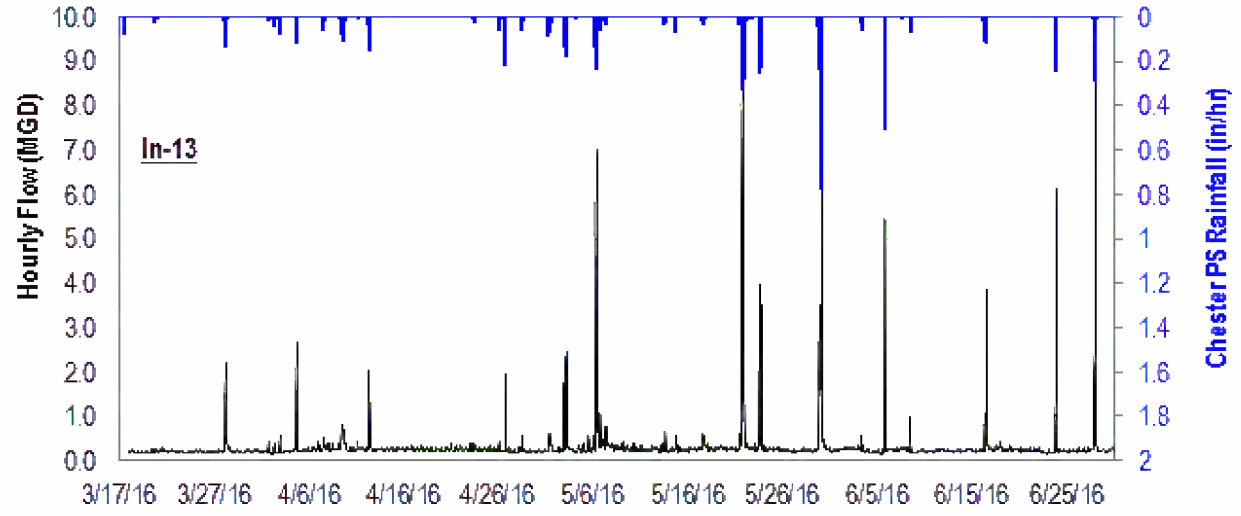


Figure 25: Flow Monitoring Data, In-13

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

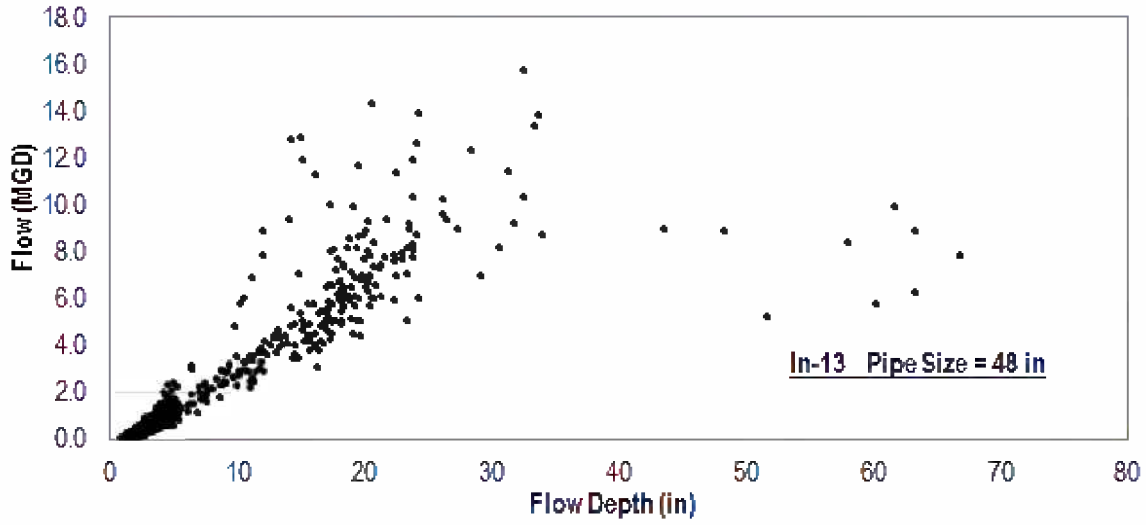
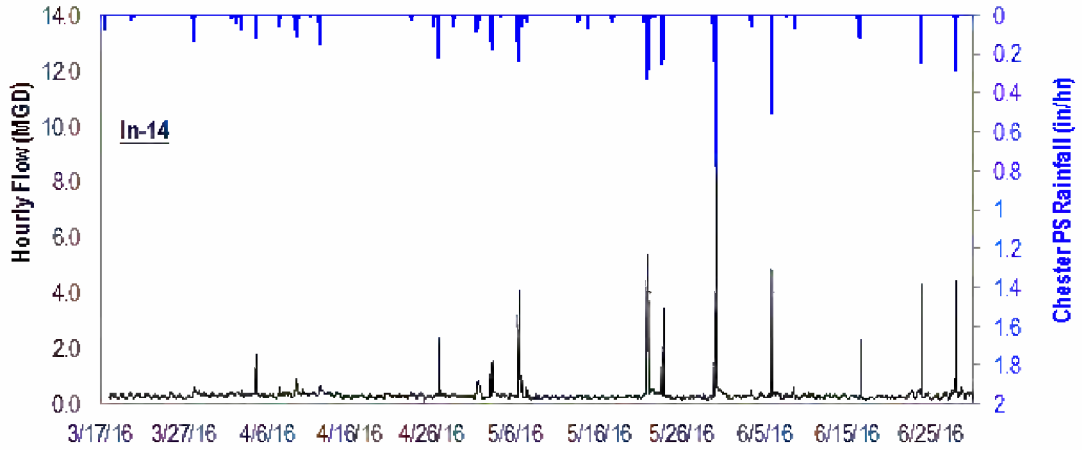
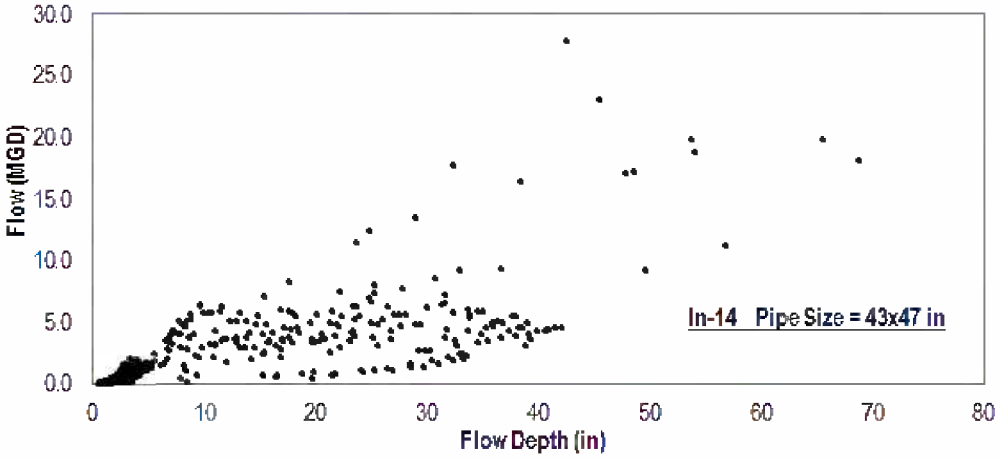


Figure 26: Flow Monitoring Data, In-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

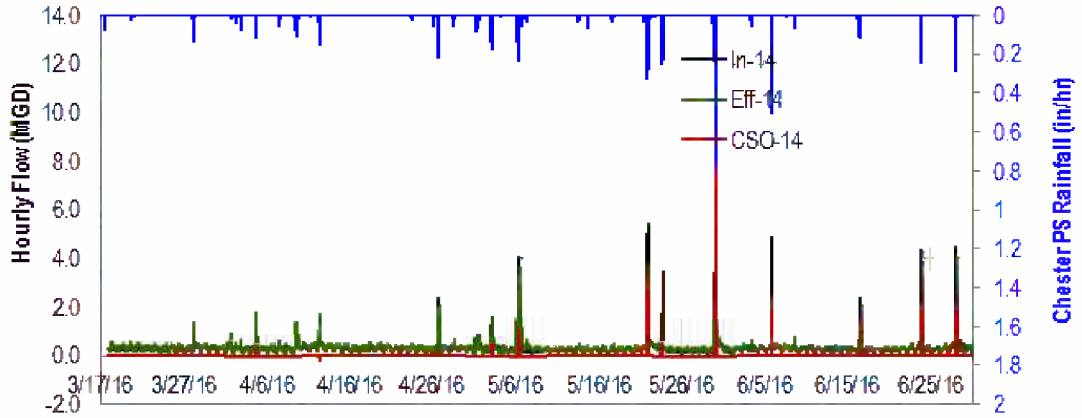
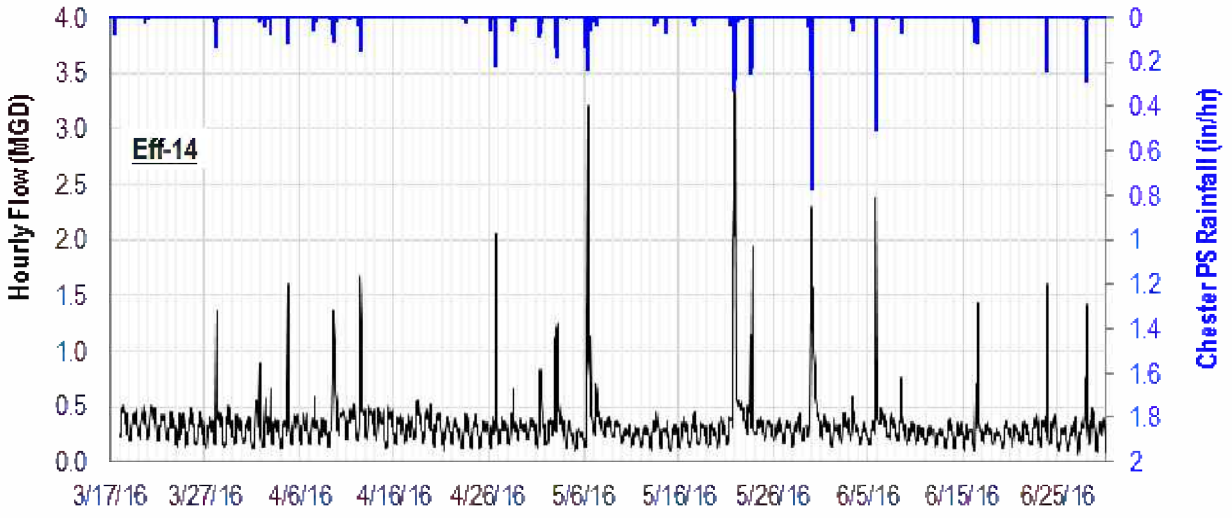


Figure 27: Flow Monitoring Data, Eff-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

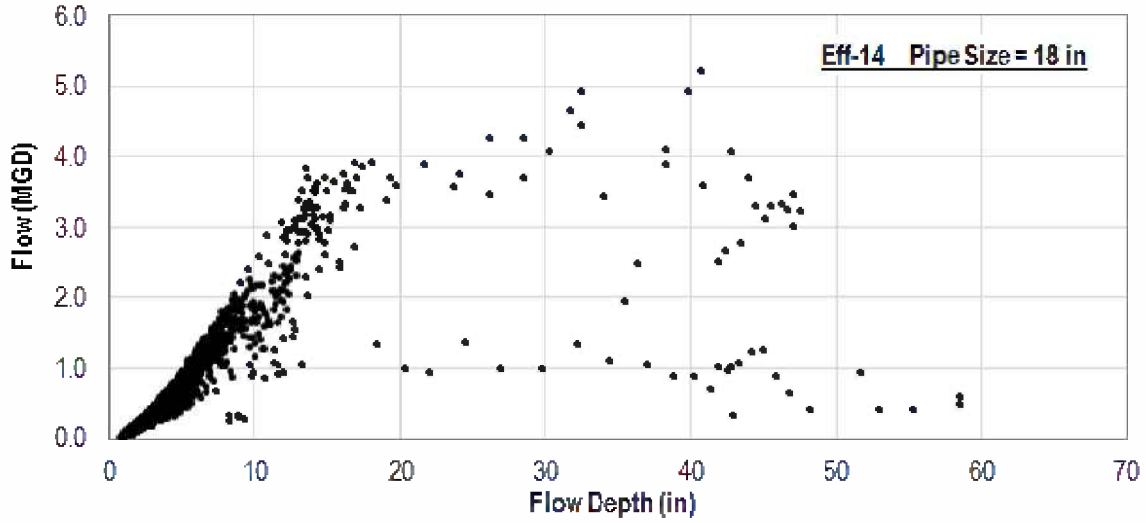


Figure 28: Flow Monitoring Data, CSO-14

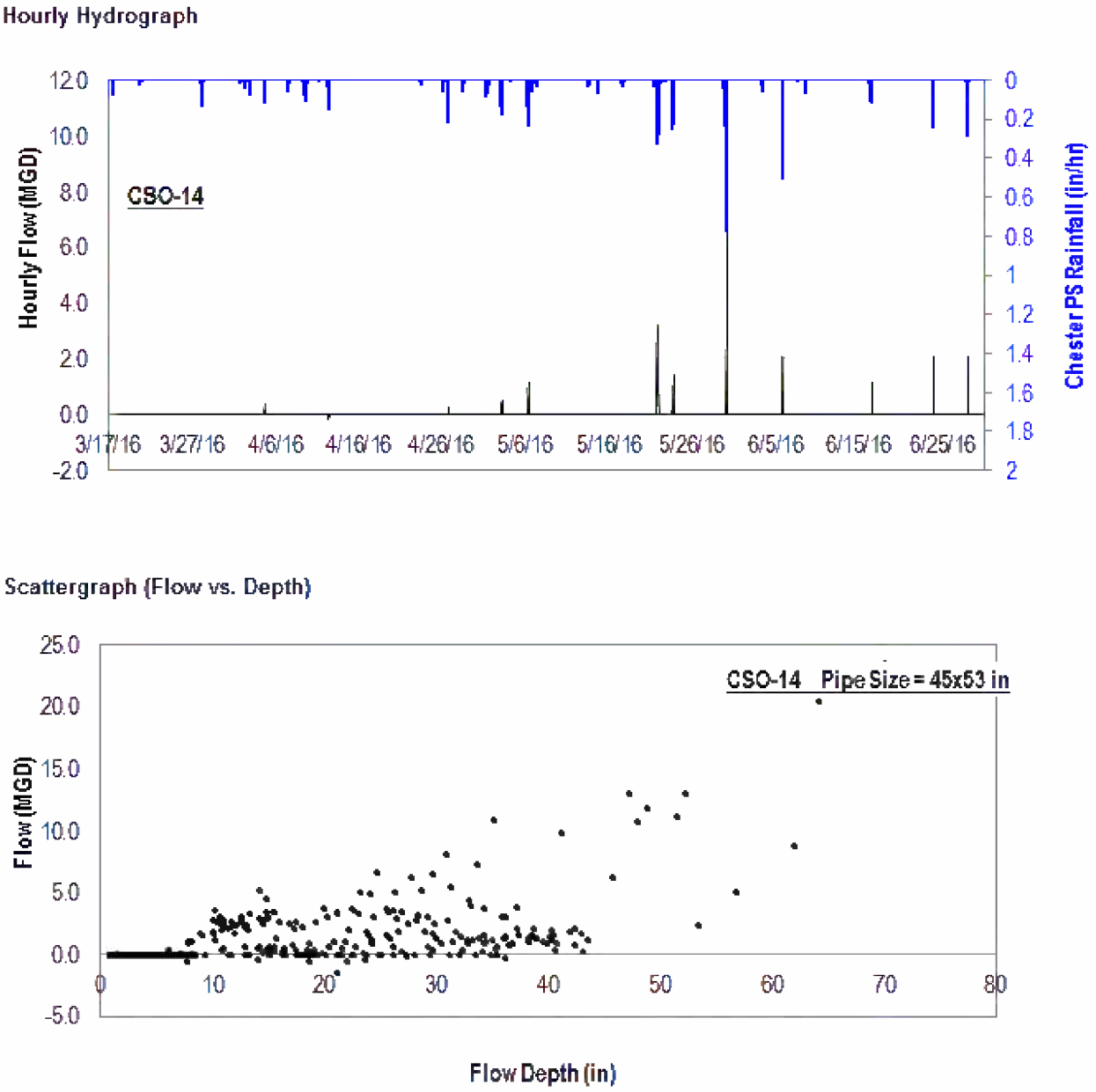


Figure 29: Flow Monitoring Data, In-16

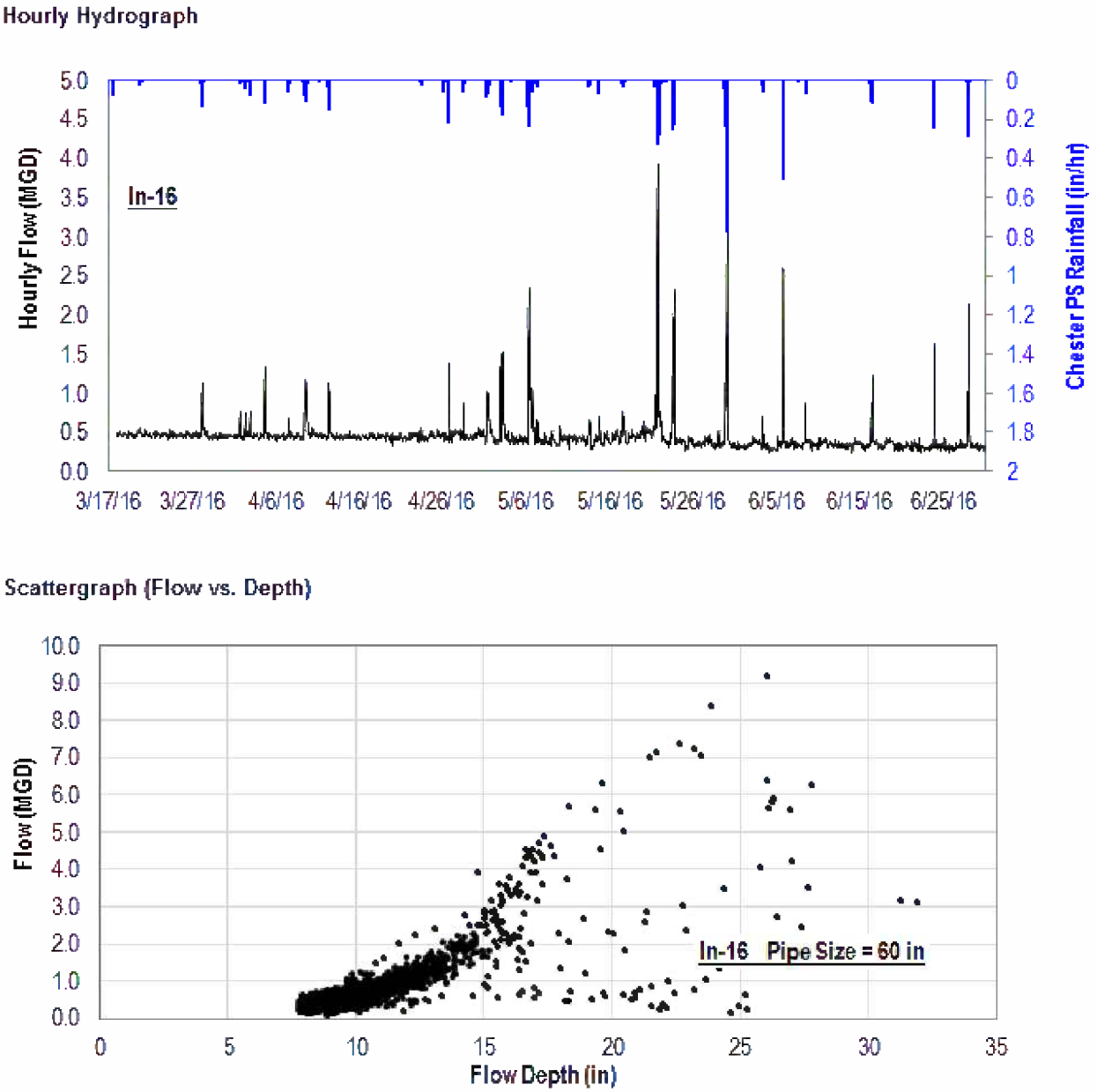


Figure 30: Flow Monitoring Data, In-17

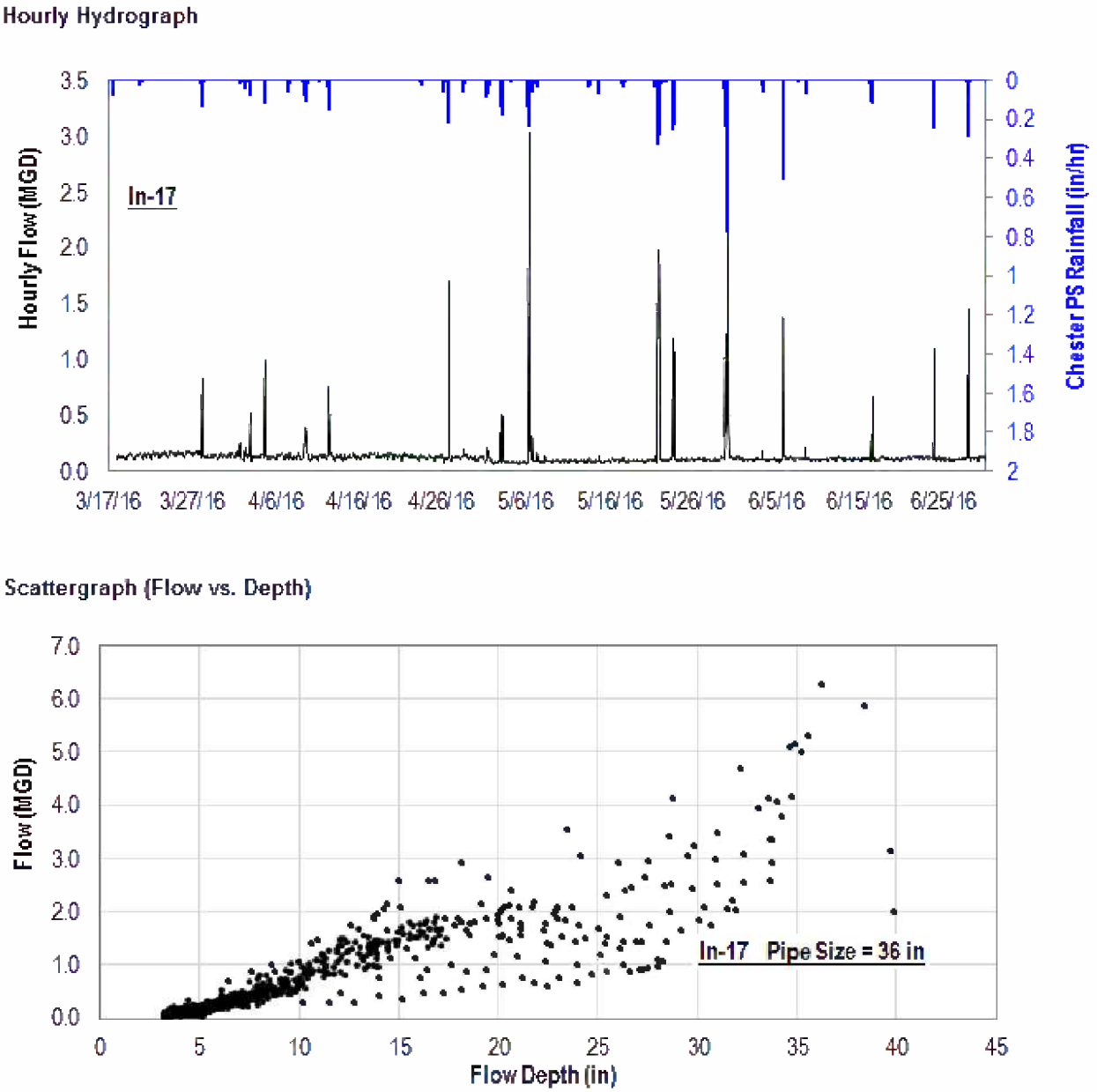


Figure 31: Flow Monitoring Data, In-18

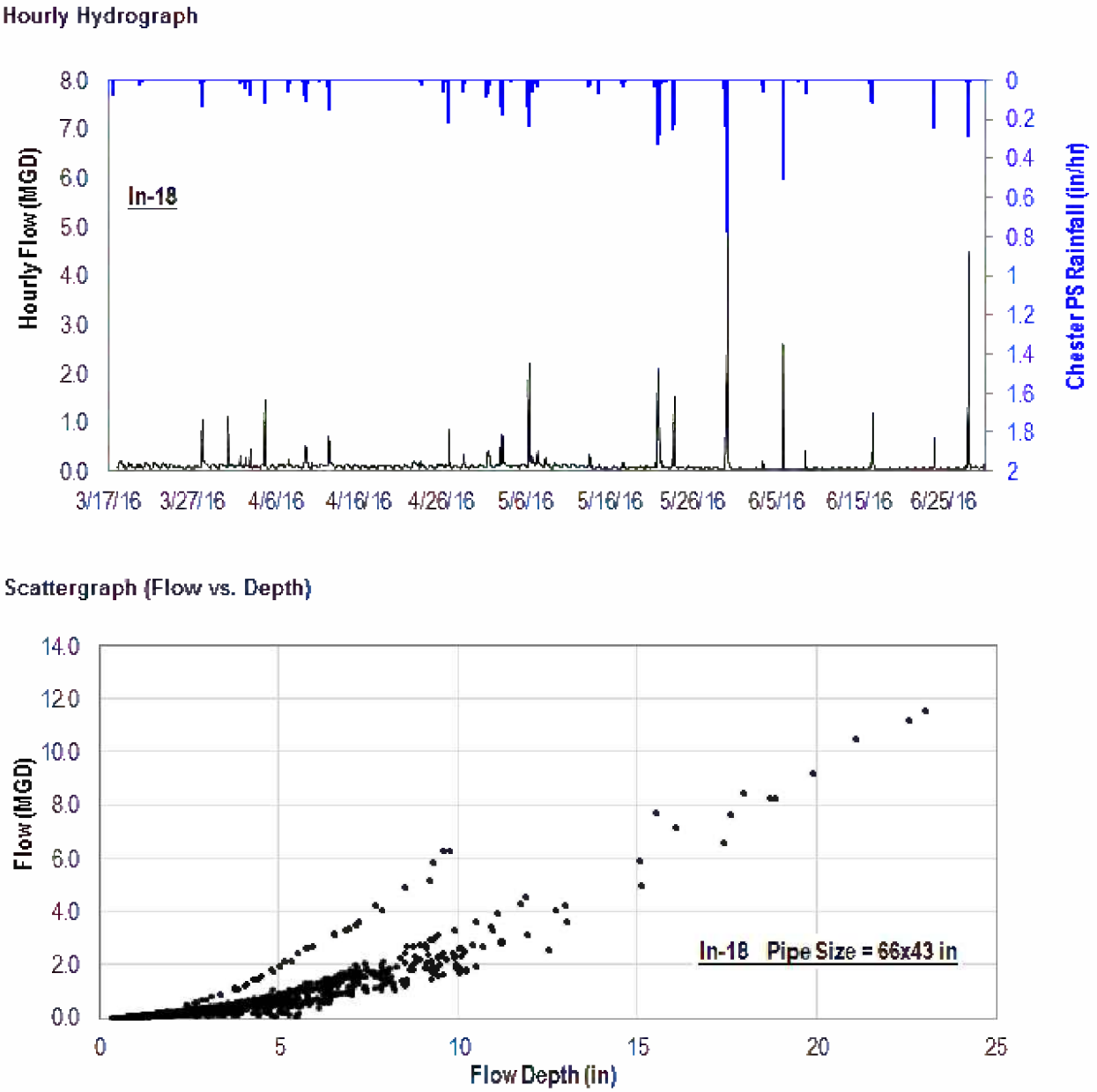
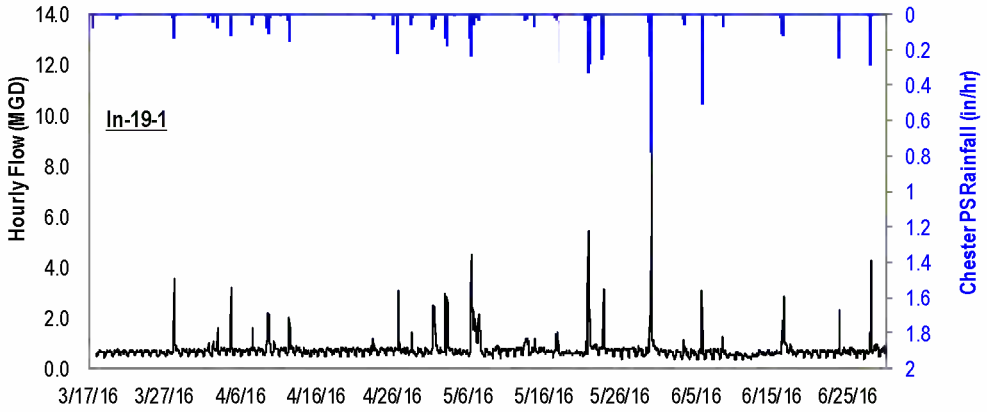
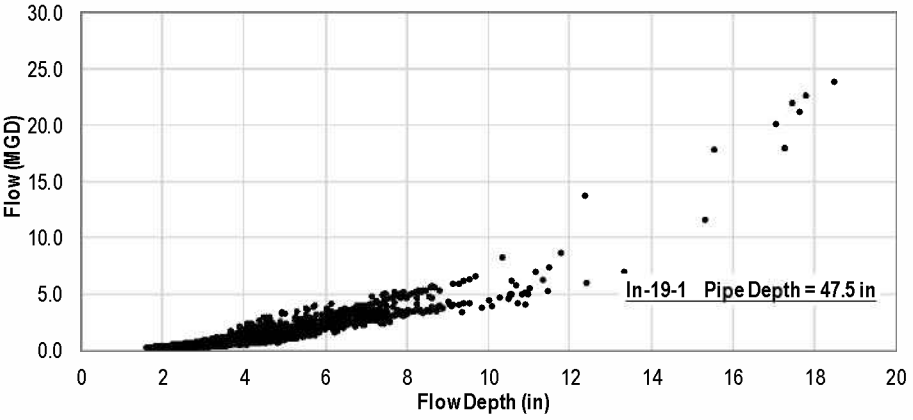


Figure 32: Flow Monitoring Data, In-19-1

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#19 Influent , Effluent and Overflow

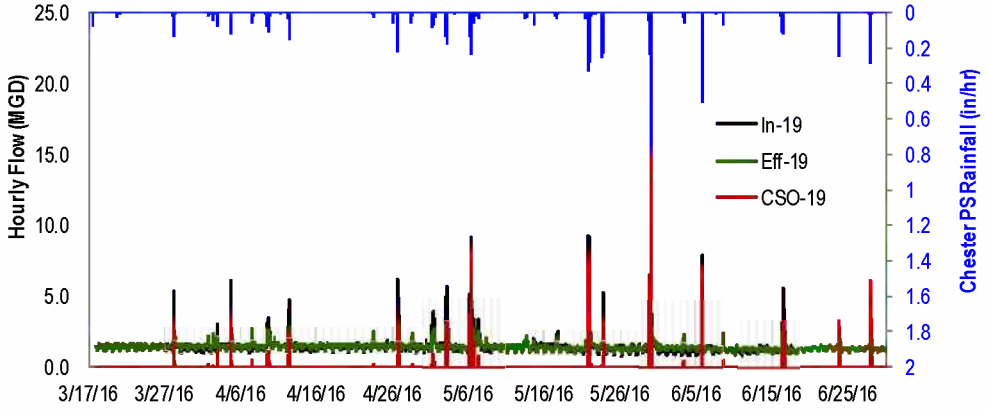


Figure 33: Flow Monitoring Data, In-19-2

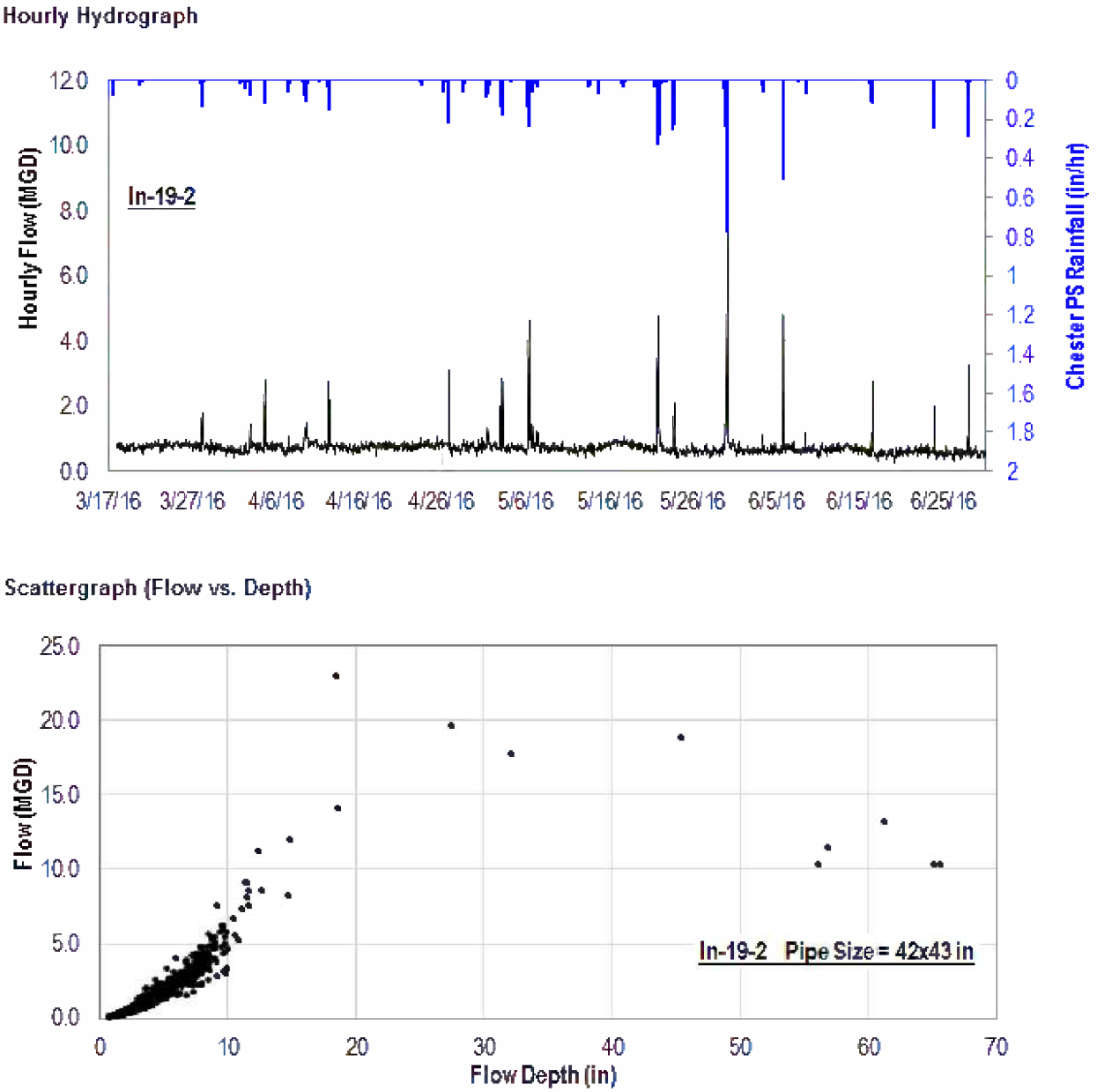


Figure 34: Flow Monitoring Data, Eff-19

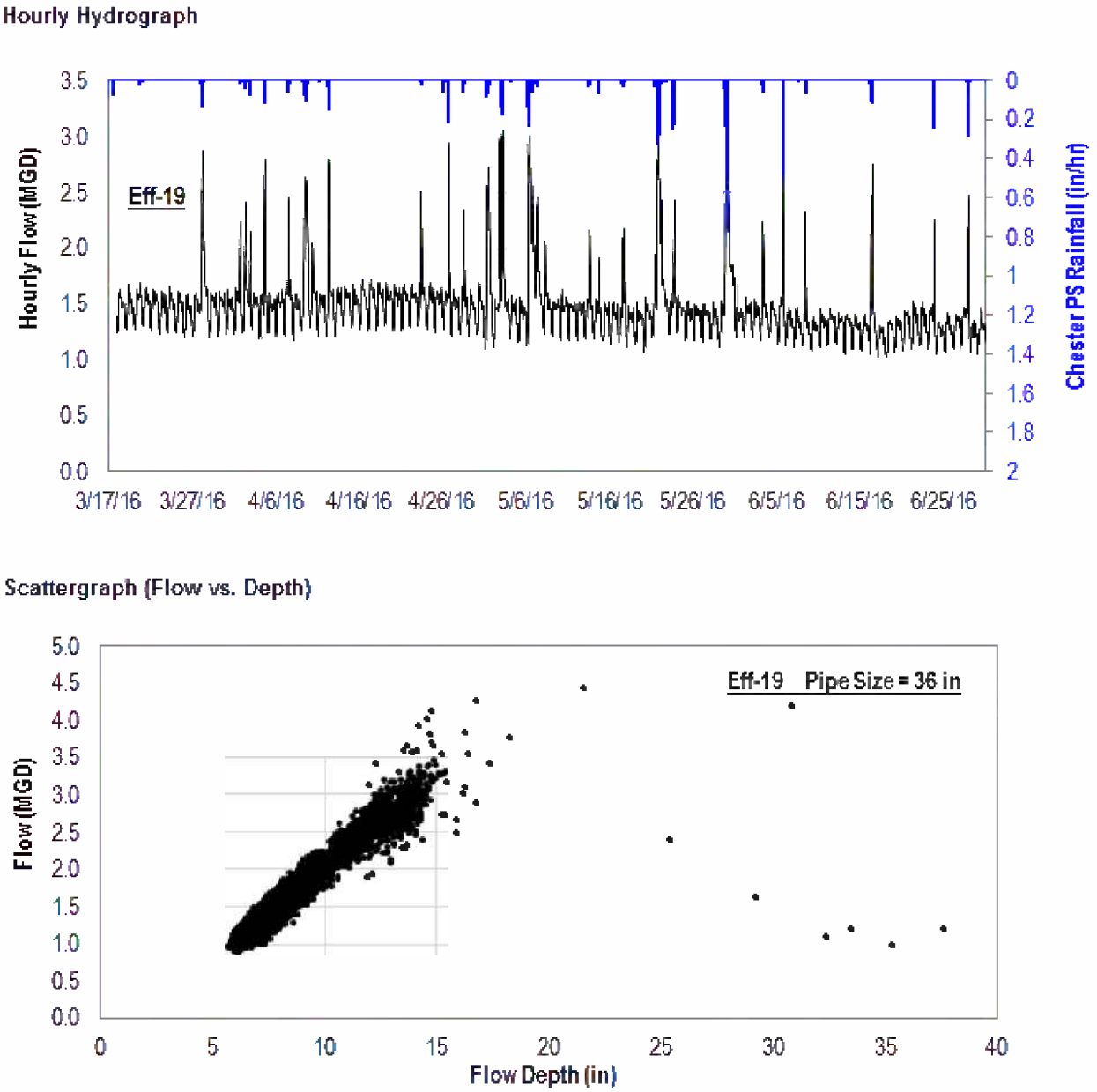
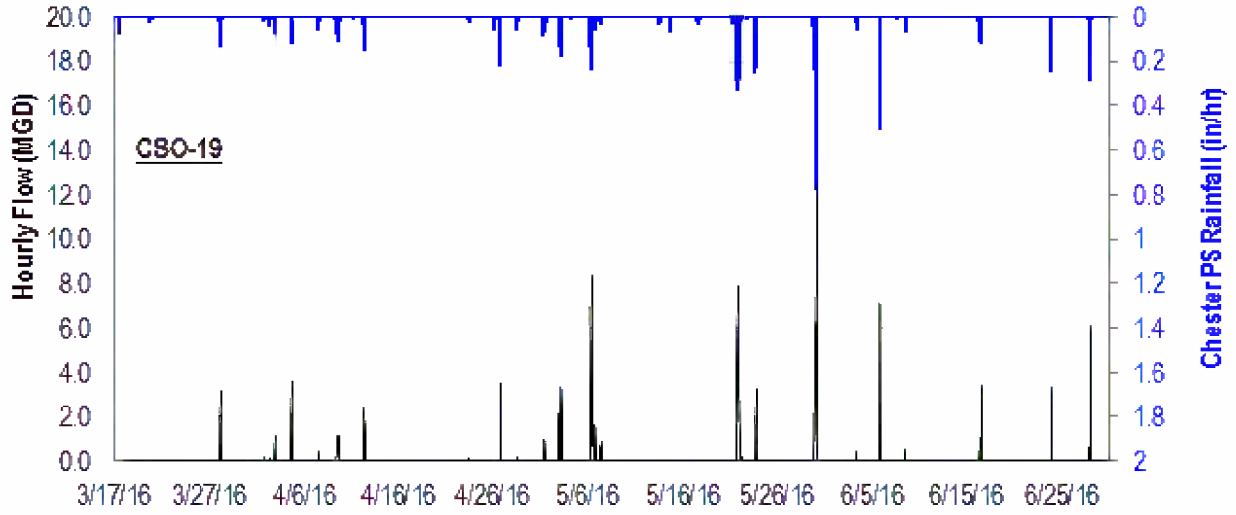


Figure 35: Flow Monitoring Data, CSO-19



Scattergraph (Flow vs. Depth)

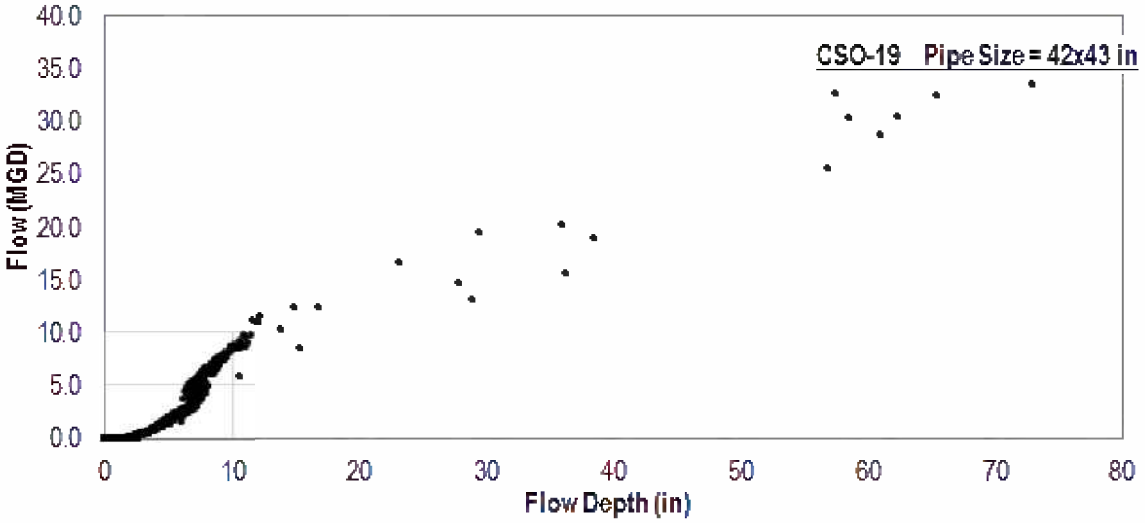


Figure 36: Flow Monitoring Data, In-25

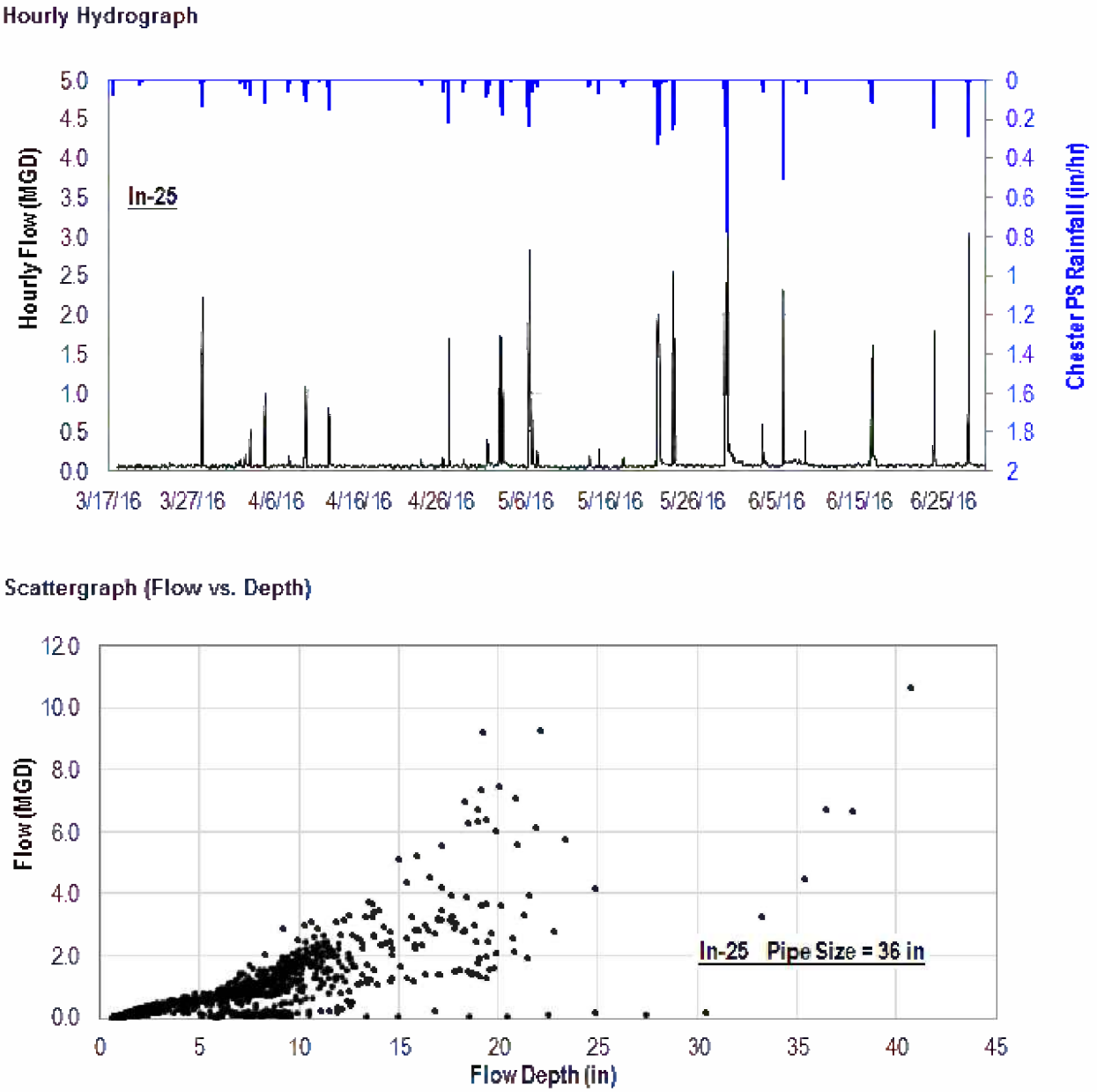


Figure 37: Flow Monitoring Data, In-26

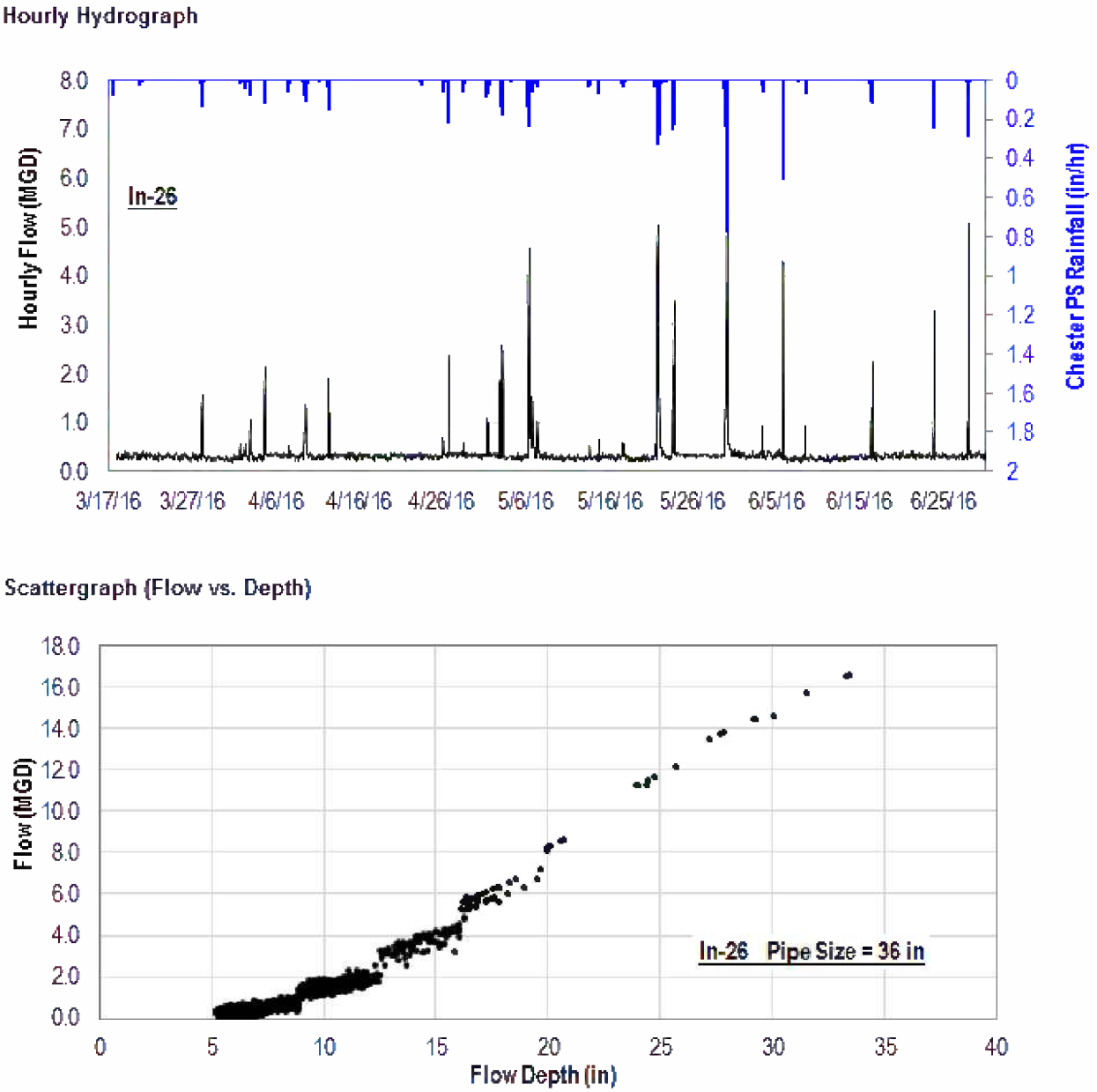
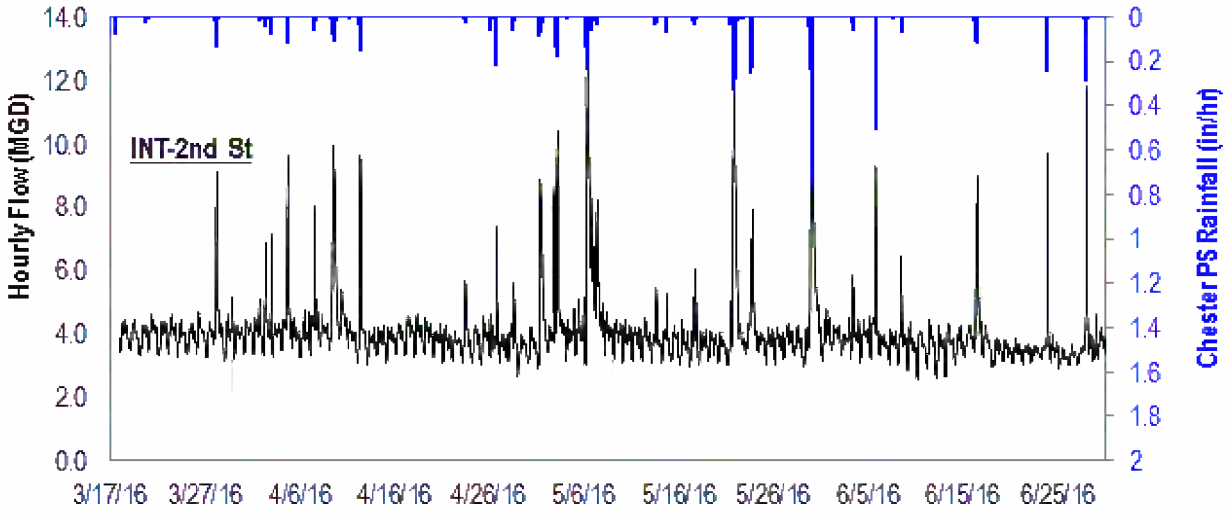


Figure 38: Flow Monitoring Data, INT-2nd St.

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

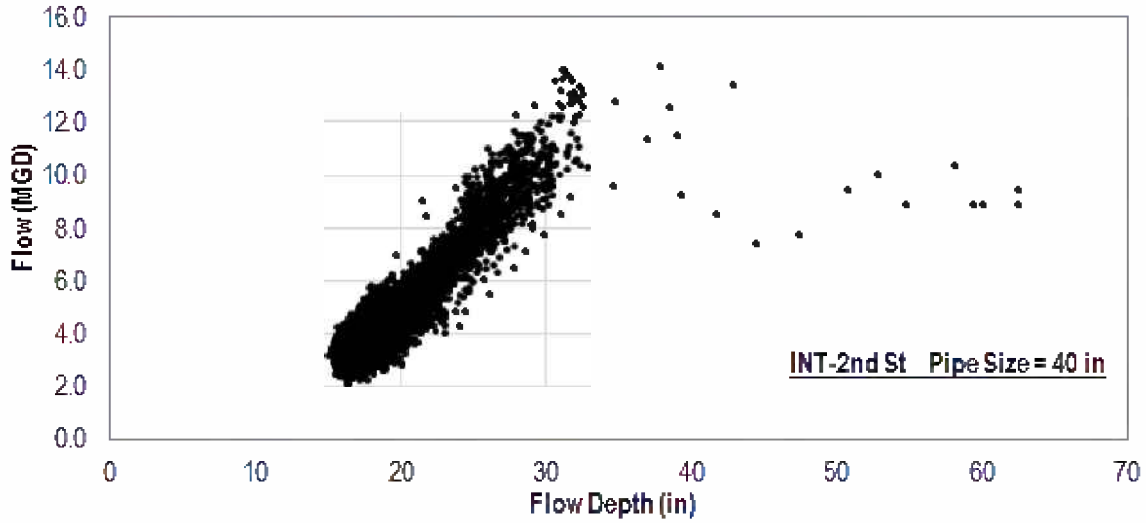


Figure 39: Flow Monitoring Data, INT-DRI

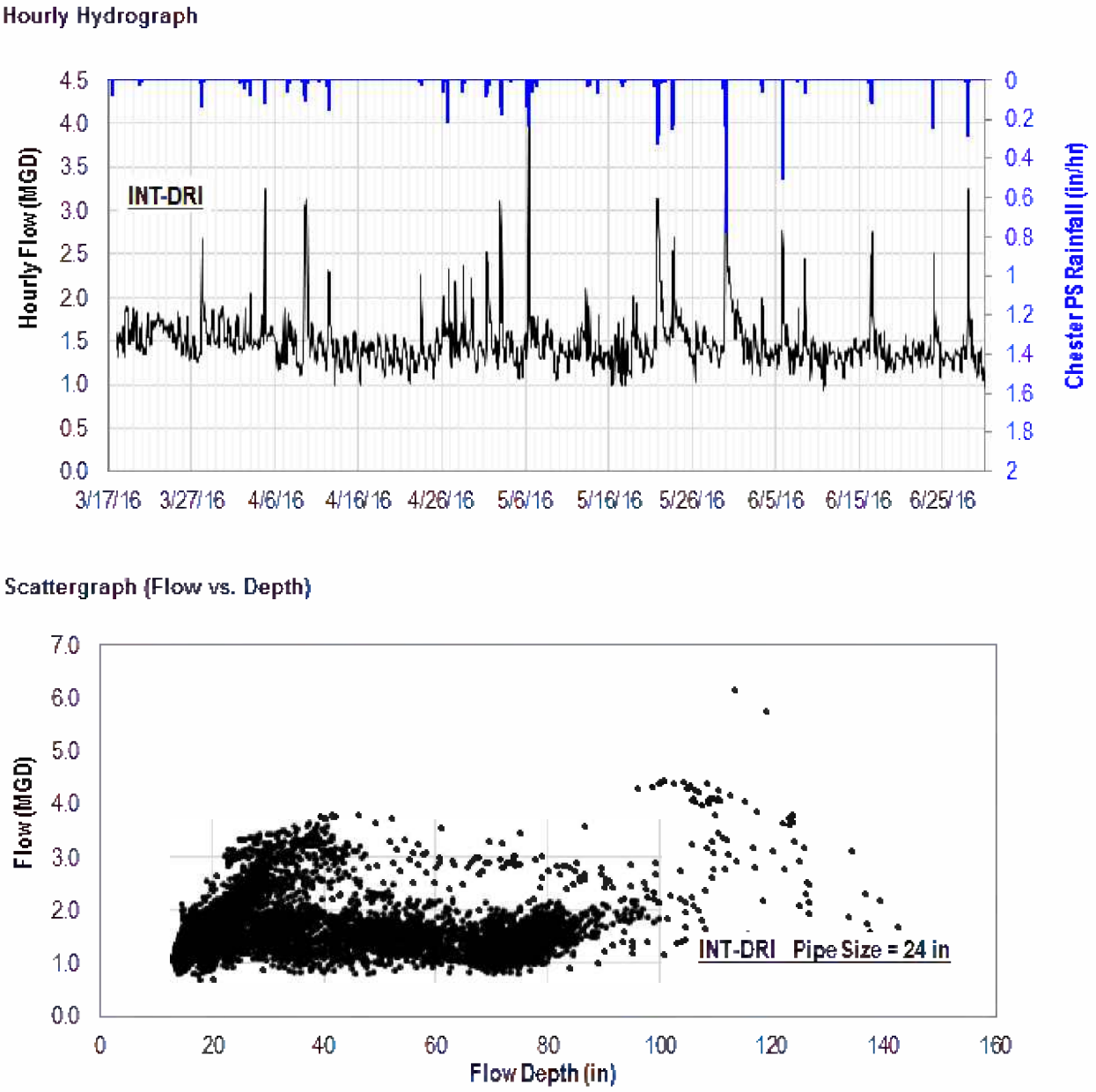


Figure 40: Flow Monitoring Data, INT-Ridley 2

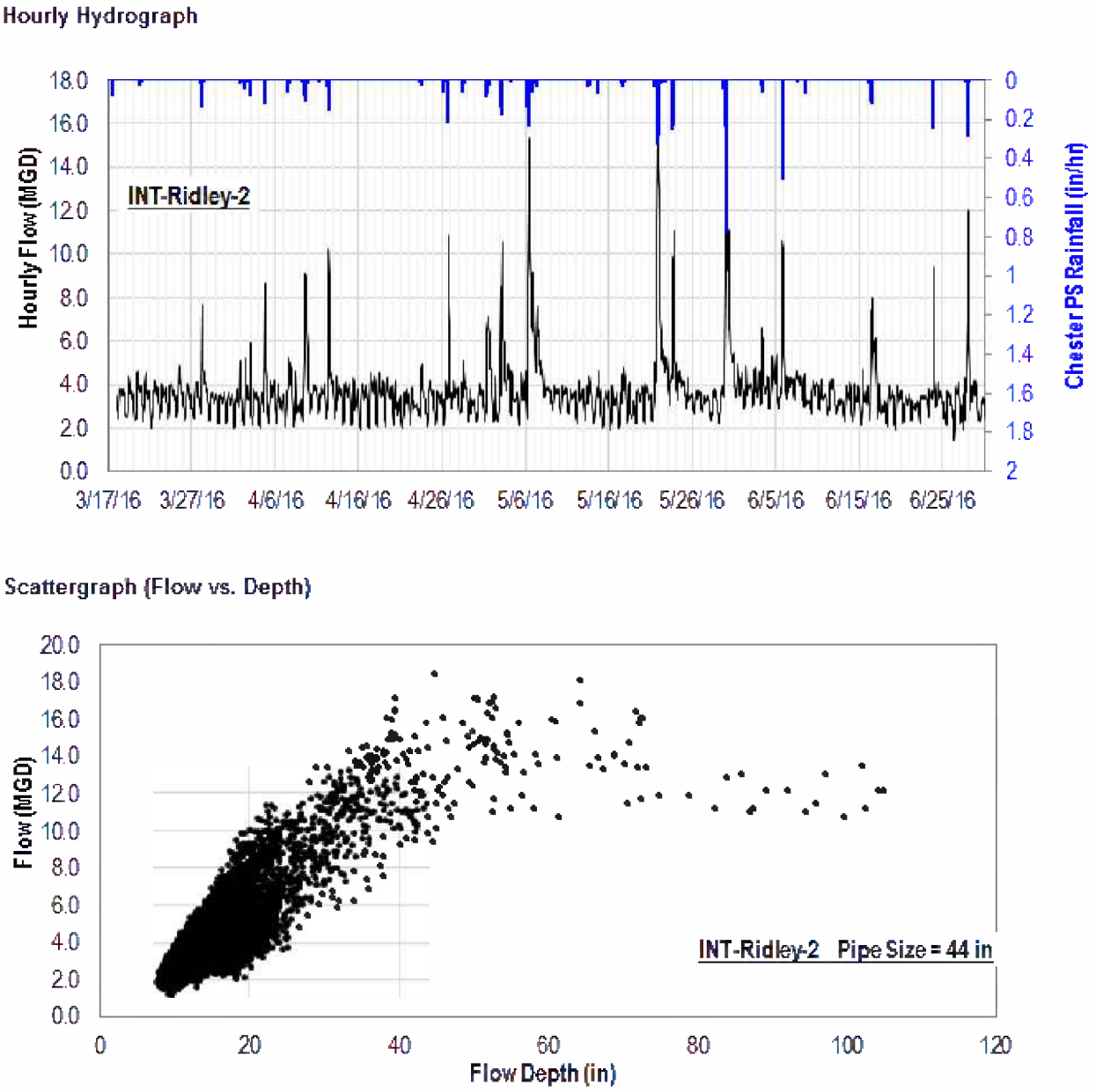


Figure 41: Flow Monitoring Data, INT-Ridley 3

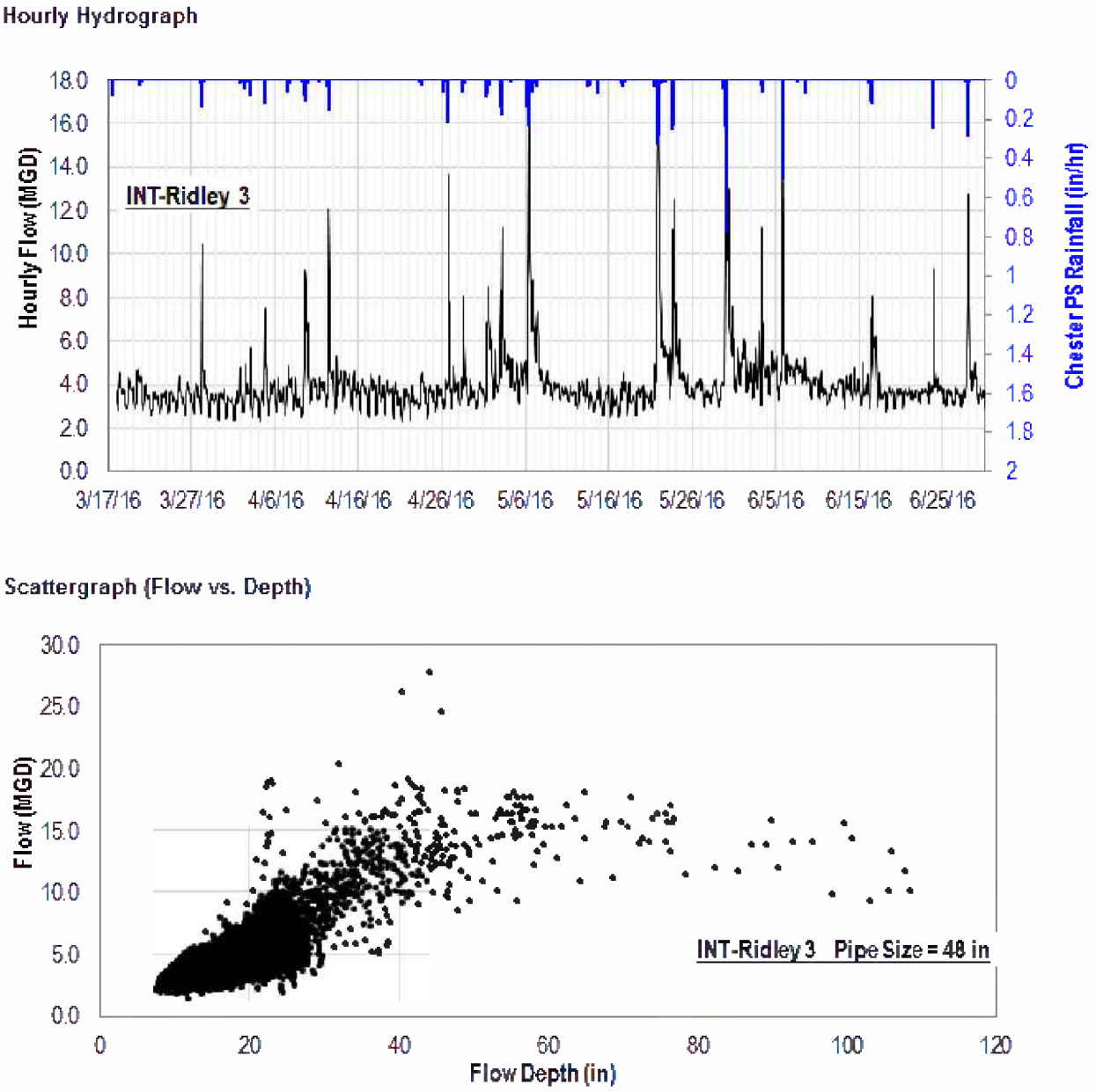


Figure 42: Flow Monitoring Data, INT-WEI

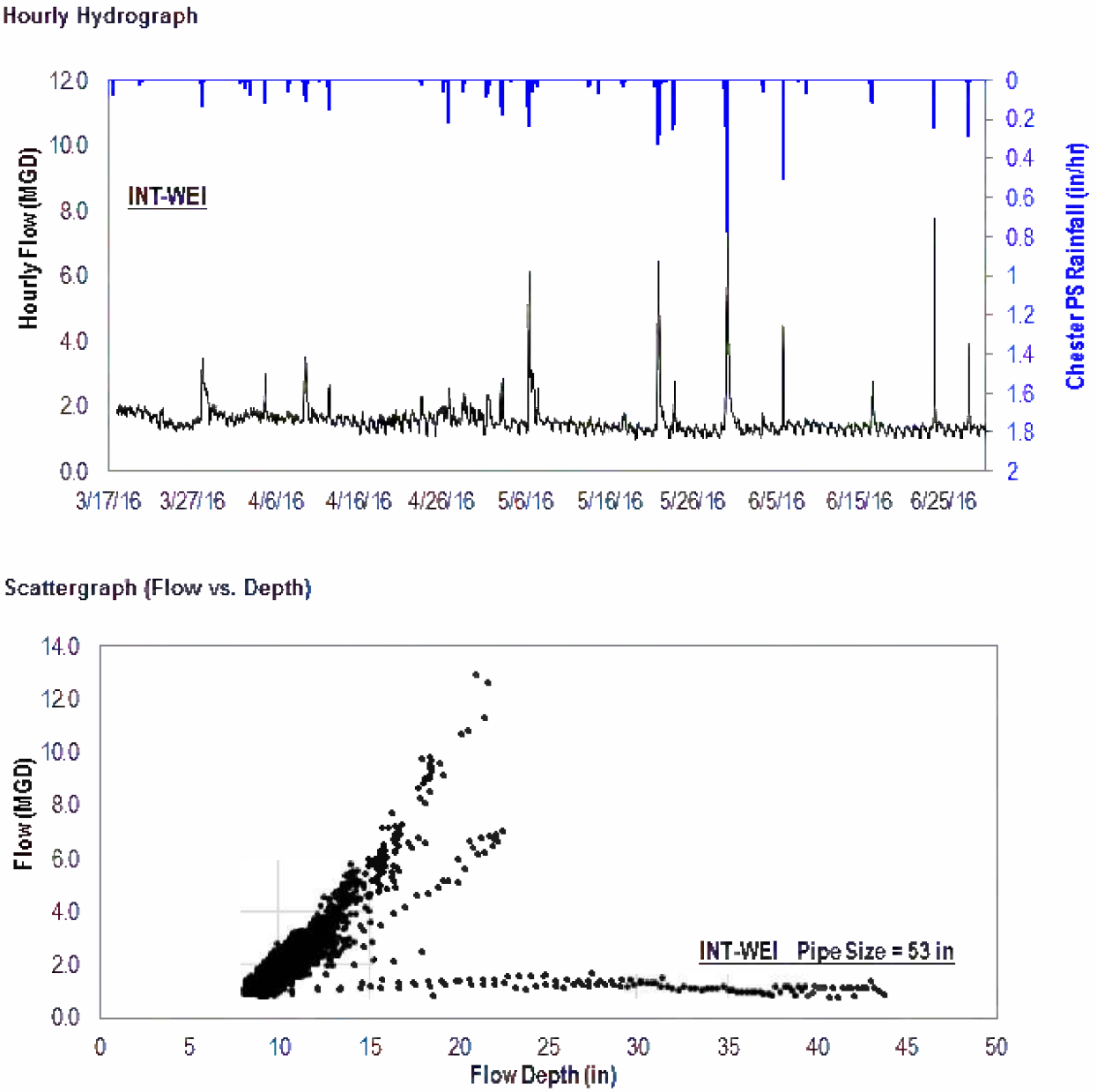


Figure 43: Flow Monitoring Data, 1-Sep

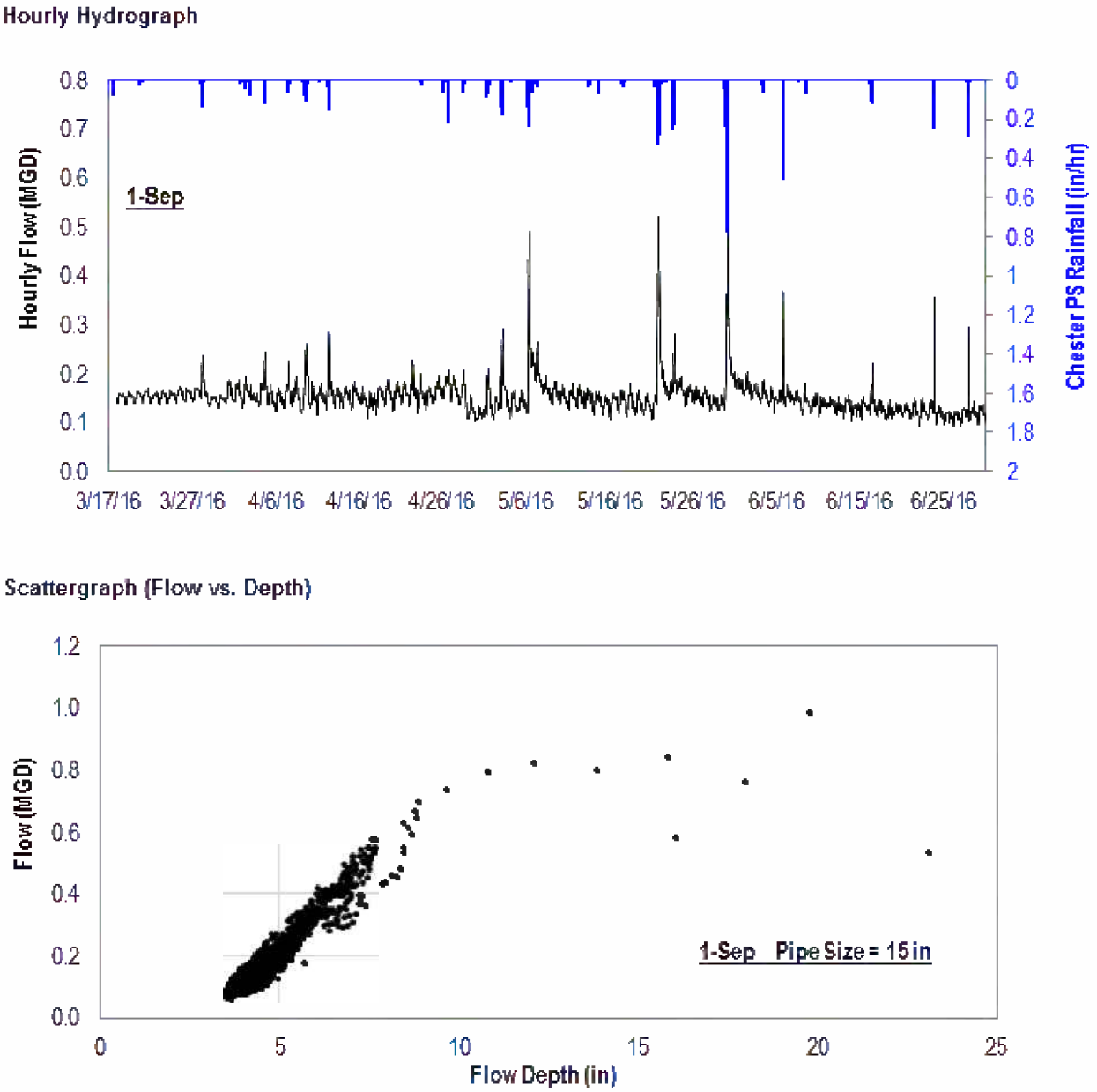


Figure 44: Flow Monitoring Data, 2-Sep

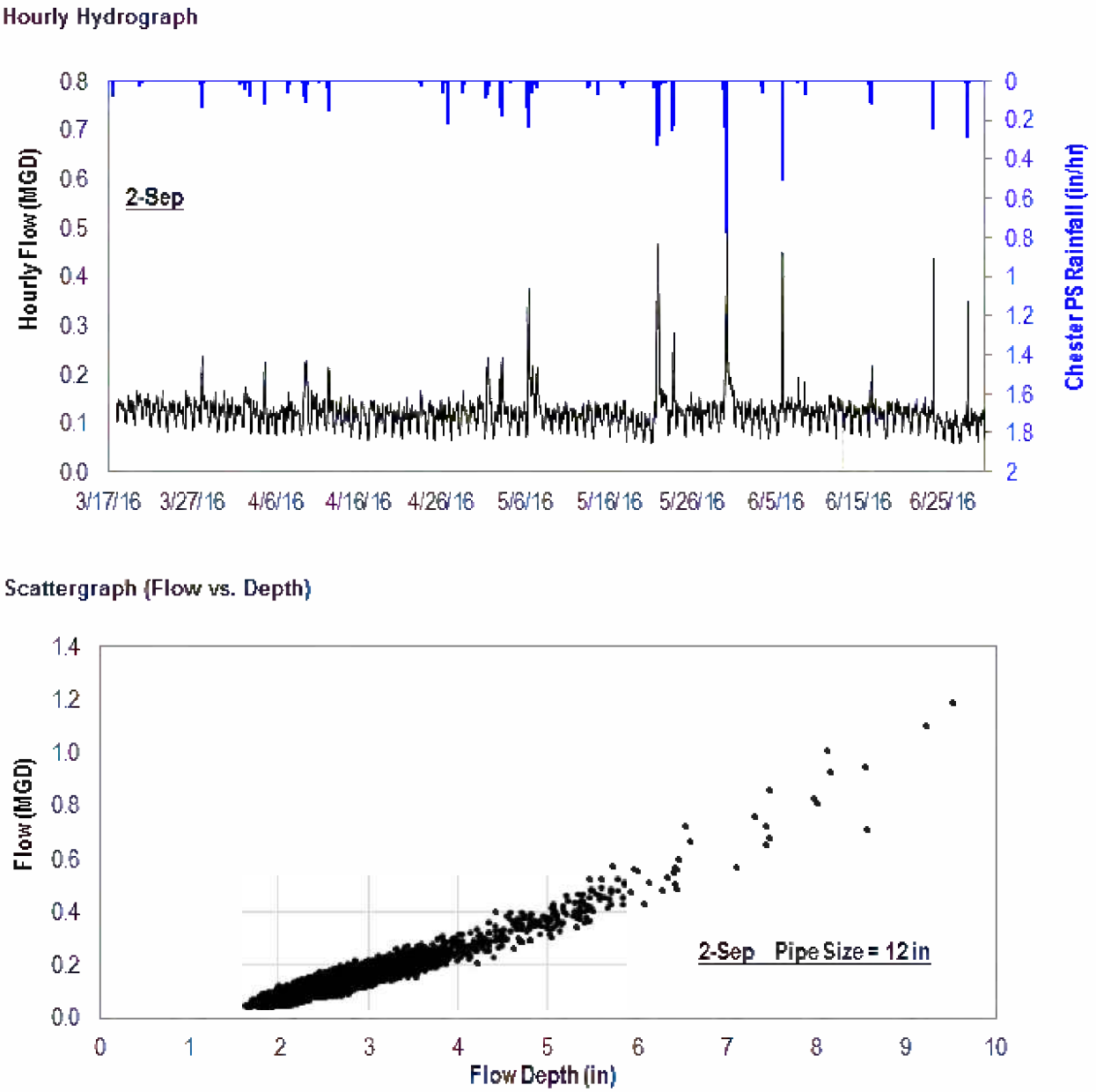


Figure 45: Flow Monitoring Data, 3-Sep

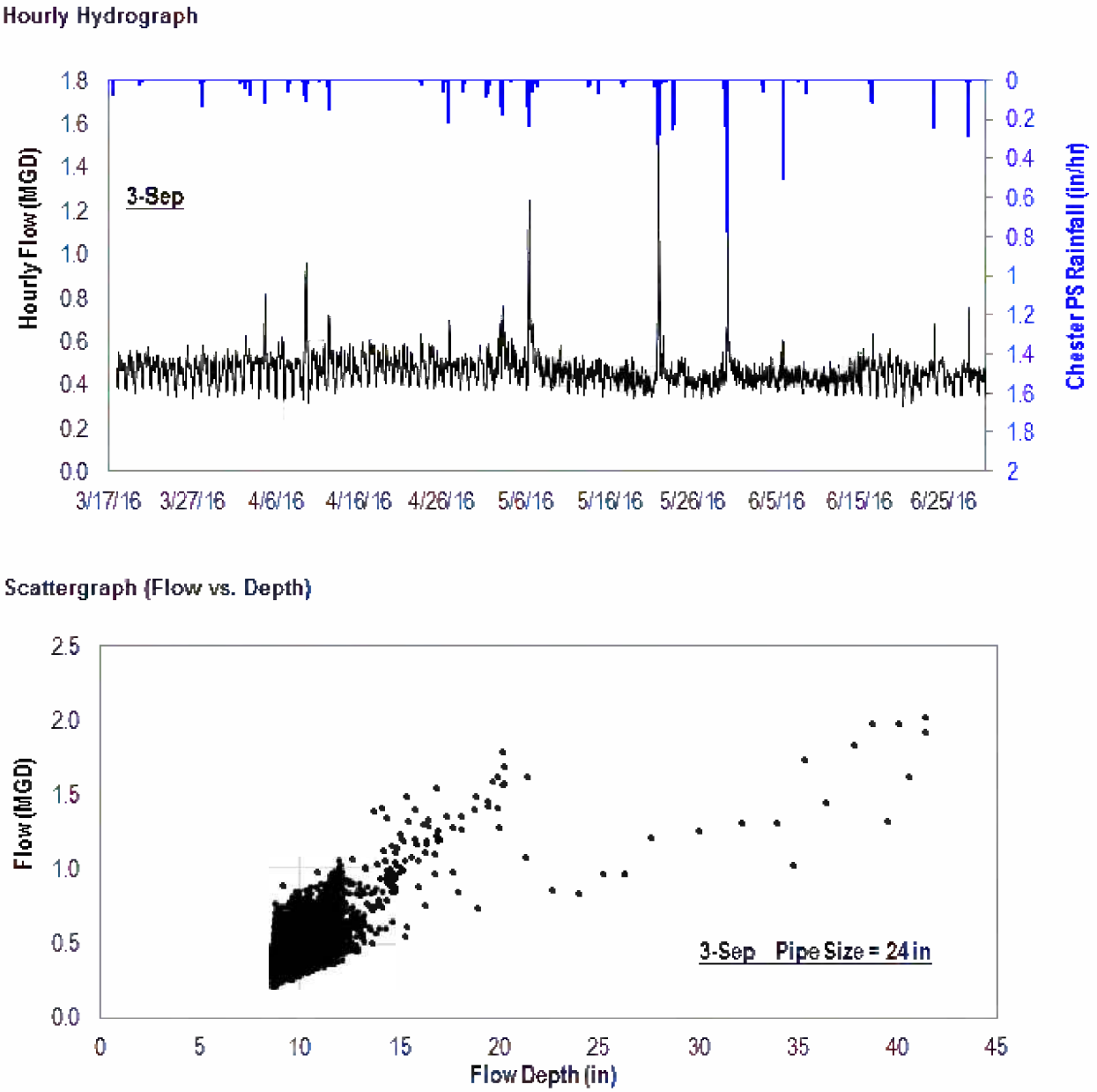


Figure 46: Flow Monitoring Data, Side 1

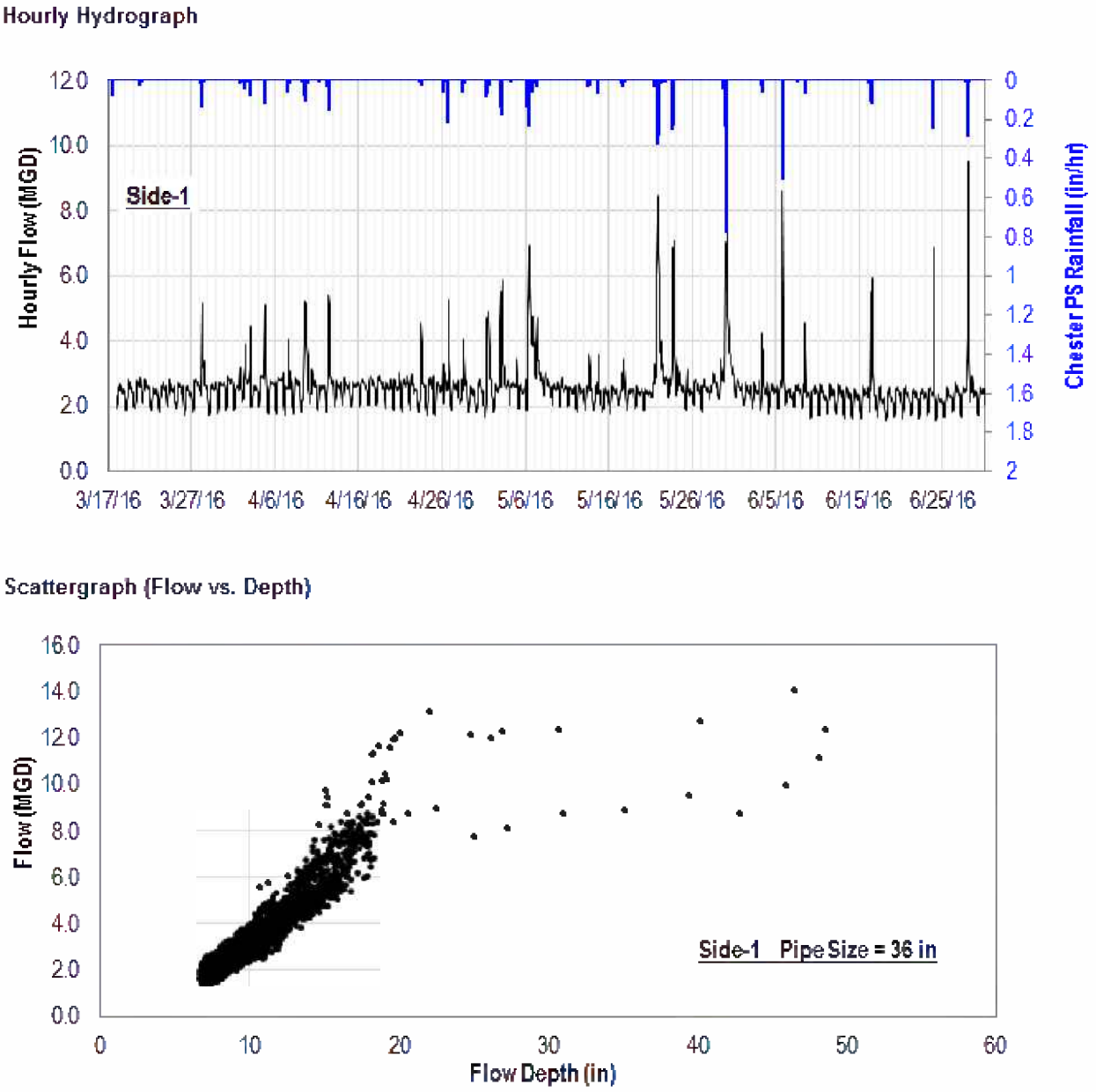
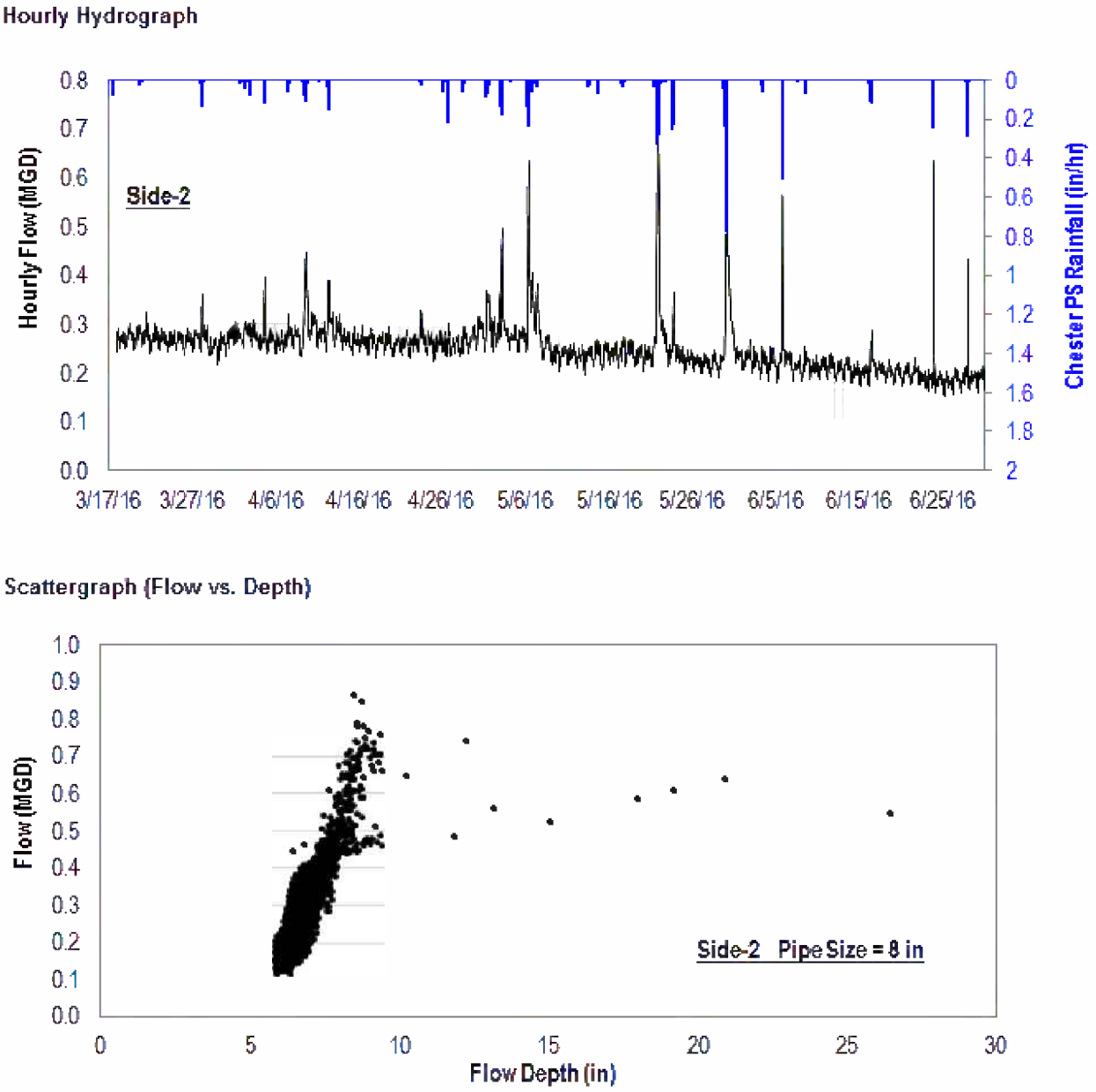


Figure 47: Flow Monitoring Data, Side-2



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Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Rainfall and Flow Monitoring Quarterly Report No. 2

(July 1, 2016 to September 30, 2016)

(Final)

October 2016

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Rainfall and Flow Monitoring Report No. 2.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	*Signature*	10/21/16 *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	10/20/16 *Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	10/21/16 *Date*

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Section 1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) entered into a Consent Decree (CD) with the United States Government in August 2015. The purpose of the Consent Decree is to establish a schedule for implementation of Long Term Control Plan Update (LTCPU) to achieve full compliance with the Clean Water Act and the regulations and Clean Streams Law and regulations. The lodging of this Consent Decree was entered by the court on August 17, 2015, it was signed and filed on November 10, 2015 by the United States District Court for the Eastern District of Pennsylvania.

According to the Consent Decree, DELCORA's Hydrologic and Hydraulic Model (H&H Model) must be updated to meet the requirements in Section V.A.14 of the Consent Decree. A detailed plan to update, calibrate and validate the H&H model has been submitted and approved by the USEPA on March 1, 2016. Additional rainfall and flow monitoring is required to calibrate and validate the H&H model. Requirements of rainfall and flow monitoring are detailed in the Consent Decree Section V.A.14.d and e, which is included in the following:

> "*d.* *Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve* ***(12) months****, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*
>
> *e.* *For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data."*

In summary, rainfall and flow monitoring shall be conducted for at least 12 months, and quarterly technical memoranda shall be submitted to Plaintiffs for review.

To satisfy the above mentioned rainfall and flow monitoring requirements, and in accordance with the submitted DELCORA H&H Model Update and Calibration Plan, DELCORA has installed 5 new rain gauges and 39 new flow meters in its sewer collection system. Starting from March 18, 2016, most of the newly installed rain gauges and flow meters were in service and began generating data.

This report is a summary of the Rainfall and Flow Monitoring during July 1, 2016 to September 30, 2016.

Section 2 Rainfall Monitoring

2.1 Rainfall Monitoring Locations

The site locations of the four existing and five newly installed rain gauges are shown in **Figure 1**. These rain gauges provide an effective spatial coverage of the entire WRTP's service area.

The four (4) existing rainfall gauges are in Delaware County that record precipitation in 15-minute increments. The gauges are located at the following DELCORA owned facilities:

- Western Regional Treatment Plant (WRTP, will be used for model calibration)
- Central Delaware County Pump Station (CDPS, will be used for model calibration)
- Muckinipates Pump Station (MPS, will be used for model calibration)
- Darby Creek Pump Station (DCPS, will NOT be used for model calibration)

The five (5) newly installed rain gauges are listed in **Table 1** with detail information of rain gauge location, service starting date, and data recording interval.

Table 1: Newly Installed Rain Gauges

	Rain Gauge ID	Location	Service Start Date	Data Interval
1	RG_Rose Valley	18 N. Longpoint Lane, Media, PA	3/05/16	5-minute
2	RG_Chester-PS	55 East 2nd Street, Chester, PA	3/05/16	5-minute
3	RG_NCPS	1628 Naamans Creek Rd., Marcus Hook, PA	3/05/16	5-minute
4	RG_Springfield	217 Saxer Avenue, Springfield, PA	4/03/16	5-minute
5	RG_UCT	1671 N. Upper Providence Road, Media, PA	4/16/16	5-minute

2.2 Rain Gauge Calibration/Verification Procedure

Rain Gauge calibrations were performed during the rain gauge installation. Additional calibrations will be performed to the manufacturer's specifications on a bi-annual basis or as needed if irregular data is observed. Rain gauges are routinely checked for debris, and cleared after snow/ice storms.

Each "tip" of the rain gauge bucket should correspond with 0.01" of rain. To ensure the modem is reading the tipping bucket pulse accurately, the tech will tip the bucket 10 times in rapid succession. The tech should see that 0.1" of rain is recorded.

2.3 Rainfall Event Summary

Rainfall events were analyzed for each individual rain gauge based on the inter-event time of 12 hours. In total there were 26 rainfall events during reporting period. **Table 2** lists rainfall events with total precipitation greater than 0.1 inch.

Figure 1: Rain Gauge Locations

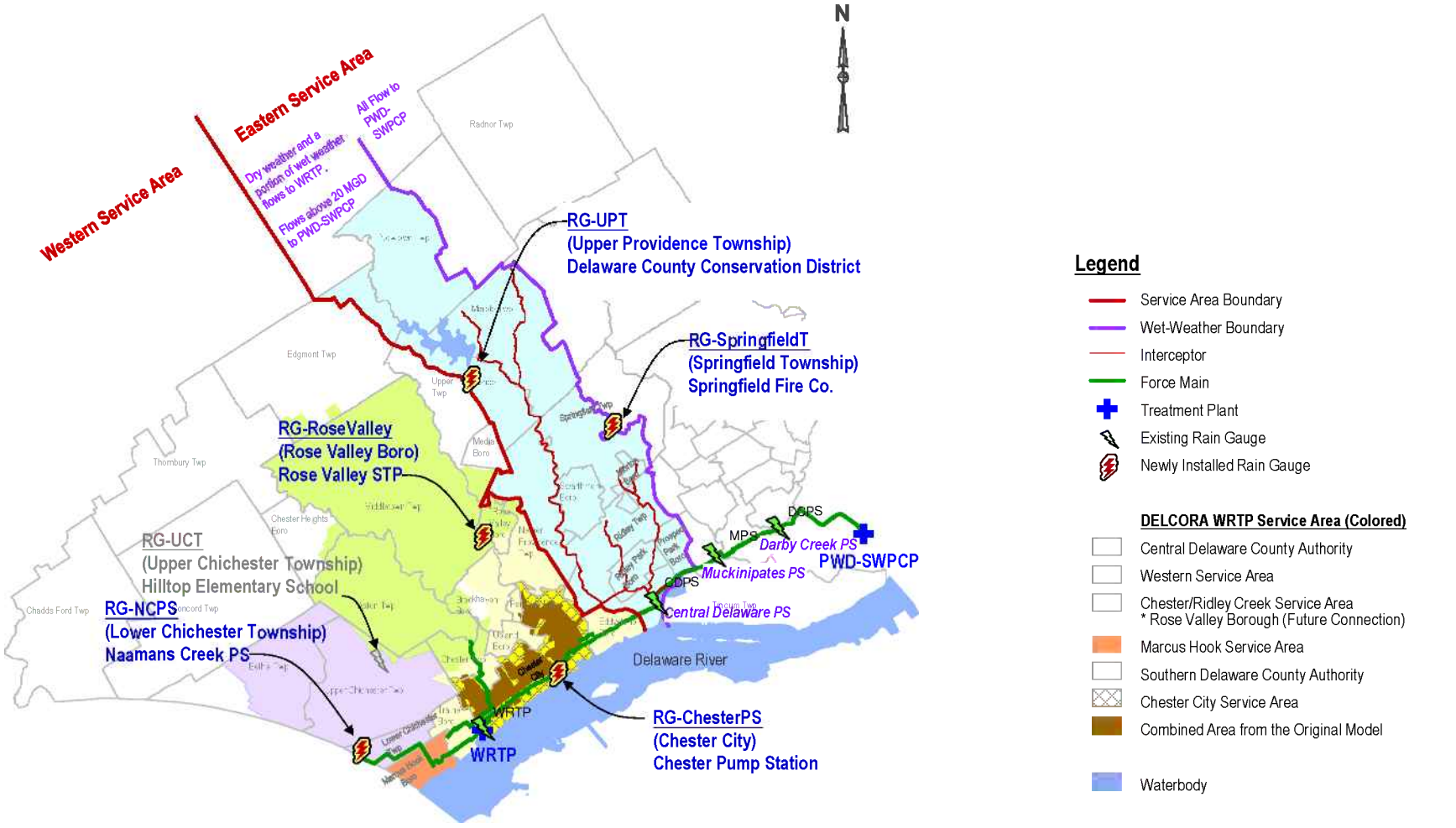


Figure 2 shows rainfall amounts at each rain gauge in each month for July, August and September. It is obvious that rainfall in the area has significant spatial and temporal variance. As an example, during this reporting period, the rain gauge at the Chester Pump Station (Chester PS) recorded a total rainfall of 8.371 inches while the gauge at the Upper Providence Township (UPT) recorded 14.74 inches. **Figure 3** shows the 1-hour rainfall profile for all of the 5 rain gauges.

Table 2: Rainfall Event Summary, 7/1/16 - 9/30/16

	Rain Event Starting Time	Rose Valley	Chester-PS	NCPS	Springfield	UPT
1	7/1/2016 13:40	0.19	0	0	0.12	0.01
2	7/4/2016 14:55	0.44	0.45	0.88	0.46	0.66
3	7/9/2016 16:00	0.25	0.03	0.3	0.1	0.21
4	7/13/2016 9:45	0.35	0.14	0.12	0.66	0.8
5	7/18/2016 15:40	0.21	0.37	0.53	0.19	0.16
6	7/23/2016 16:55	0.23	0.09	0.26	0	0
7	7/25/2016 4:35	1.46	1.05	1.71	2.18	2.97
8	7/28/2016 14:25	0.42	1.26	1.63	0.35	0.55
9	7/30/2016 16:45	0.35	0.27	0.48	0.3	1.1
10	8/11/2016 8:30	0.09	0.04	0	0.31	0.02
11	8/17/2016 0:55	0.23	0.17	0.09	0.25	0.07
12	8/17/2016 22:40	0.31	0.3	0.43	0.22	0.29
13	8/18/2016 22:25	0.29	0.21	0.18	0.13	0.19
14	8/21/2016 14:05	0.45	0.36	0.41	0.57	1.17
15	8/31/2016 19:50	0.27	0.18	0.27	0.26	0.21
16	9/19/2016 6:15	1.69	0.96	1.65	1.33	2.63
17	9/27/2016 3:40	0.13	0.13	0.15	0.12	0.12
18	9/28/2016 11:55	2.55	2.36	3.65	2.09	3.58
	Subtotal (7/1/16-9/30/16)	**9.91**	**8.37**	**12.74**	**9.64**	**14.74**

Figure 2: Rainfall Event Summary, 7/1/16 - 9/30/16

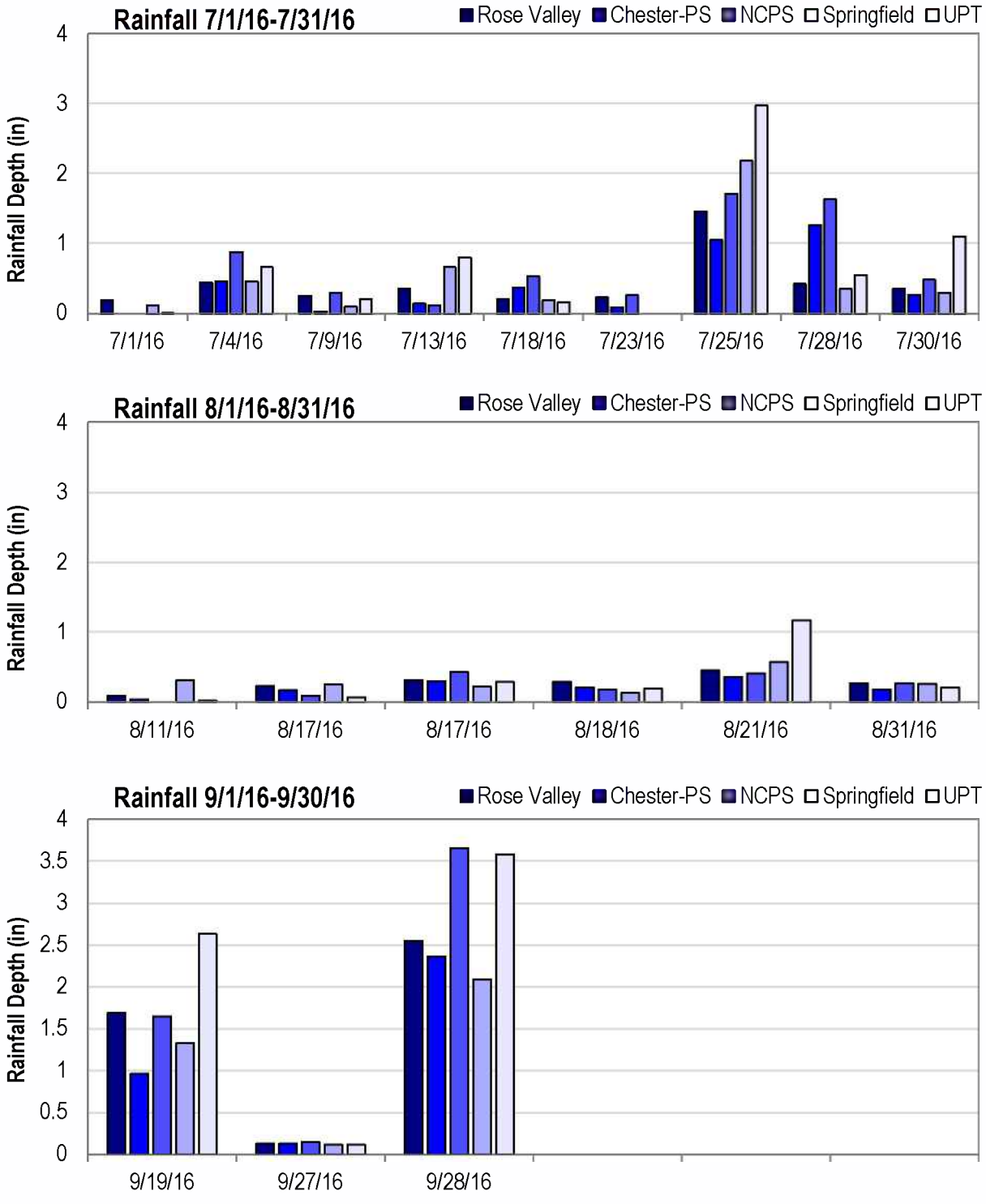
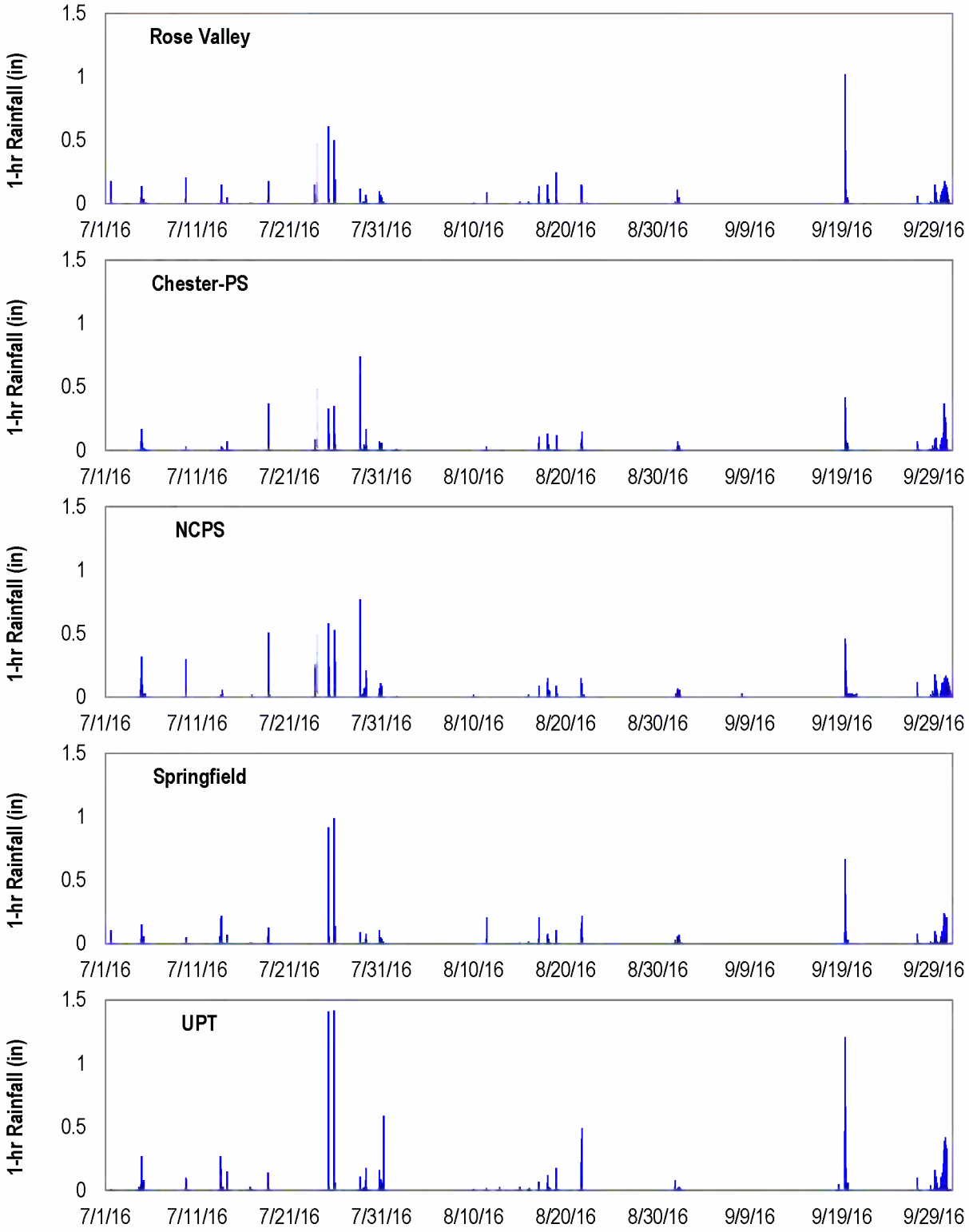


Figure 3: Hourly Rainfall Profile



2.3.1 Rainfall Return Frequency

Rainfall return frequency was analyzed for rain gauges RG_NCPS and RG_UPT because they recorded greater rainfall amounts than the others. The frequency analysis was also performed for RG_ChesterPS because it is located in the combined area.

Figure 4 shows Duration-Depth-Frequency (DDF) plot for RG_NCPS. Three storms were recorded with total precipitation volumes greater than 1 inch. The 9/28/16 storm has a return frequency of 2-year, and the other two events (7/28/16 and 9/19/16) are less than 1-year events.

Figure 4: Duration-Depth-Frequency (DDF) Plot, RG_NCPS

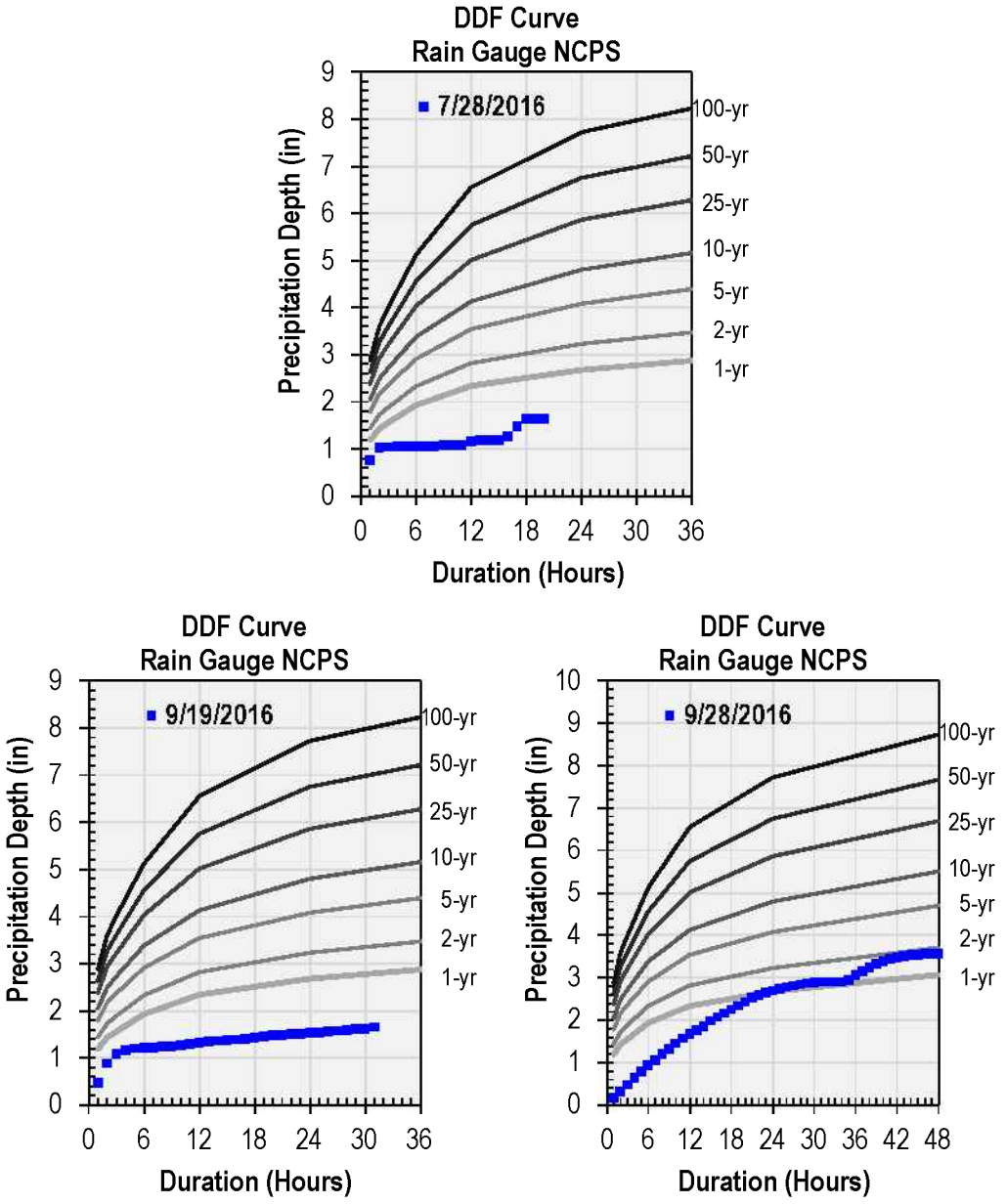


Figure 5 shows Duration-Depth-Frequency (DDF) plot for RG_UPT. Six storms were recorded with a total precipitation volume greater than 1 inch. Both short storms in 7/25/16 storm have return frequencies close to 2-year, the other storm in 9/19/2016 is a 5-year storm, the storm in 9/28/2016 is a 2-year storm, and the other two events (7/30/16 and 8/21/16) are less than 1-year events.

Figure 5: Duration-Depth-Frequency (DDF) Plot, RG_UPT

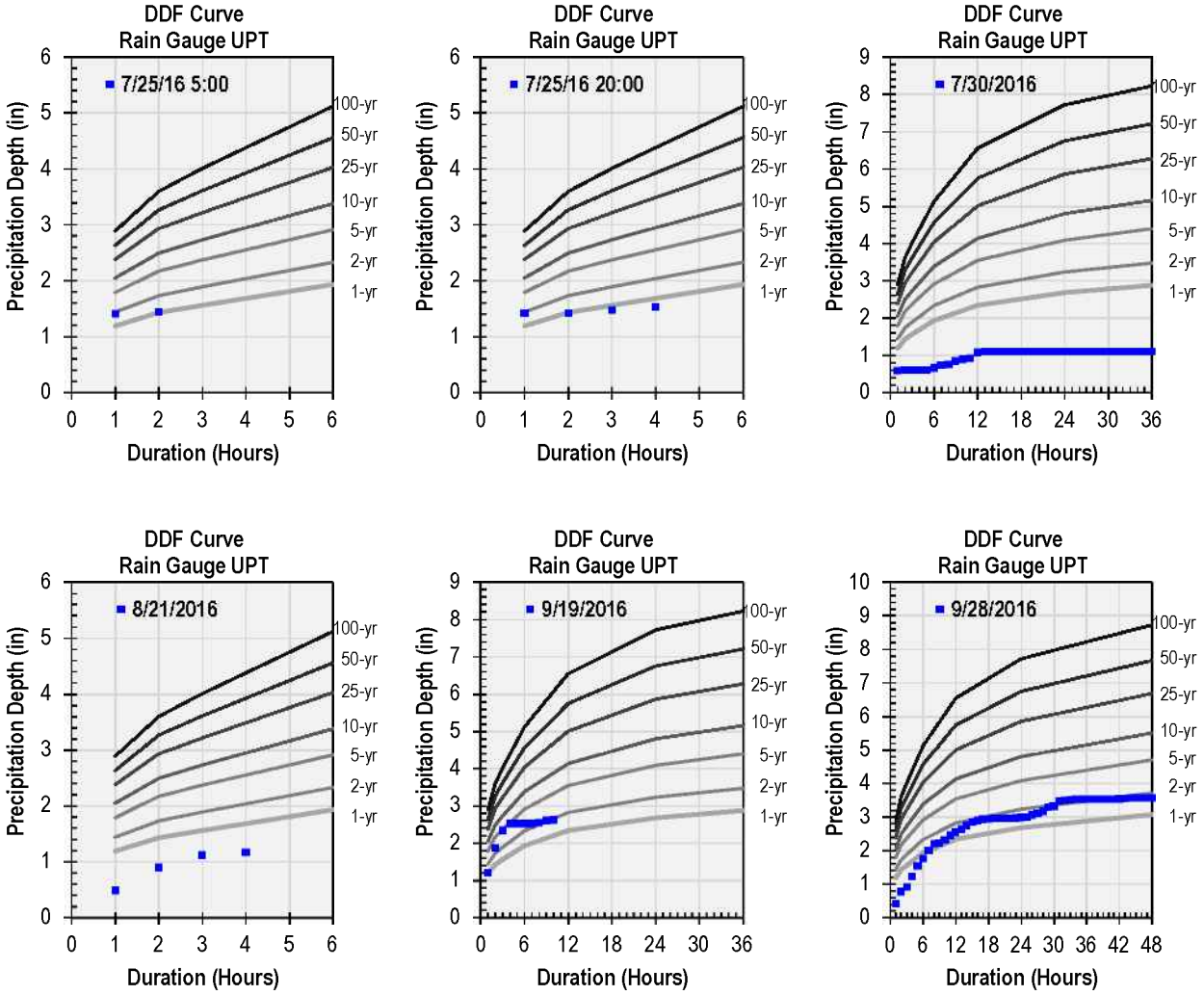
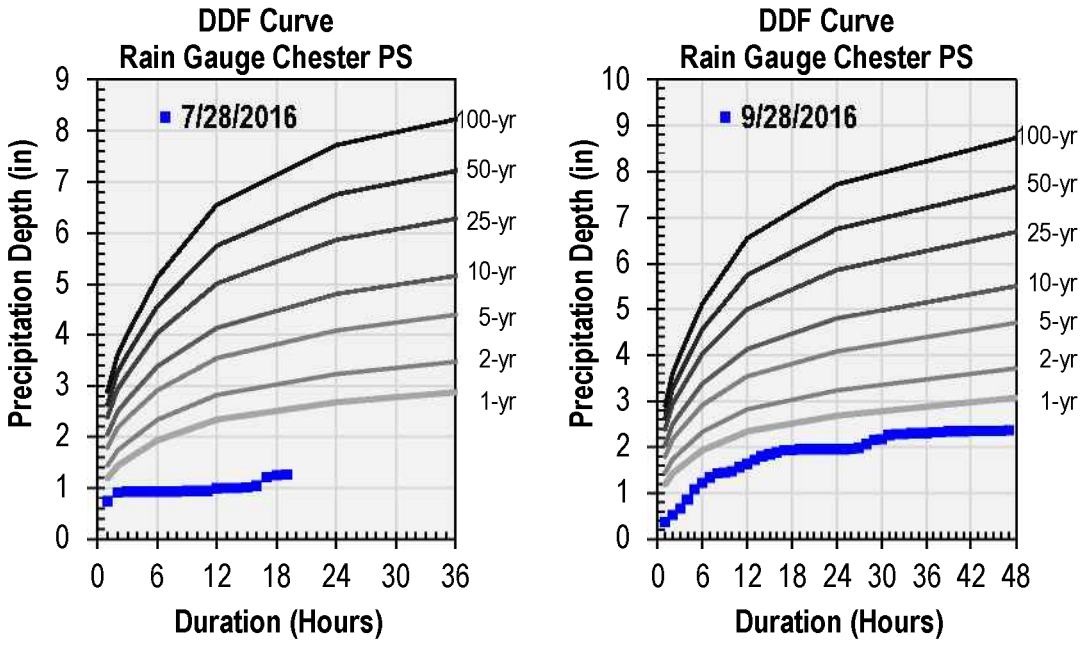


Figure 6 shows Duration-Depth-Frequency (DDF) plot for RG_ChesterPS. Two storms were recorded with a total precipitation volume greater than 1 inch. Both of them (7/28/16 and 9/28/16) are less than 1-year events.

Figure 6: Duration-Depth-Frequency (DDF) Plot, RG_Chester PS



Section 3 Flow Meter Monitoring

3.1 Flow Monitoring Program

The site locations of the existing and newly installed flow meters are shown in **Figure 7**. **Figure 8** shows the newly installed flow meters on a larger scale, mostly in the combined area. These new meters were installed to investigate surface runoff from the combined area and CSO discharges, rainfall-derived inflow and infiltration (RDII) from the separated area, and system response to the wet weather conditions. The schematic of the newly installed flow meters is included in **Figure 9**.

The newly installed flow meter locations are categorized into the following four types:

- Category 1: Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
- Category 2: Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
- Category 3: Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.
- Category 4: Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
- Category 5: Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

One meter was proposed at manhole MH3029 to measure flow from the separated area upstream of the combined area (CSO#018). The site was severely surcharged during field investigation. Meanwhile it was found that at manhole MH3002 (four manholes upstream of MH3029, approximately 800 feet upstream) another CSL flow meter (Ridley Creek MH-28) was already installed for DELCORA. It was determined that instead of installing a new flow meter around the site, the team will use the existing meter Ridley Creek MH-28 for this flow monitoring program.

In total, 39 flow meters are included in this monitoring program. Details of the installed flow meters are included in **Table 3**.

3.2 Flow Meters Field Calibration/Verification Procedures

As part of the operation of flow meters, verifications of meter accuracy are performed on a regular basis. Calibrations are performed at a minimum every eight weeks, or more as needed.

The procedure used for performing meter calibrations is outlined below. This procedure only defines the required result. Any specific equipment function issues should be referred to the equipment manual or the manufacturer's technical support department.

Table 3: Details of the Newly Installed Flow Meters

Meter ID	GIS ID	Location	Pipe Size (in)	Material	Evidence of Surcharge	Category
CSO 02	3462	DS	36	Brick	Yes	2
CSO 03	2726	DS	38	Brick	Yes	2
CSO 05	2634	DS	48	Concrete	Yes	2
CSO 08	3463	DS	60	Concrete	Yes	2
CSO 14	3481	DS	45"x53"	Brick	Yes	2
CSO 19	690	DS	42"x43"	Concrete	Yes	2
Eff-02	3460	US	8	Clay	Yes	2
Eff-03	3454	DS	14.25	Concrete	Yes	2
Eff-05	2635	DS	12	Concrete	Yes	2
Eff-08	2246	DS	18.2	PVC	Yes	2
Eff-14	3482	DS	18	Concrete	Yes	2
Eff-19	***	DS	36	Concrete	Yes	2
In-03	2721	US	36	Brick	Yes	1
In-05	2634	US	28	Brick	Yes	1
In-08	3463	US	60	Concrete	Yes	1
In-09	1987	US	48	Cast Iron	Yes	1
In-10	1670	US	36	Brick	Yes	1
In-11	1770	US	49	Cast Iron	Yes	1
In-13	3479	US	48	Concrete	Yes	1
In-14	3481	DS	43"x47"	Brick	Yes	1
In-16	752	US	60	Concrete	No	1
In-17	691	US	36	Brick	Yes	1
In-18	3033	US	66"x43"	Concrete	Yes	1
In-19-1	625	DS	49"x47.5"	Clay	No	1
In-19-2	688	US	42"	Concrete	Yes	1
In-2	2751	DS	36	Corrugated PVC	No	1
In-25	3502	US	36	Concrete	Yes	1
In-26	1192	US	36	Brick	No	1
INT- 2nd St	1548	DS	40	Concrete	No	5
INT-DRI	2743	US	24	Clay	Yes	5
INT-Ridley 2	1487	US	44	Concrete	Yes	5
INT-Ridley 3	1509	US	48	Concrete	Yes	5
INT-WestEnd	2755	US	53	Concrete	No	5
Sep-1	2135	US	15	Clay	Yes	4
Sep-2	2134	DS	12	Clay	No	4
Sep-3	798	US	24	Clay	No	4
Sep-4 (Existing, Ridley Creek MH-28)			30	Concrete	No	4
Side-1	1571	US	36	Concrete	No	3
Side-2	2135	US	8	Clay	Yes	3

Figure 7: Existing and Newly Installed Flow Meter Locations

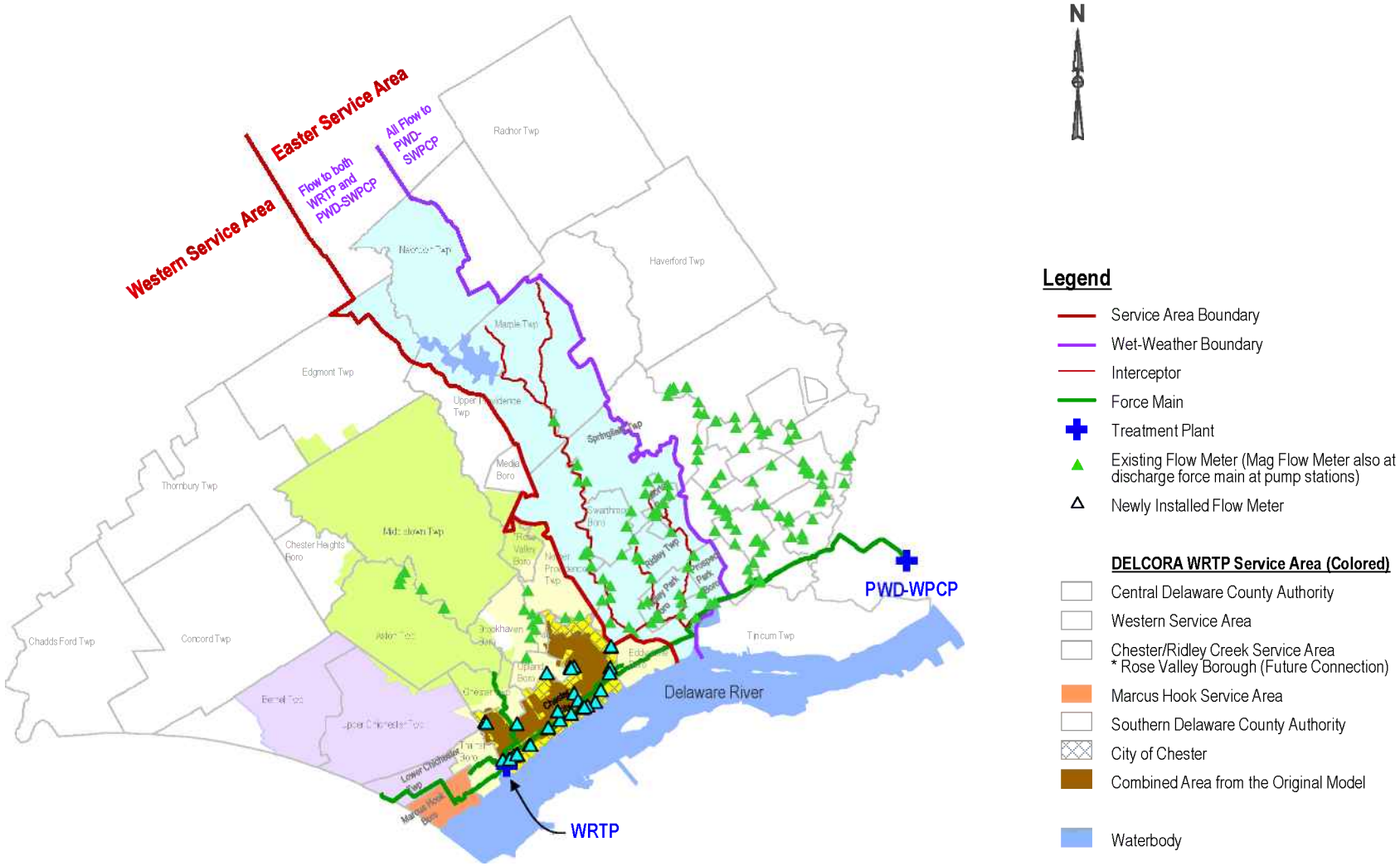


Figure 8: Newly Installed Flow Meter Locations

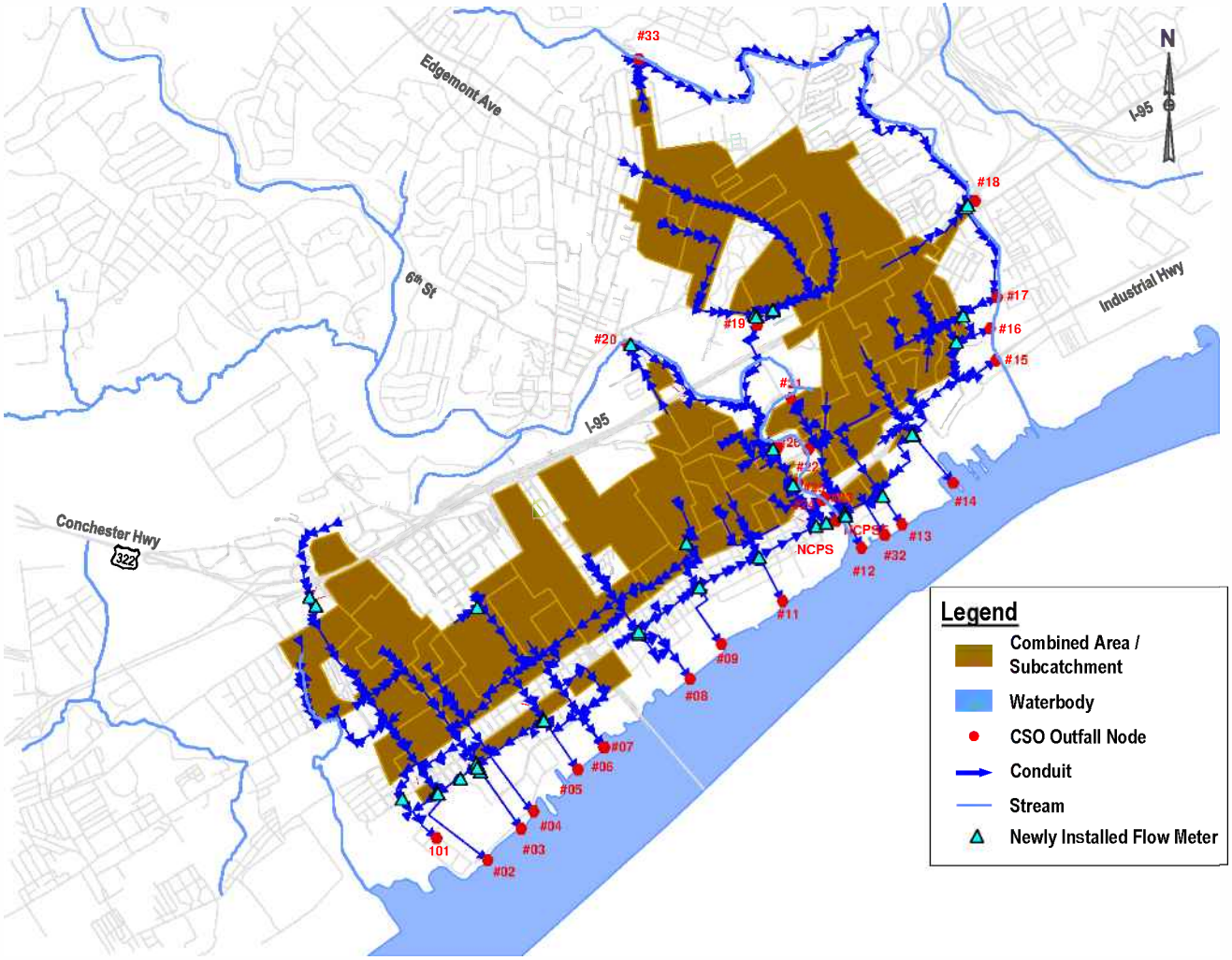
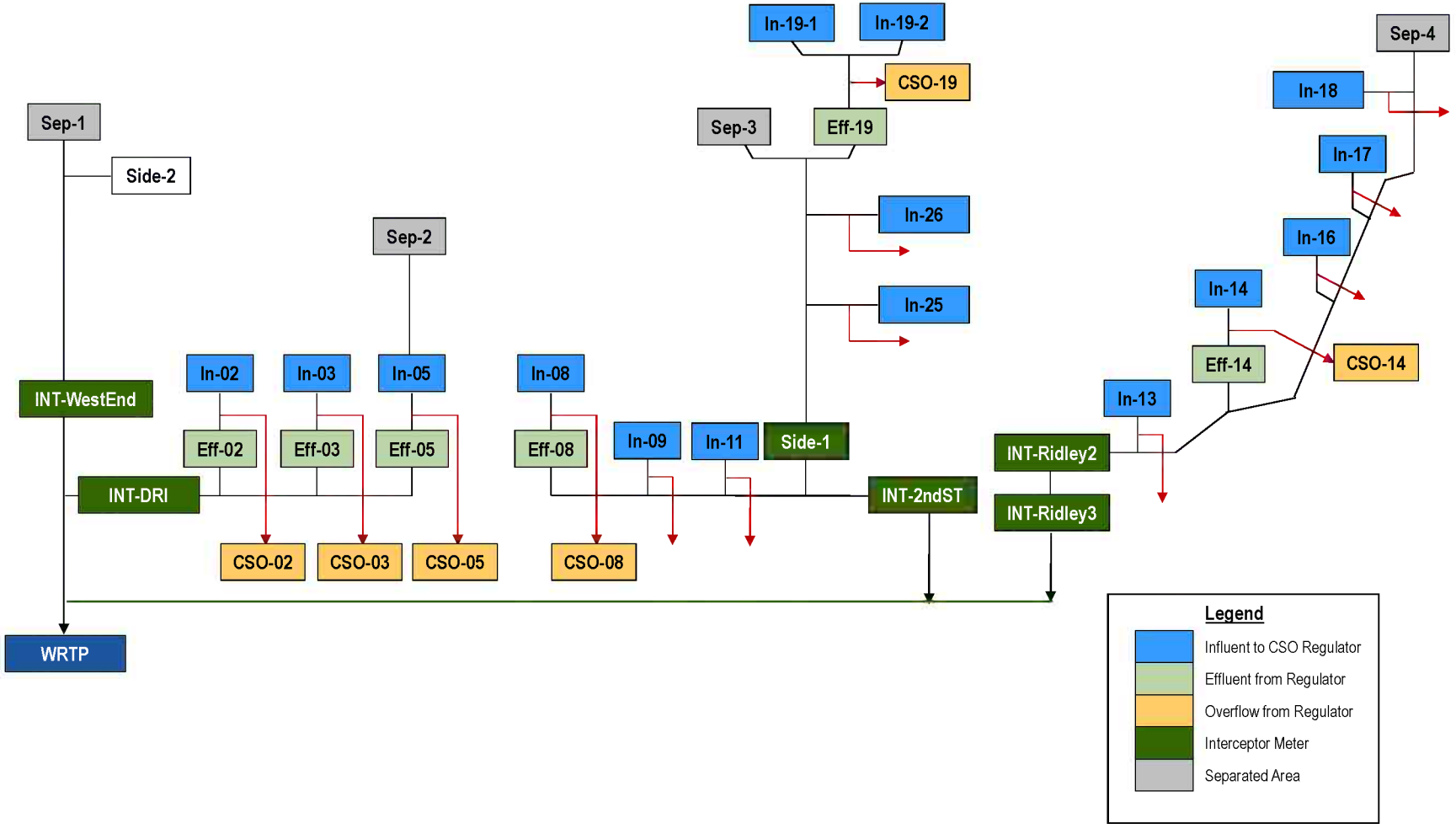


Figure 9: Flow Monitoring Schematic



Manually Downloaded Meters
This method is used for any meter that cannot be interrogated remotely by the data analyst. Field technicians use the *Daily Field Download Sheet* for recording the calibration results.

- Record the date.
- Record the field time, which is the local time.
- Record the meter time.
- Record the instantaneous depth reading from the meter.
- Measure the peak velocity.
- Record the instantaneous average or peak, whichever is applicable.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Remote Connection Meters
This method is used for any meter that can be interrogated remotely. The data analyst uses the *Daily Field Download Sheet* for single depth and velocity meters and the *Multi- Sensor Calibration Sheet* for meter types that record multiple depth and/or velocity readings.

- Fill all site visit information fields on form.
- Have the field tech measure the depth of flow and record with time.
- Record the time and instantaneous depth reading from the meter or the depth sensor, whichever is applicable. All available depth sensors should be activated and compared to the field measurement.
- Have the field tech measure the peak the velocity or have them perform a velocity profile if the depth is sufficient then record with time.
- Record the time and instantaneous velocity reading from the meter or the velocity sensor, whichever is applicable. All available velocity sensors should be activated and compared to the field measurement.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Special Cases

- Blind Verifications: A blind verification occurs when a field technician's only role is to measure the depth and velocity of the flow and report the values to the data analyst. In these cases, the crew is "blind" to what the meter is reading. The data analyst will then compare the readings to current/recent data or live readings. Should the blind verification be out of tolerance, the analyst can direct the crew to perform additional blind verifications or perform a conventional verification and/or troubleshoot as necessary.

- Installations/Removals: When installing or removing meters, the above calibration method should be used for three consecutive verifications, performed at 5 minute intervals.
- Third Party Audit: When performing a calibration at a meter that is not maintained by CSL and where CSL is to verify the meter function, the CSL Audit report should be used.

3.3 Flow Monitoring Data Summary

Flow, level and velocity data are received for each flow monitoring site at 5-minute intervals (Sep-4 has 15-min interval data). Metering data is analyzed for dry weather flows (DWF), hourly peak flows, and hourly peaking factors for each monitoring site. A "dry weather" condition was defined as a period with no precipitation that begins three days after the last wet weather event and lasts until the beginning of the next precipitation event.

Table 4 shows dry weather flow (DWF), hourly peak flow, hourly peaking factor and flow condition observations.

The dry weather flows are also shown in the schematic in **Figure 10**. Generally the downstream dry weather flow is greater than the upstream locations for all of the meters. For meters immediately upstream and downstream of CSO regulators, the upstream and downstream dry weather flows should be similar. **Figure 11** shows the influent and effluent from CSO#08 as an example to indicate that the dry weather of the two are similar.

The hourly peaking factor in the combined area is in the range of 9 to 85 and average at 39. The hourly peaking factor for the interceptor is between 2.8 and 8.5 with an average of 4.6. The hourly peaking factor is between 2.9 and 5.5 for the separated area, with an average of 4.1.

A detailed hydrograph and scattergraph for each flow monitoring site is shown in **Figure 12** to **Figure 50**, each includes:

- The flow hydrographs show hourly flow and rainfall profile. Hourly Rainfall data is included for the convenience of reviewing flow response to the wet weather conditions. Hourly flow and rainfall were calculated from the 5-min interval.
- The scattergraphs (based on 5-min data) are essentially a plotting of flow rate versus depth. This plotting helps to understand the flow patterns and conditions on the individual monitored sewer pipes.
- For CSOs 02, 03, 05, 08, 14, & 19, flows including influent, effluent and overflows were plotted in the same plot.

Table 4: Flow Monitoring Summary

Meter ID	Hourly Peak (MGD)DWF	DWF (MGD)	Hourly Peaking Factor	Comments
In-02	6.25	0.29	21.7	Free flow most of the time
Eff-02	1.19	0.26	4.5	Surcharged under common conditions
CSO-02	5.01	0.04		Free flow most of the time
In-03	9.46	0.28	33.6	Free flow most of the time
Eff-03	1.52	0.24	6.2	Surcharged under large storms
CSO-03	8.85	0.03		Free flow most of the time
In-05	22.65	0.86	26.4	Backwater observed
Eff-05	2.30	0.75	3.1	Severely surcharged under common conditions
CSO-05	18.83	0.10		Free flow most of the time, backwater observed
In-08	21.99	0.80	27.5	Free flow most of the time
Eff-08	5.21	0.69	7.5	Free flow most of the time, backwater during large storms
CSO-08	22.36	0.11		Free flow most of the time
In-09	7.09	0.13	53.8	Free flow most of the time
In-10	4.55	0.18	25.6	Free flow most of the time
In-11	9.04	0.22	41.2	Free flow most of the time, backwater during large storms
In-13	28.52	0.34	82.8	Free flow most of the time, backwater during large storms
In-14	14.44	0.43	34.0	Backwater observed
Eff-14	4.22	0.38	11.0	Free flow mostly, backwater and surcharge during large storms
CSO-14	11.33	0.03		Free flow most of the time
In-16	12.95	0.33	38.7	Free flow most of the time, backwater during large storms
In-17	6.90	0.17	41.2	Backwater observed
In-18	10.05	0.16	61.7	Free flow most of the time
In-19-1	6.24	0.69	9.1	Free flow most of the time
In-19-2	11.62	0.57	20.2	Free flow most of the time
Eff-19	4.02	1.27	3.2	Free flow most of the time
CSO-19	10.72	0.07		Free flow most of the time
In-25	12.55	0.15	84.7	Free flow mostly, backwater observed
In-26	5.80	0.36	16.1	Free flow mostly
INT-2nd St	18.15	3.59	5.1	Free flow mostly, backwater during large storms
INT-DRI	4.08	1.46	2.8	Severe surcharge observed
INT-Ridley 2	14.26	3.11	4.6	Free flow mostly, backwater observed
INT-Ridley 3	13.94	3.35	4.2	Free flow mostly, backwater observed
INT-WEI	11.34	1.34	8.5	Free flow mostly, backwater observed
Sep-1	0.65	0.12	5.5	Free flow mostly
Sep-2	0.54	0.11	4.8	Free flow mostly
Sep-3	1.26	0.43	2.9	Free flow mostly
Sep-4	4.29	1.35	3.2	Free flow mostly
Side-1	8.44	2.35	3.6	Free flow mostly
Side-2	0.68	0.21	3.2	Free flow mostly

Figure 10: Dry Weather Flow Balance Schematic

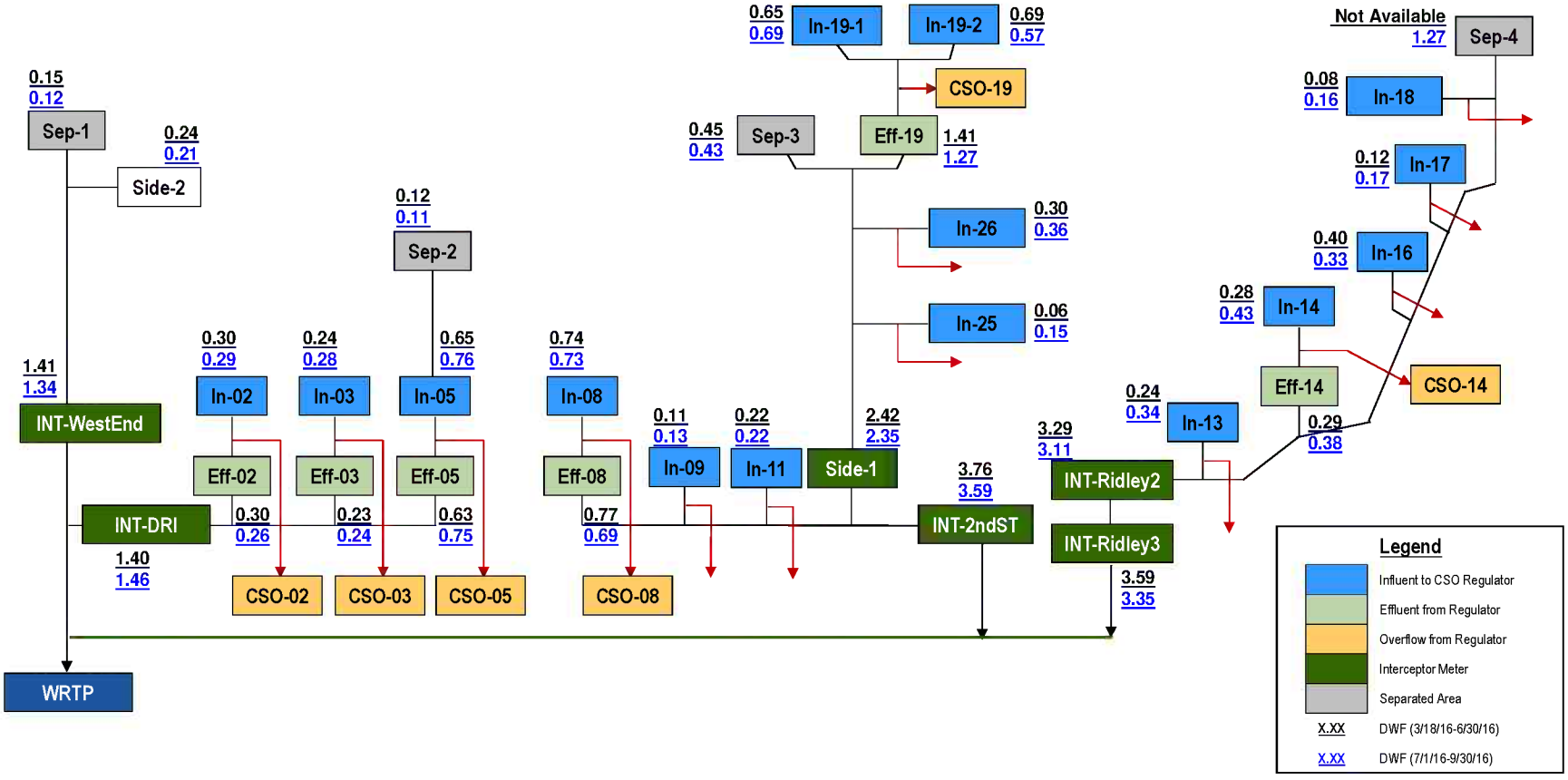


Figure 11: Flow Hydrograph In-08 and Eff-08

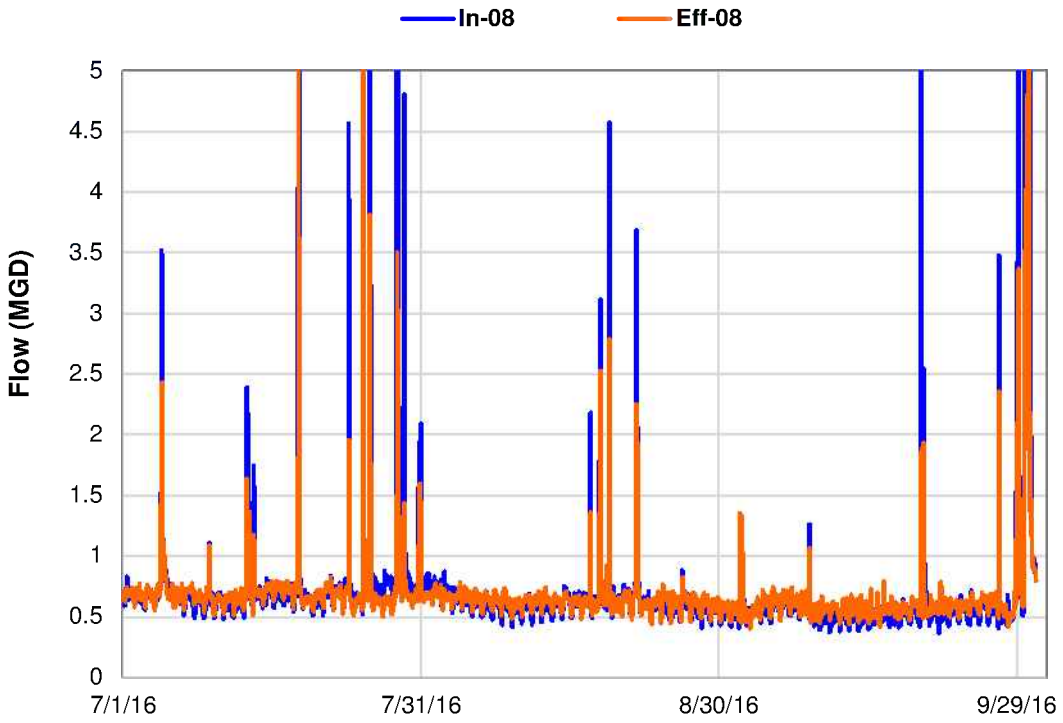
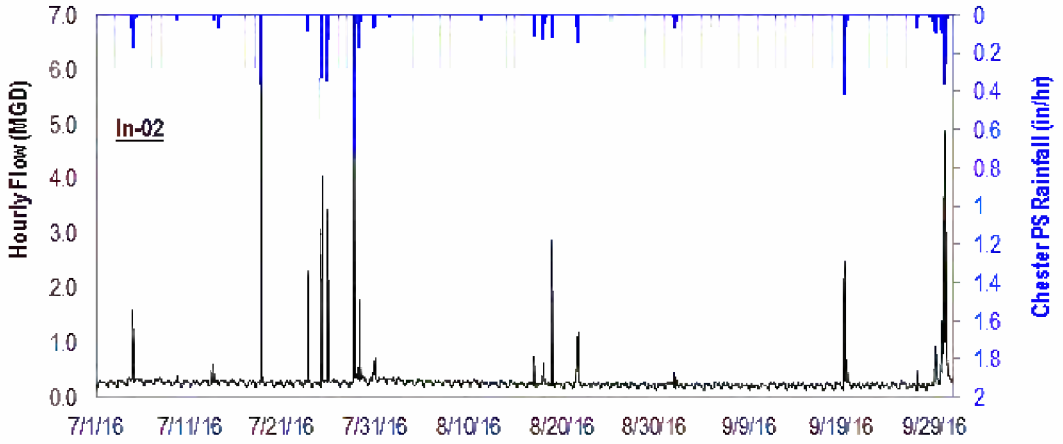
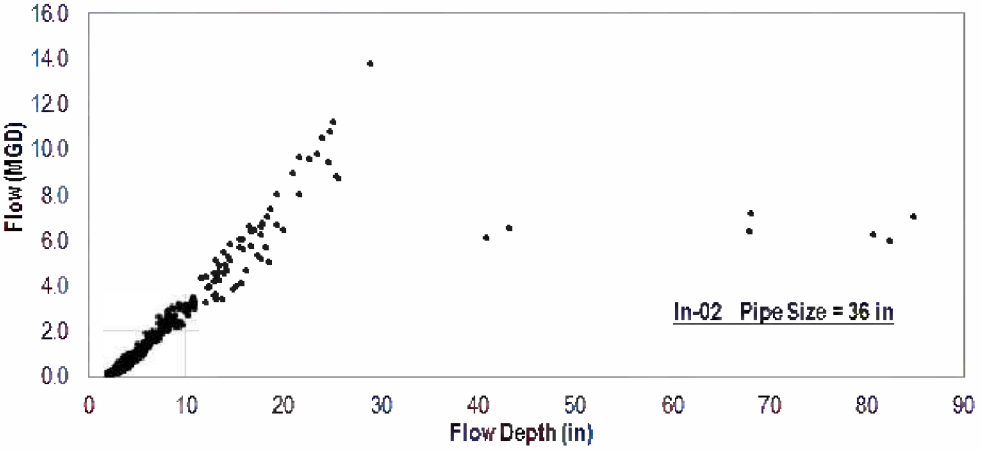


Figure 12: Flow Monitoring Data, In-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#02 Influent , Effluent and Overflow

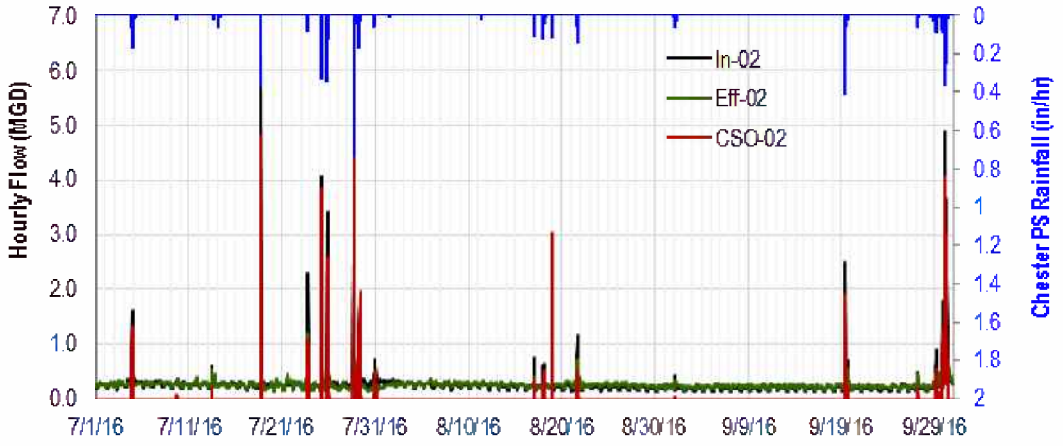
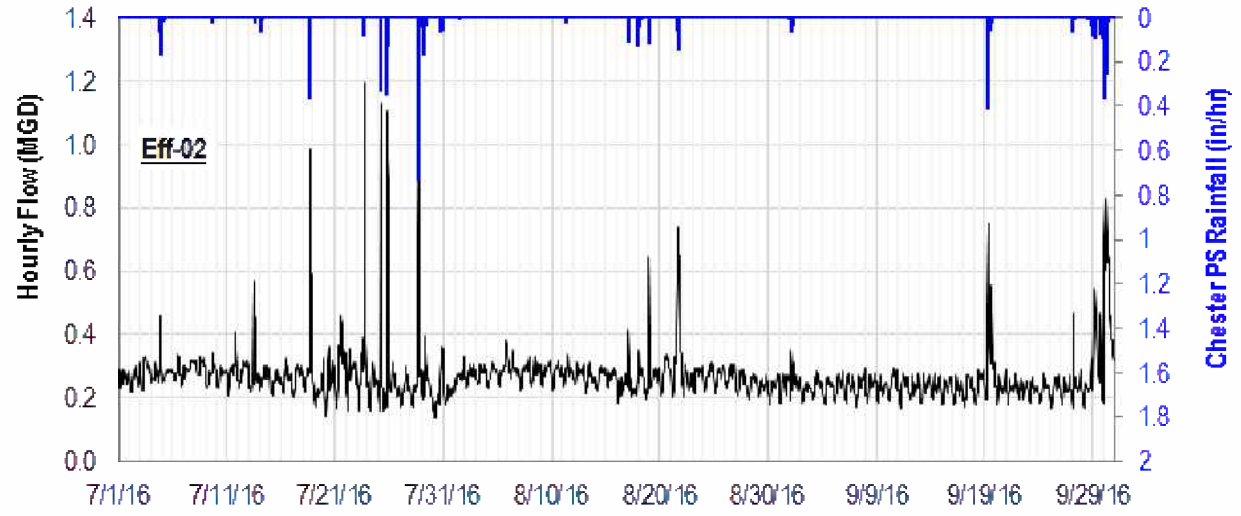


Figure 13: Flow Monitoring Data, EFF-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

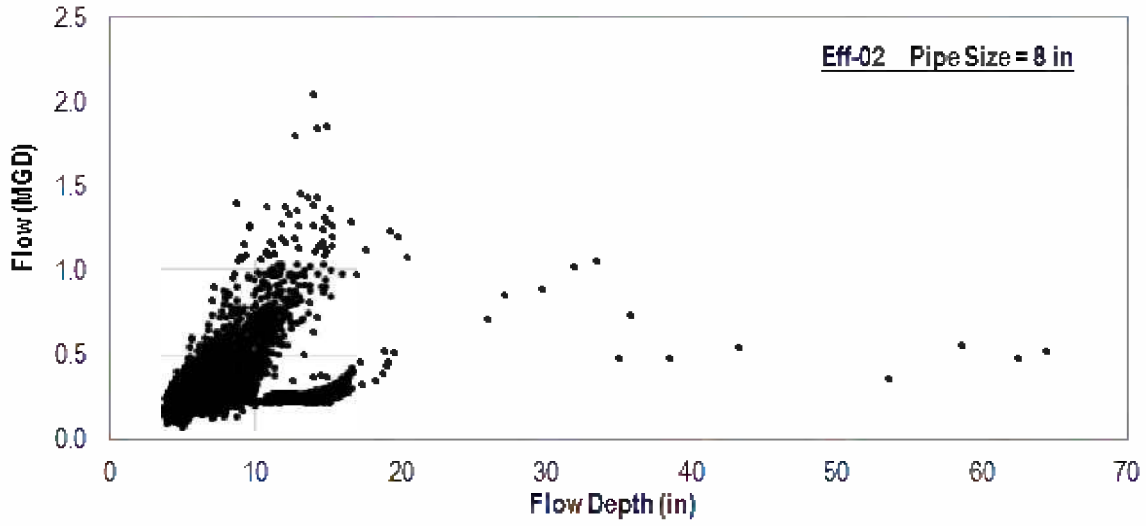
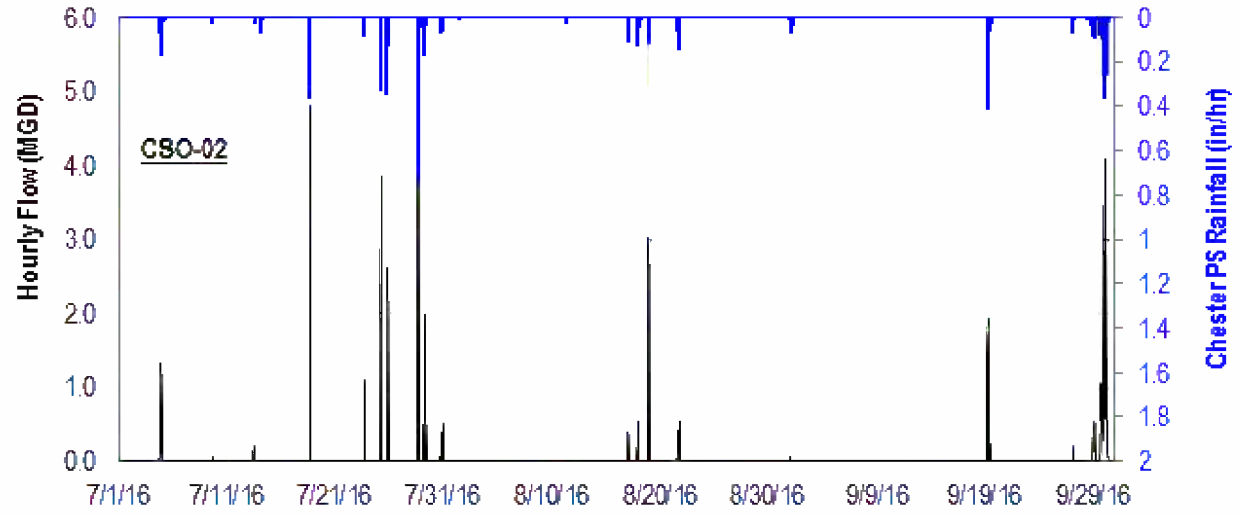


Figure 14: Flow Monitoring Data, CSO-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

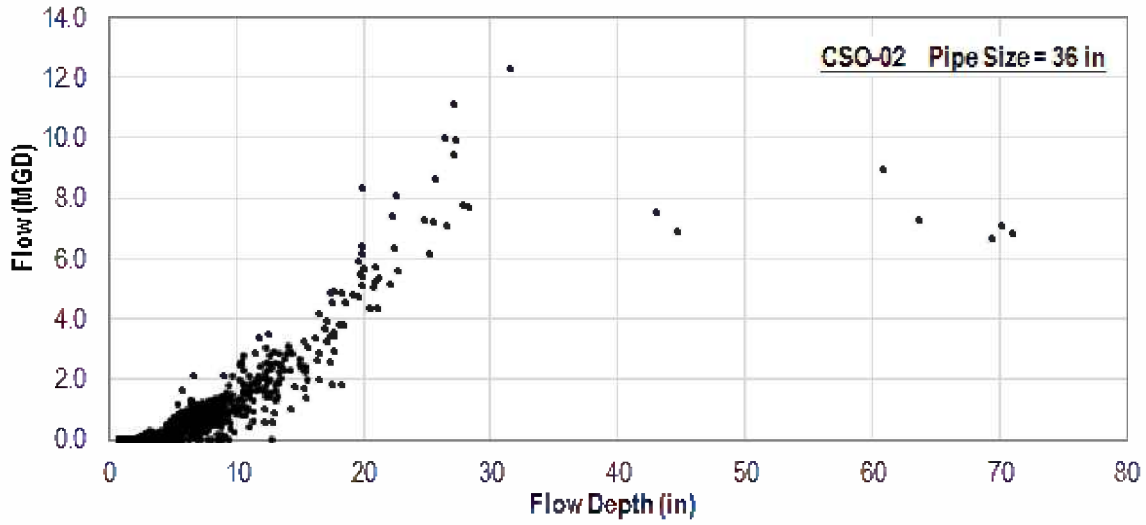
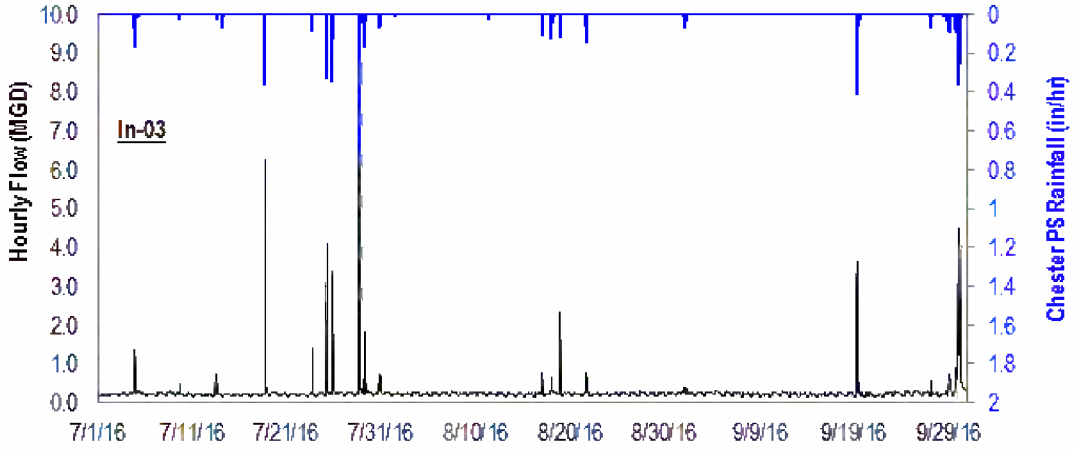
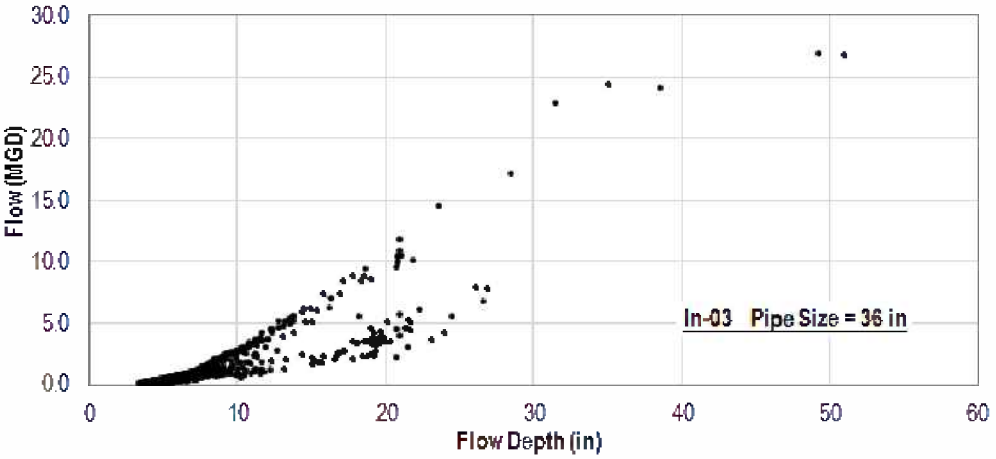


Figure 15: Flow Monitoring Data, IN-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

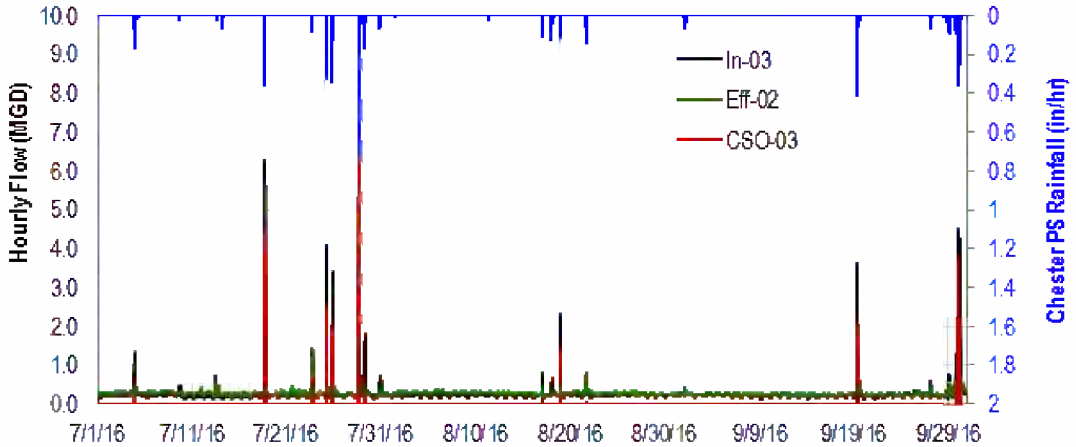


Figure 16: Flow Monitoring Data, Eff-03

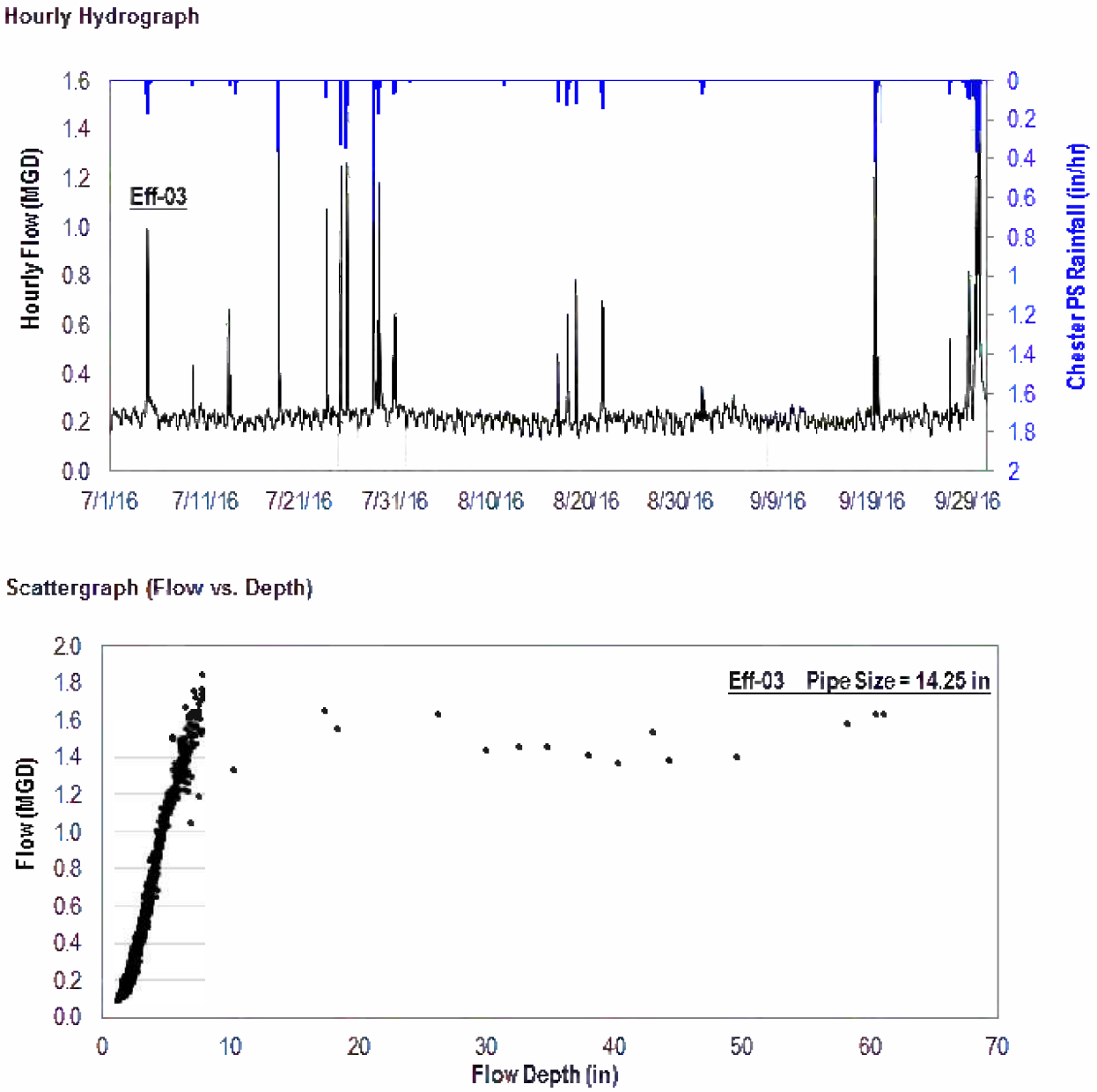


Figure 17: Flow Monitoring Data, CSO-03

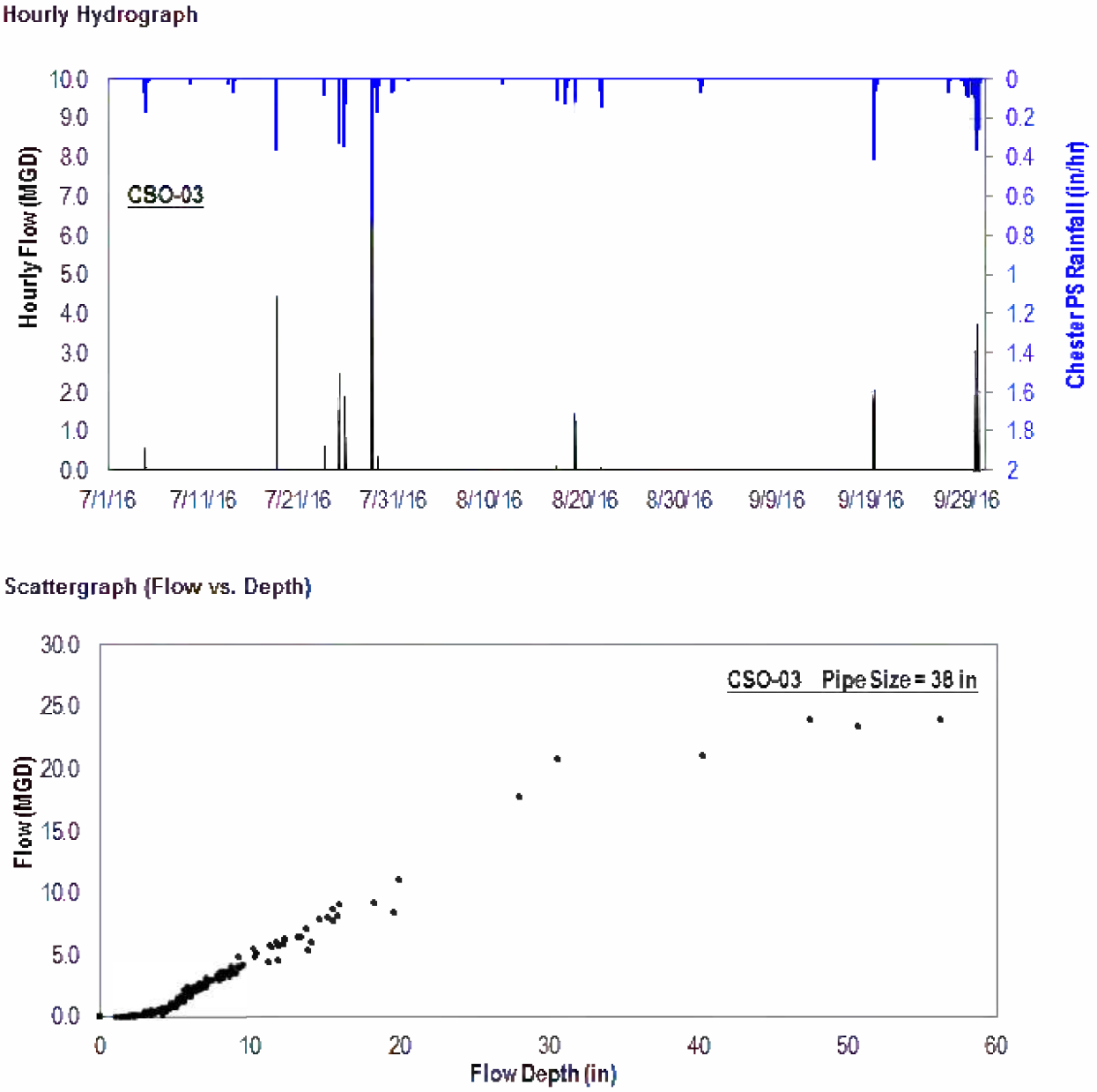
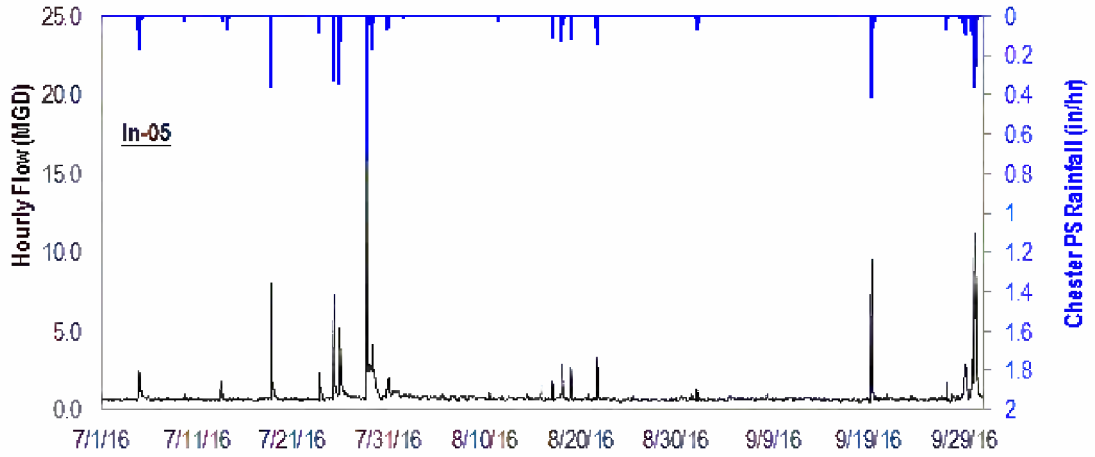
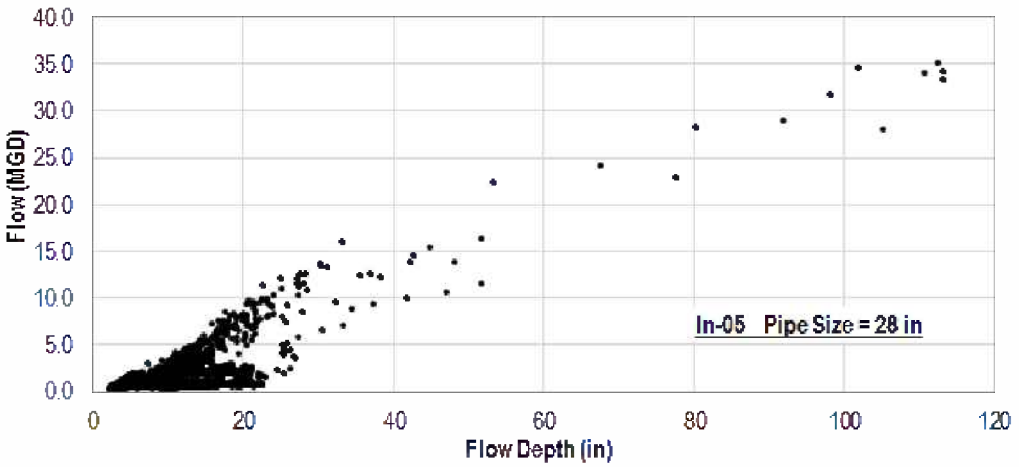


Figure 18: Flow Monitoring Data, IN-05

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#05 Influent , Effluent and Overflow

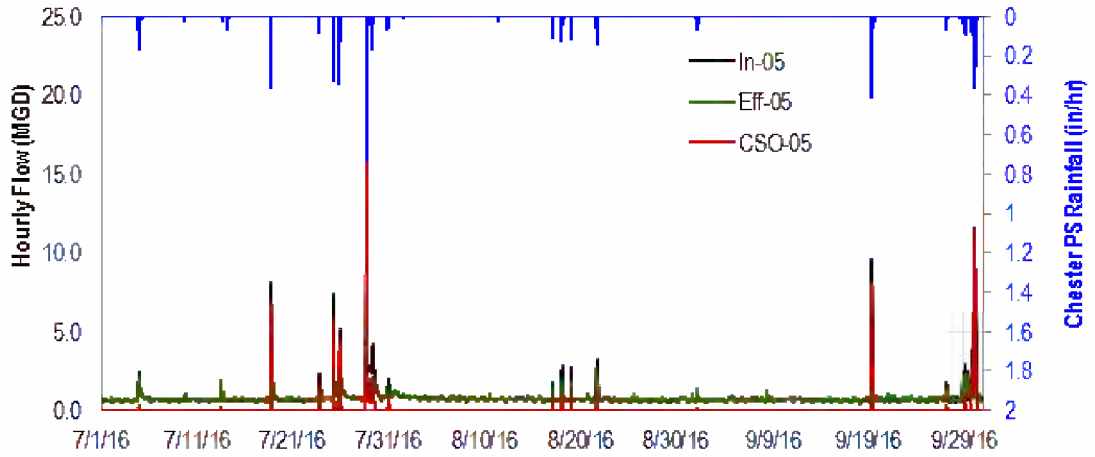


Figure 19: Flow Monitoring Data, Eff-05

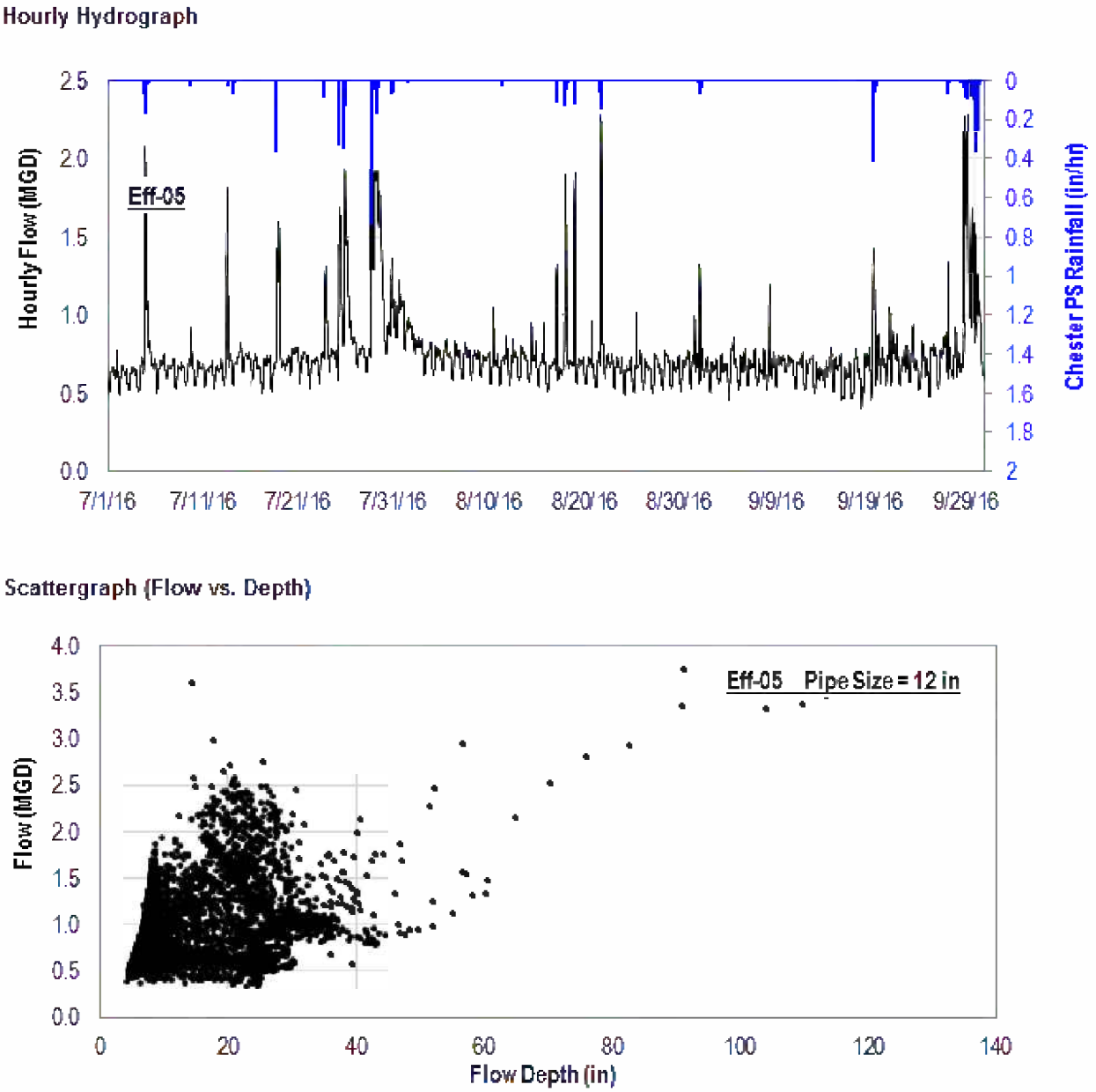


Figure 20: Flow Monitoring Data, CSO-05

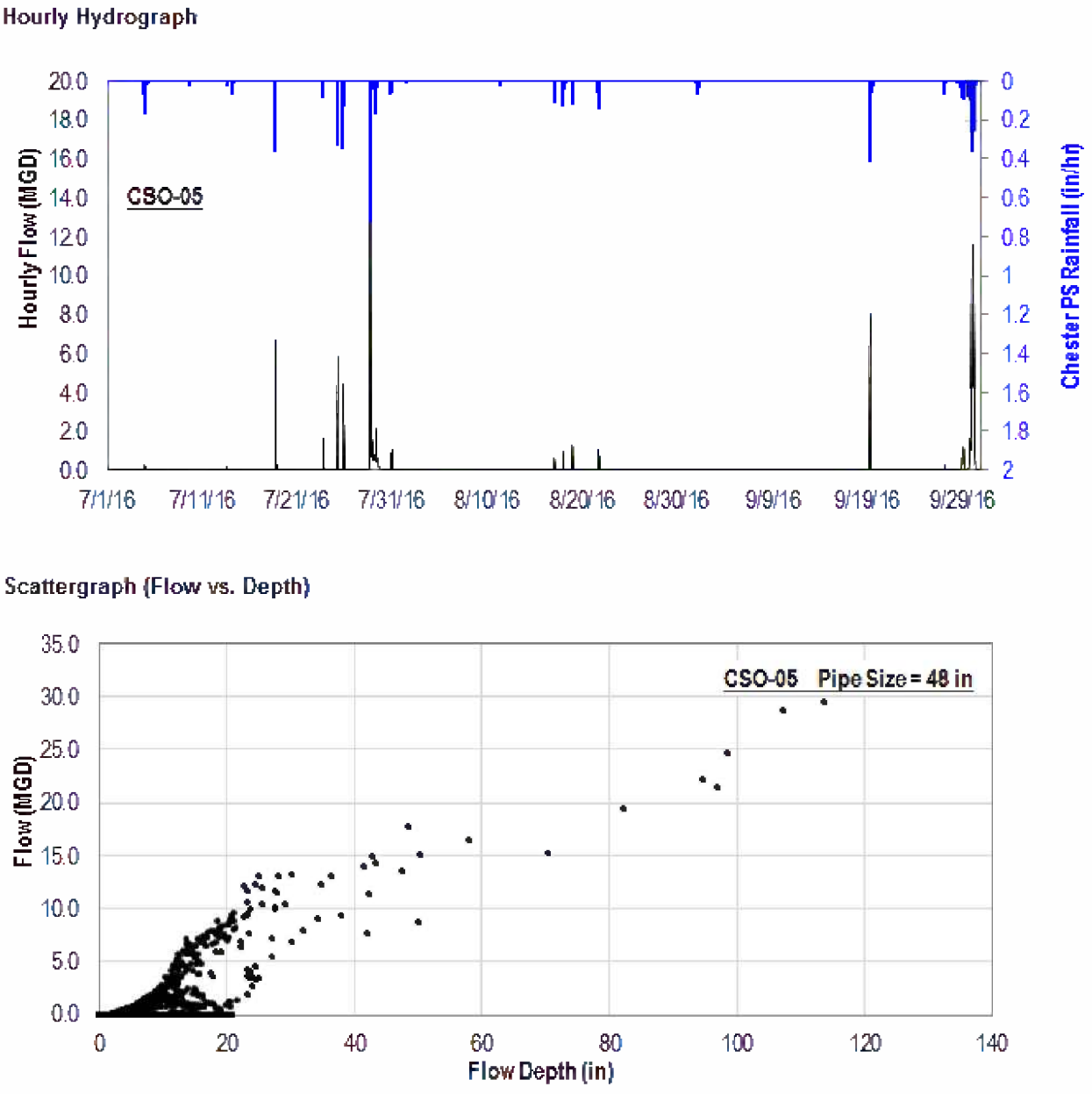
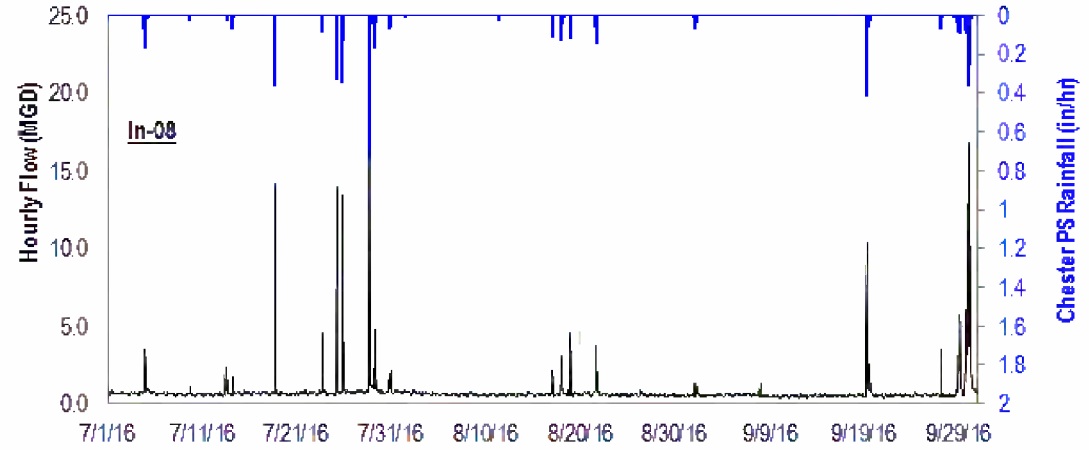
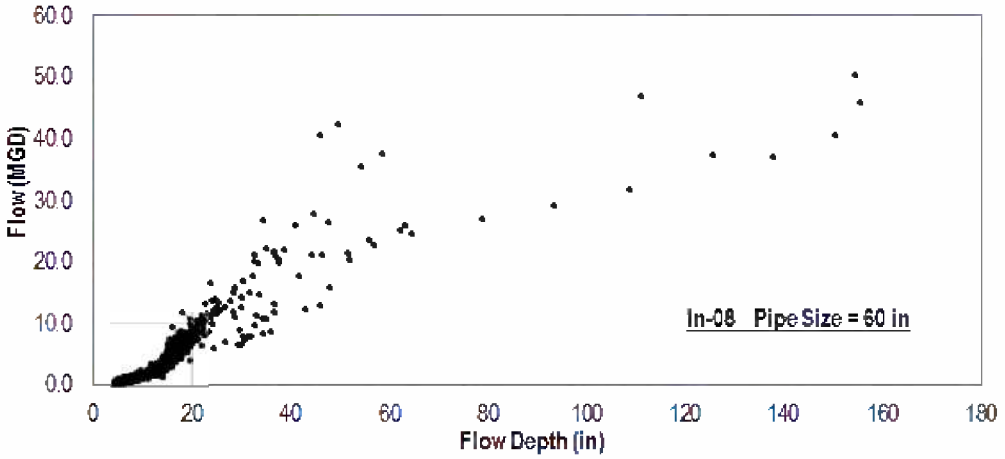


Figure 21: Flow Monitoring Data, IN-08

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#08 Influent , Effluent and Overflow

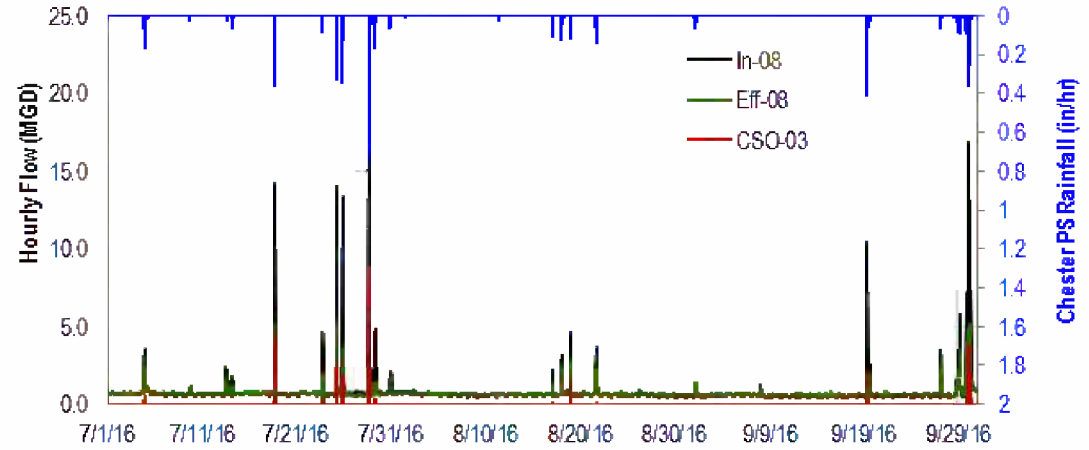


Figure 22: Flow Monitoring Data, Eff-08

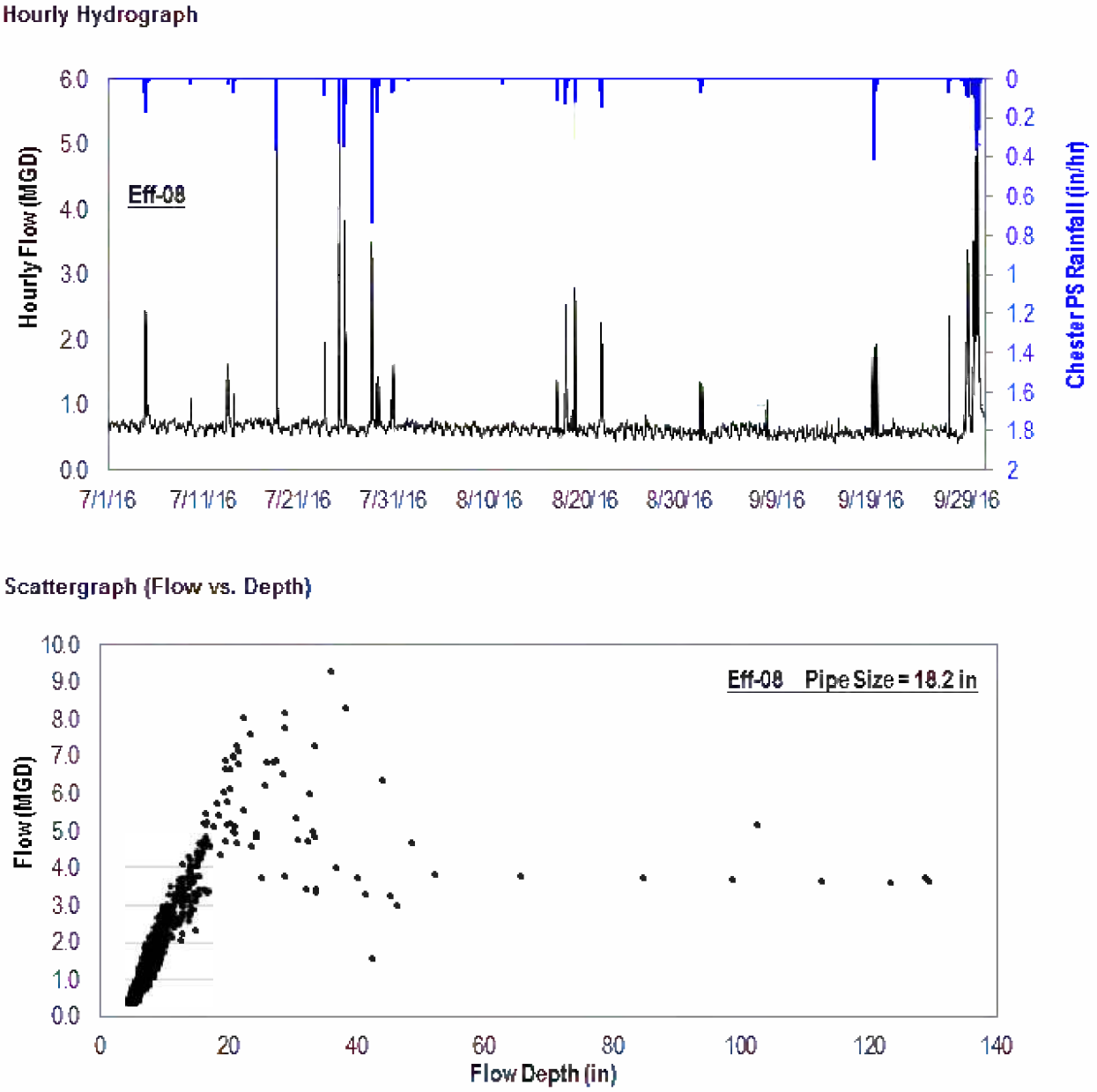


Figure 23: Flow Monitoring Data, CSO-08

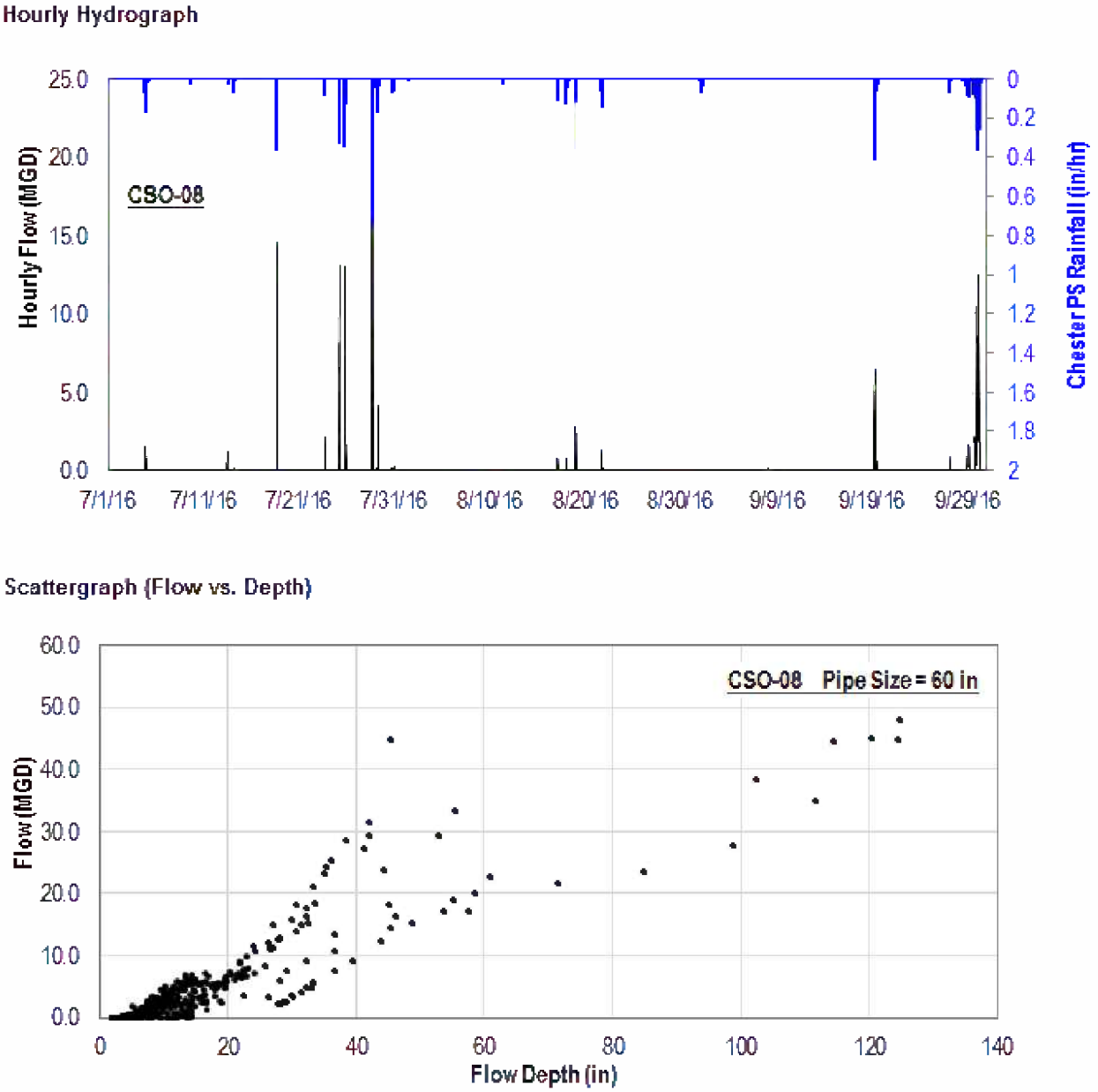


Figure 24: Flow Monitoring Data, In-09

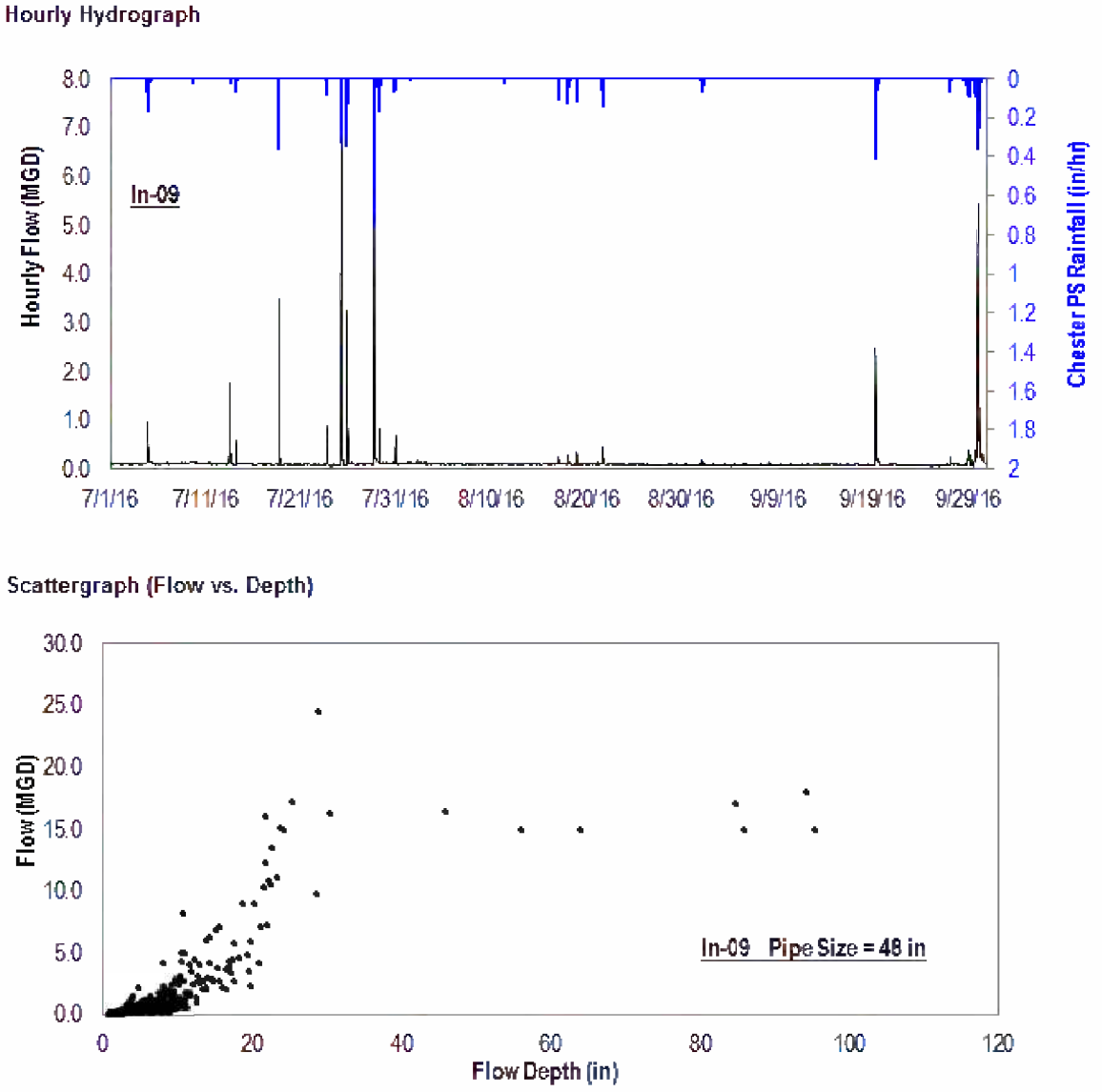


Figure 25: Flow Monitoring Data, In-10

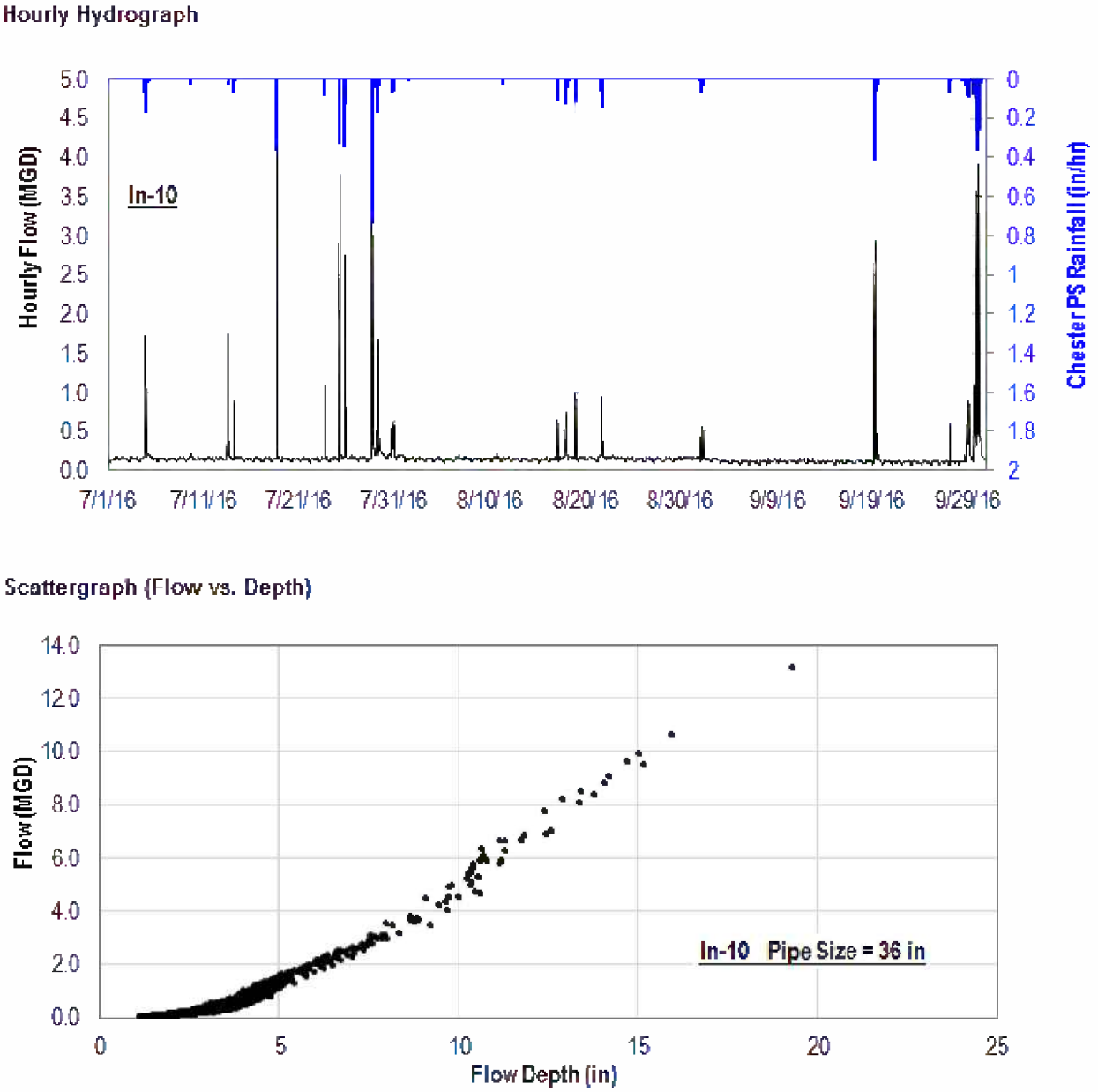


Figure 26: Flow Monitoring Data, In-11

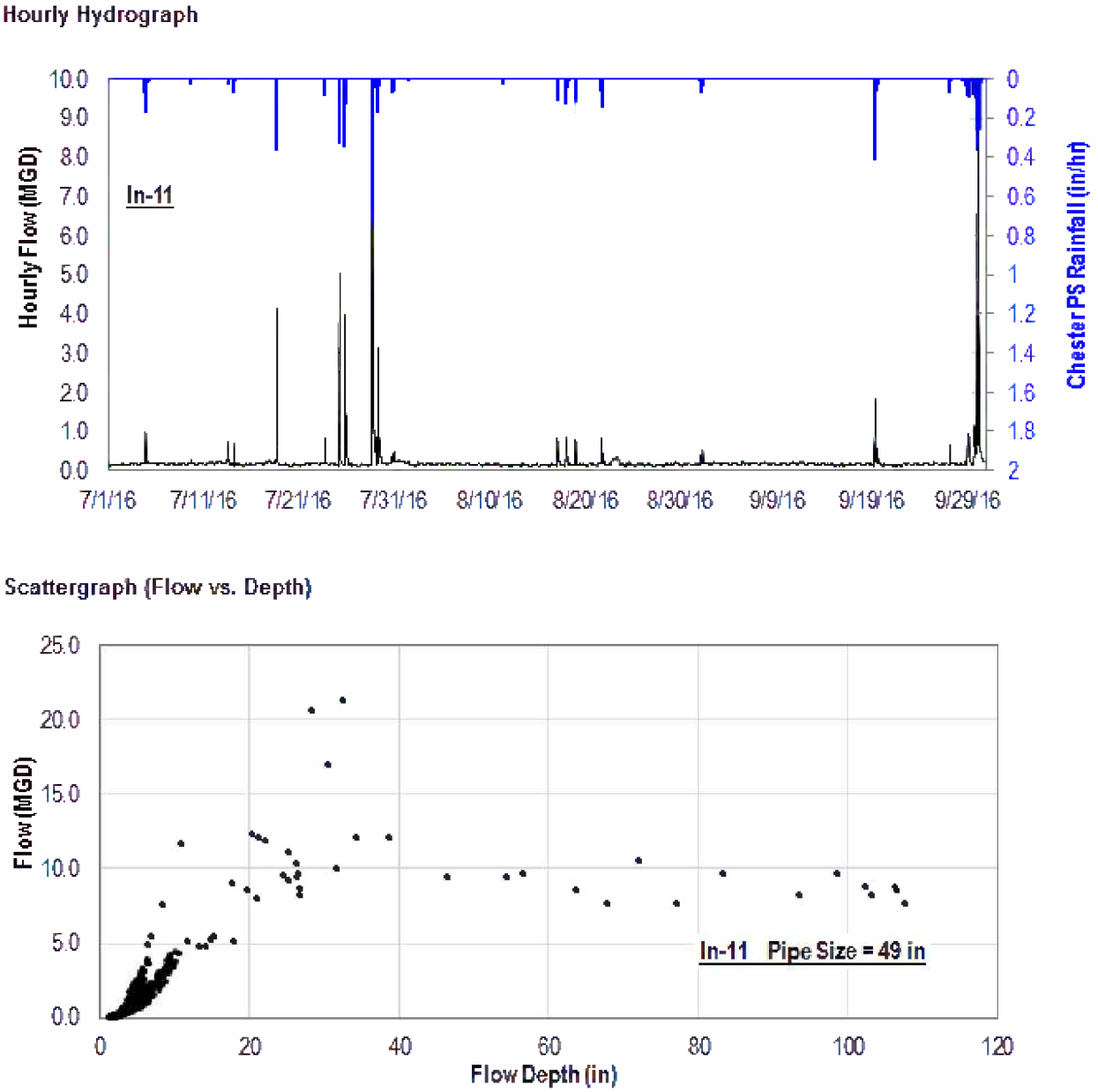


Figure 27: Flow Monitoring Data, In-13

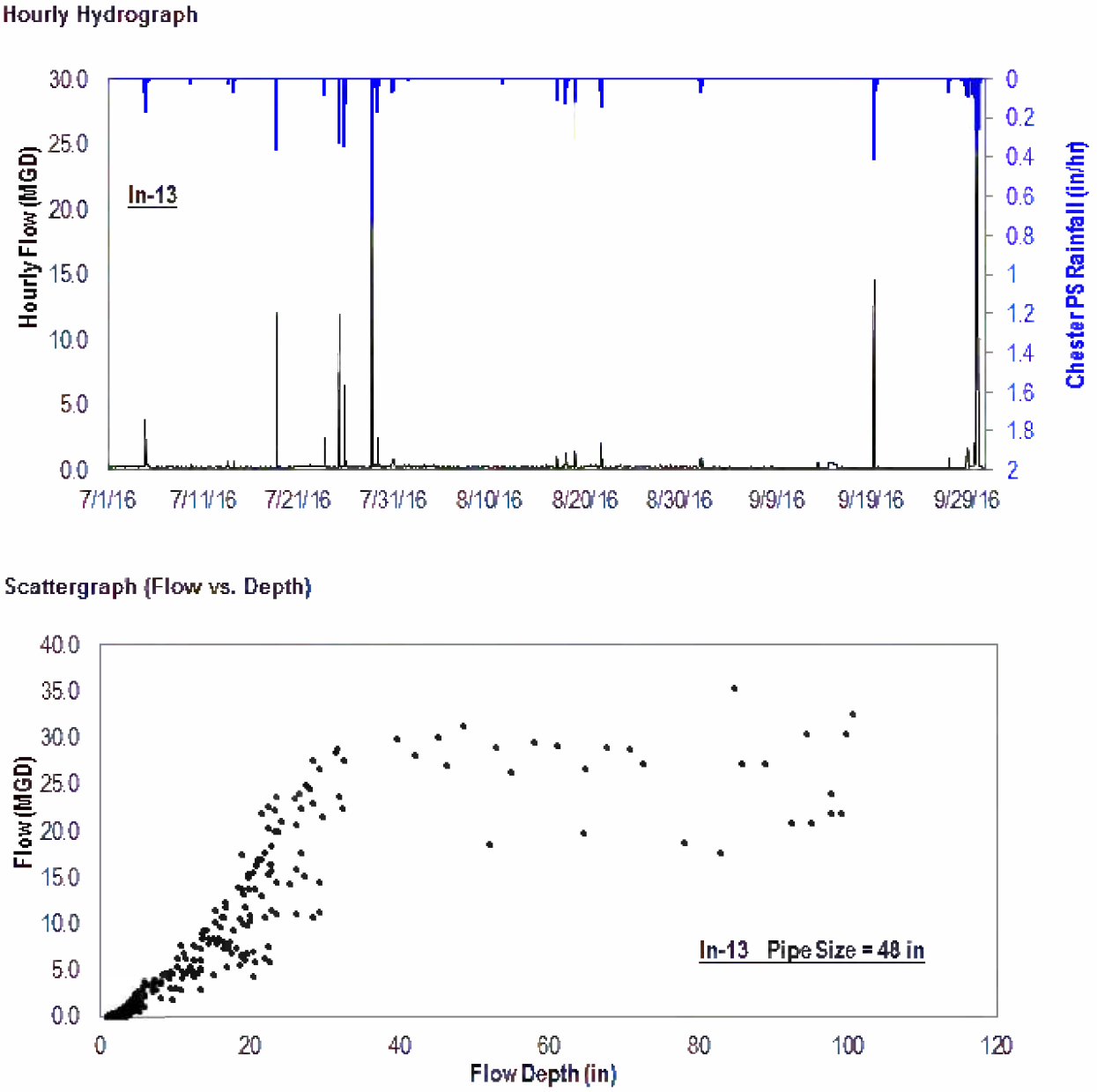
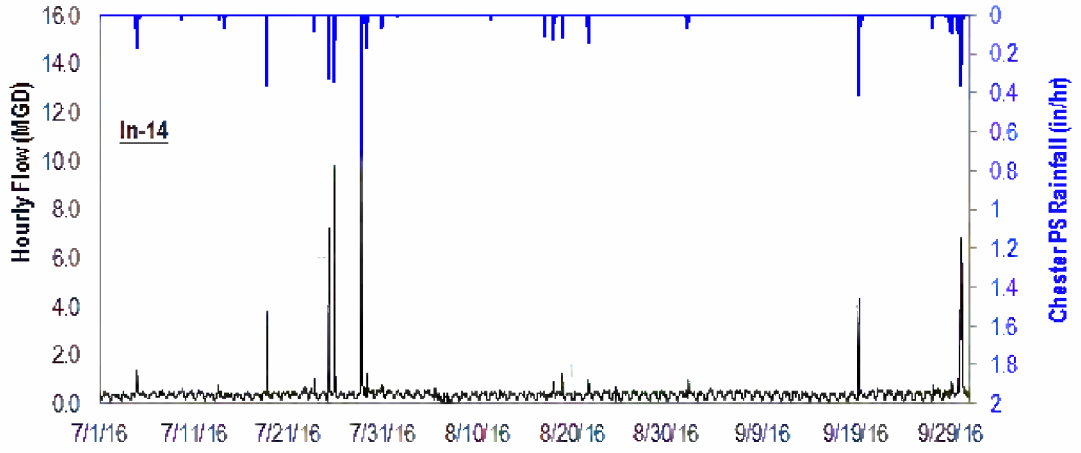
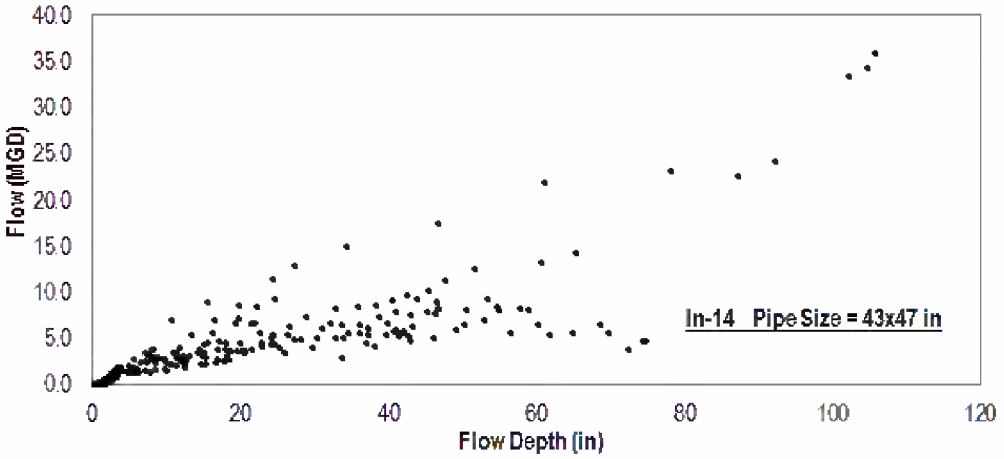


Figure 28: Flow Monitoring Data, In-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#14 Influent , Effluent and Overflow

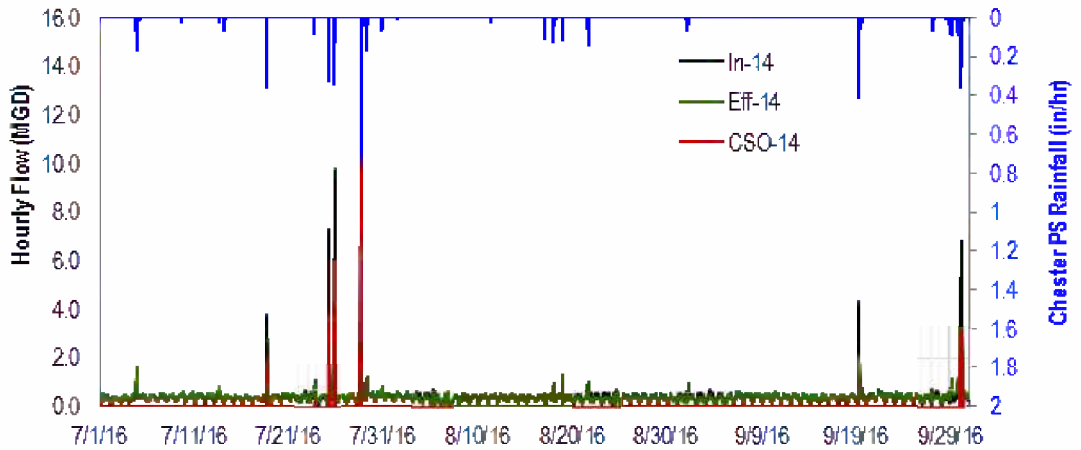


Figure 29: Flow Monitoring Data, Eff-14

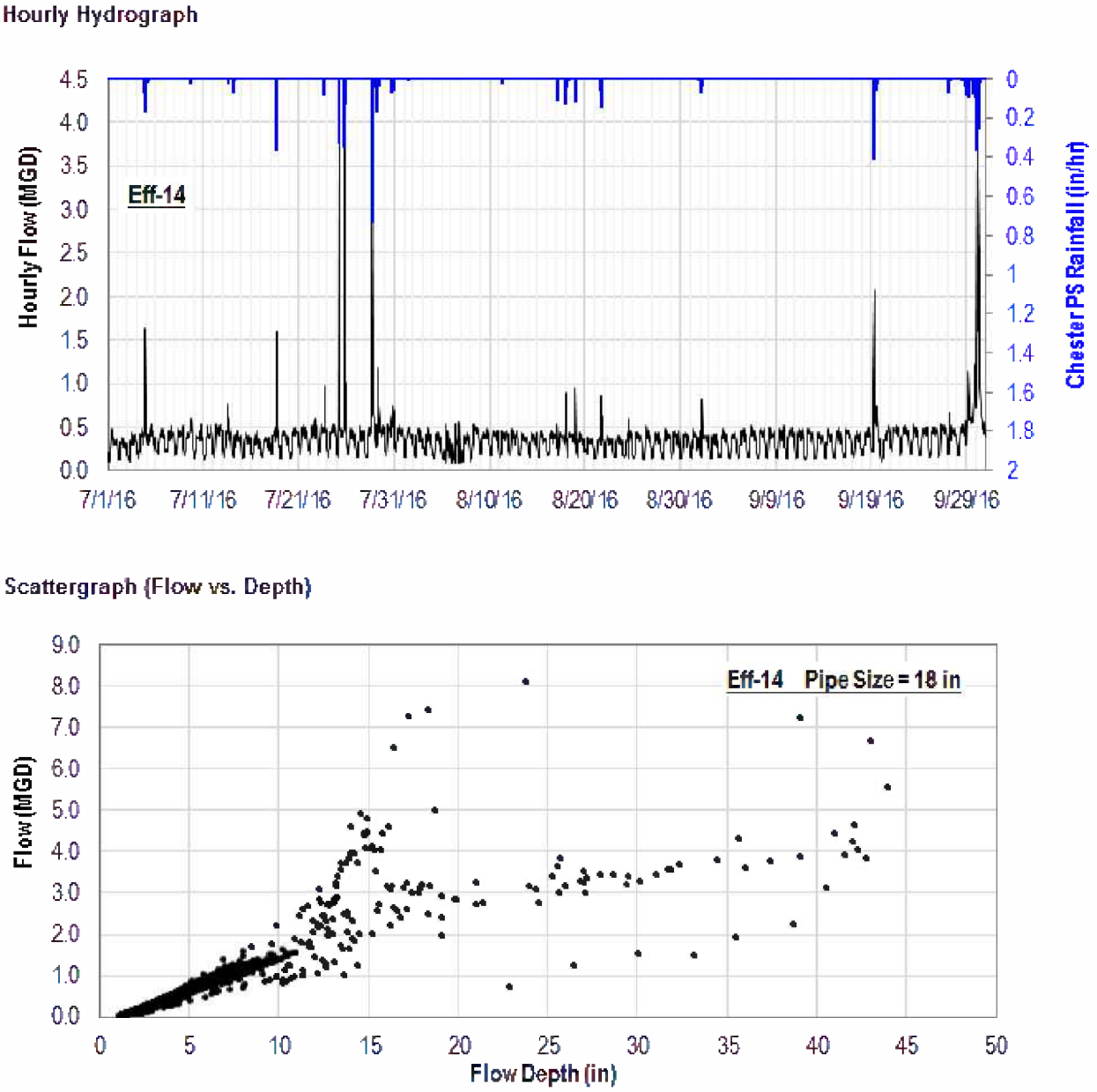


Figure 30: Flow Monitoring Data, CSO-14

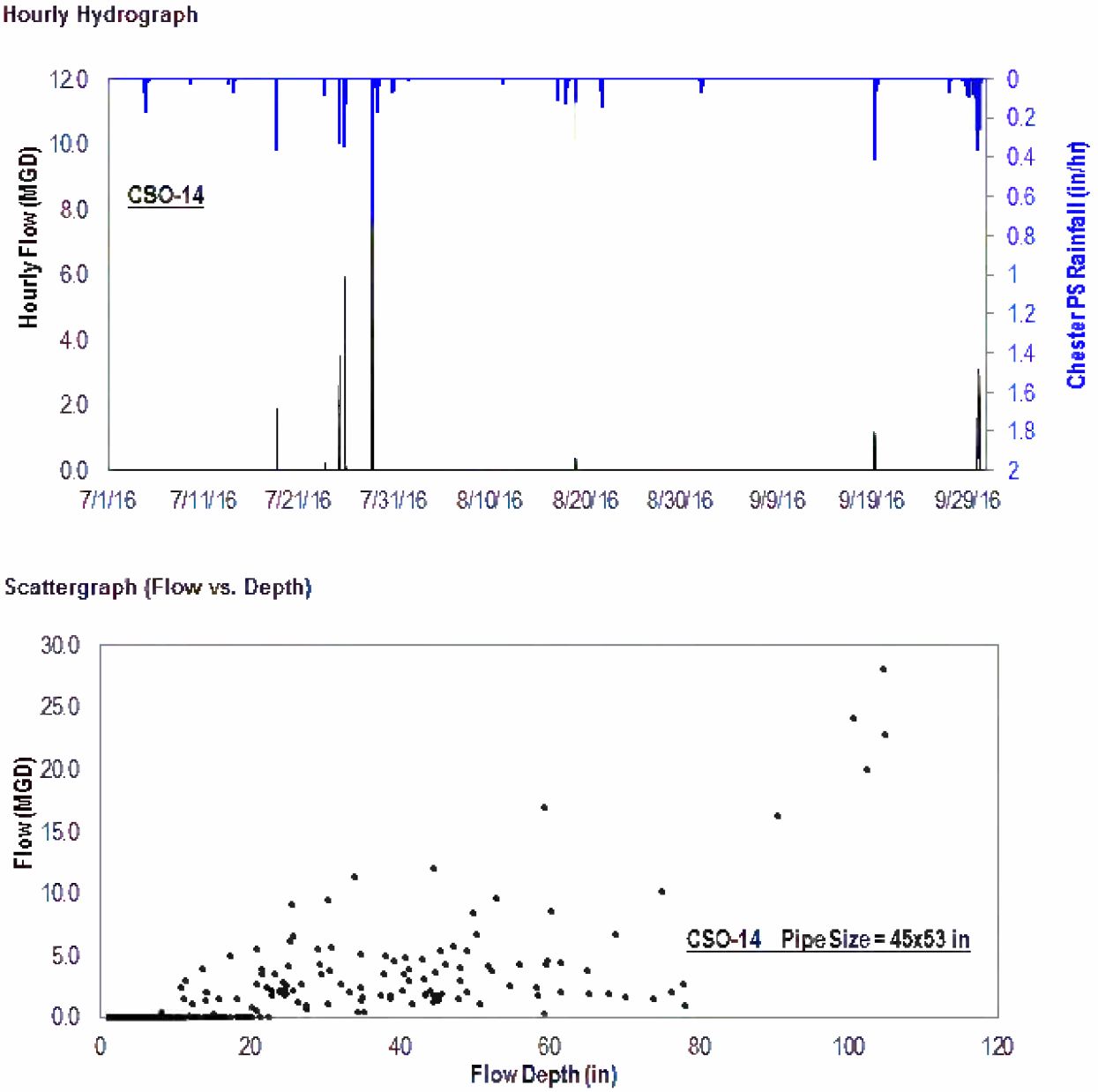


Figure 31: Flow Monitoring Data, In-16

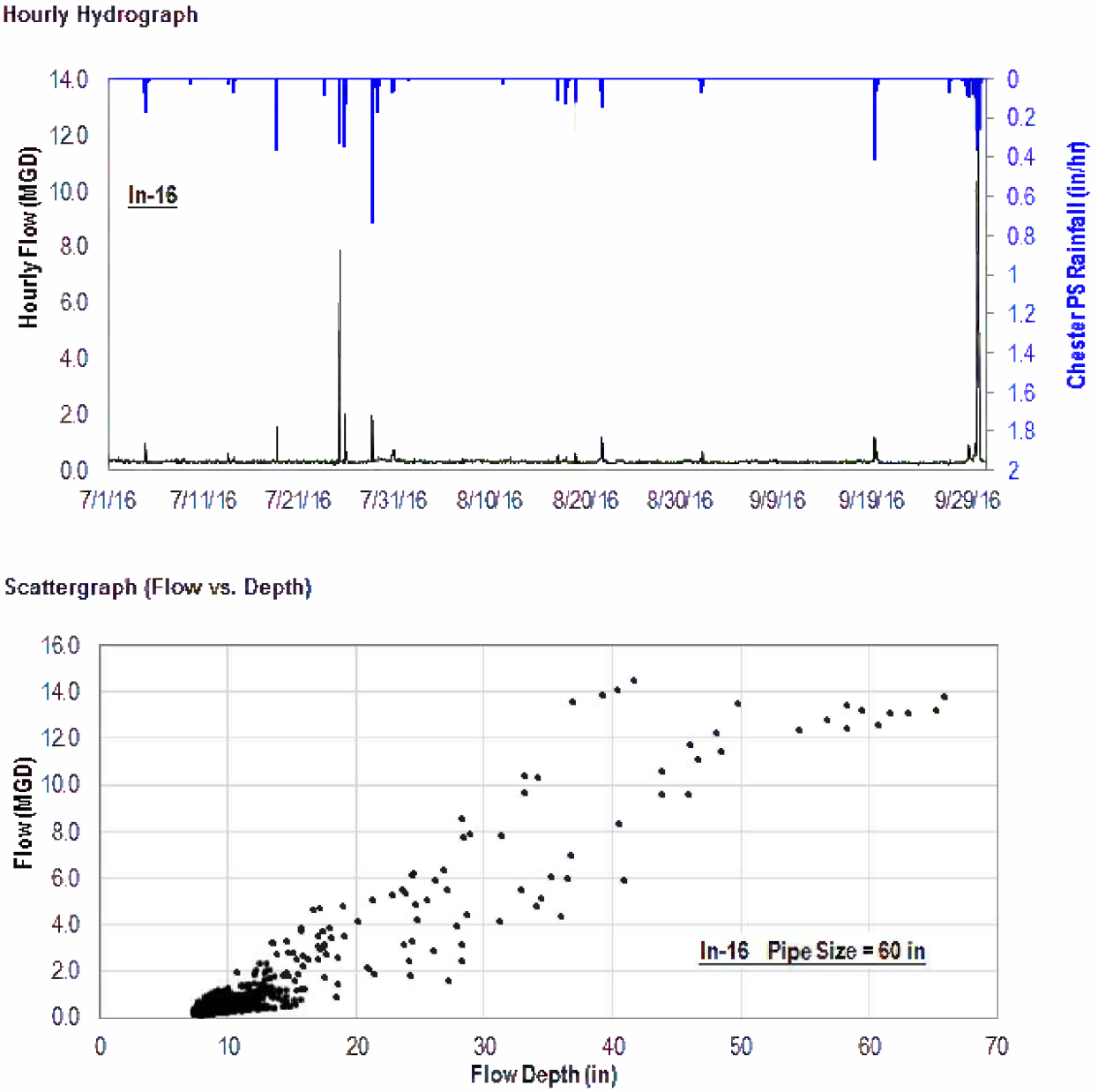


Figure 32: Flow Monitoring Data, In-17

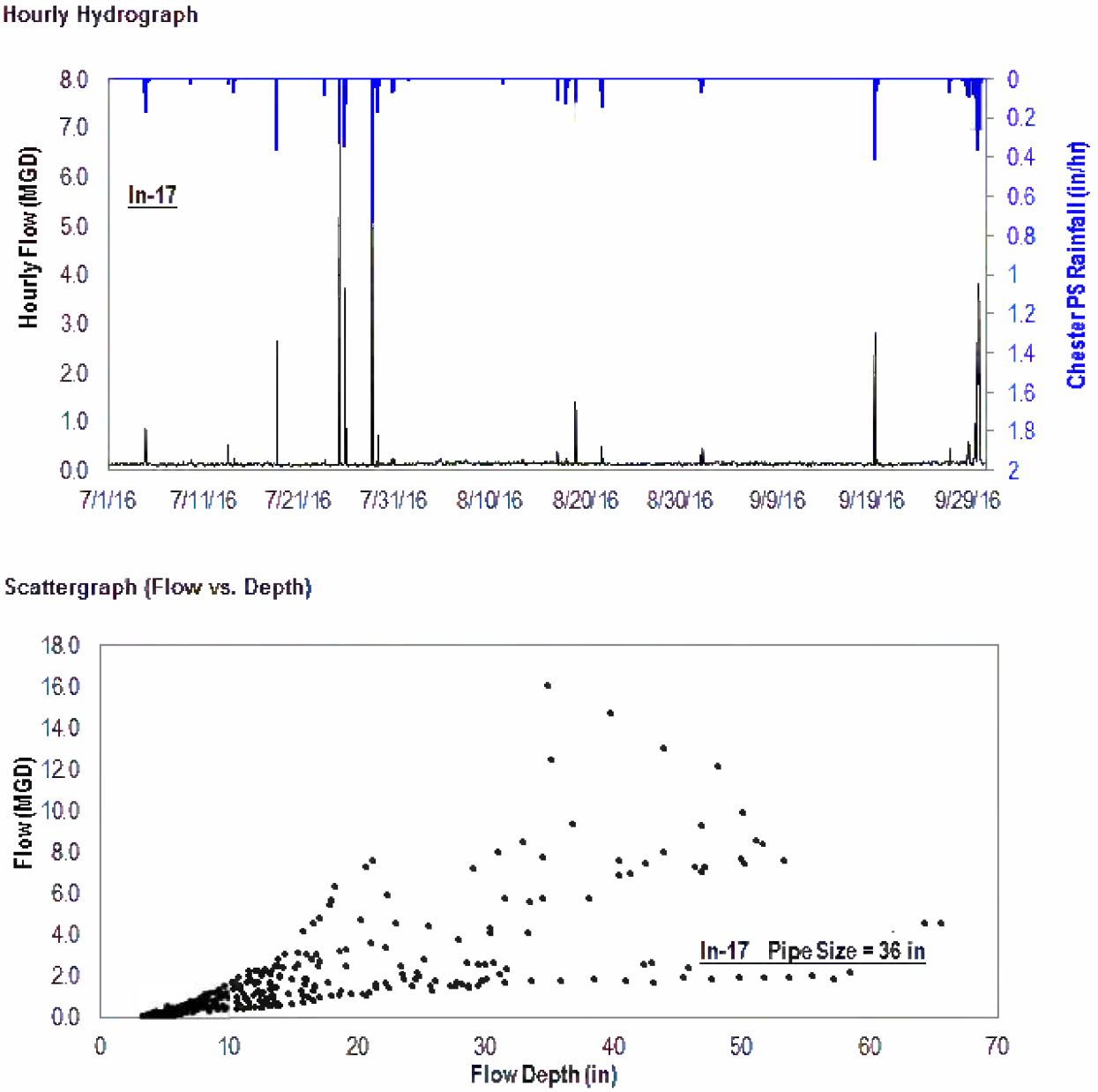


Figure 33: Flow Monitoring Data, In-18

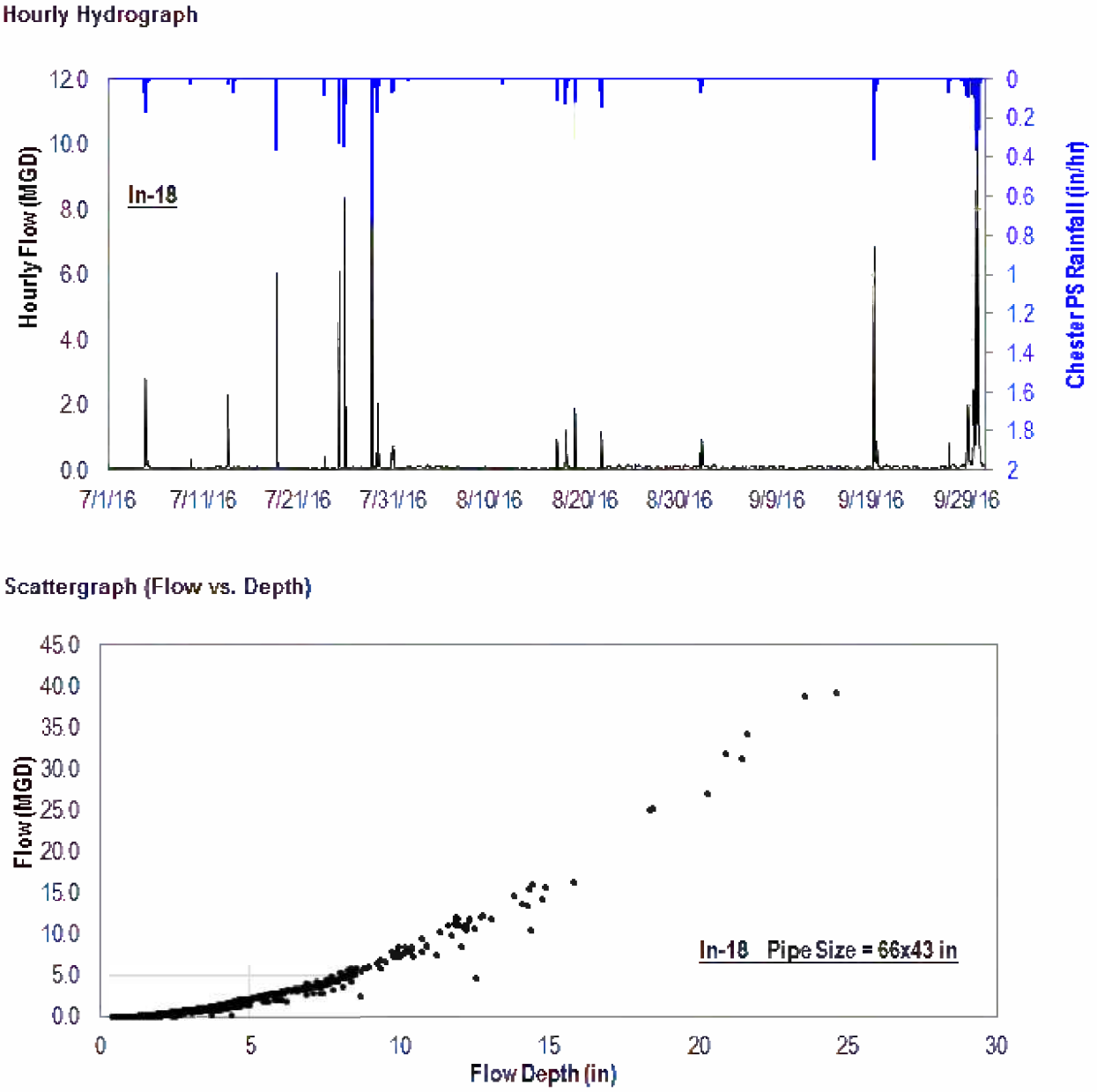
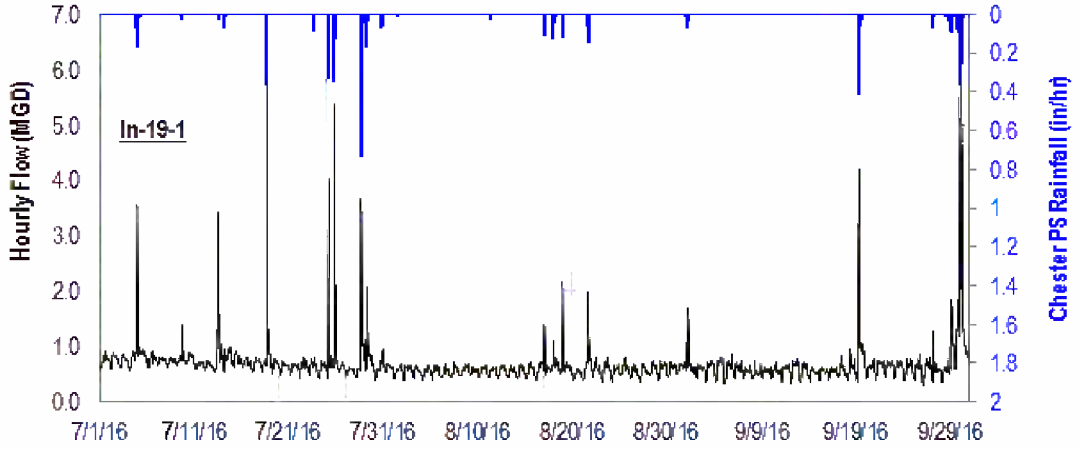
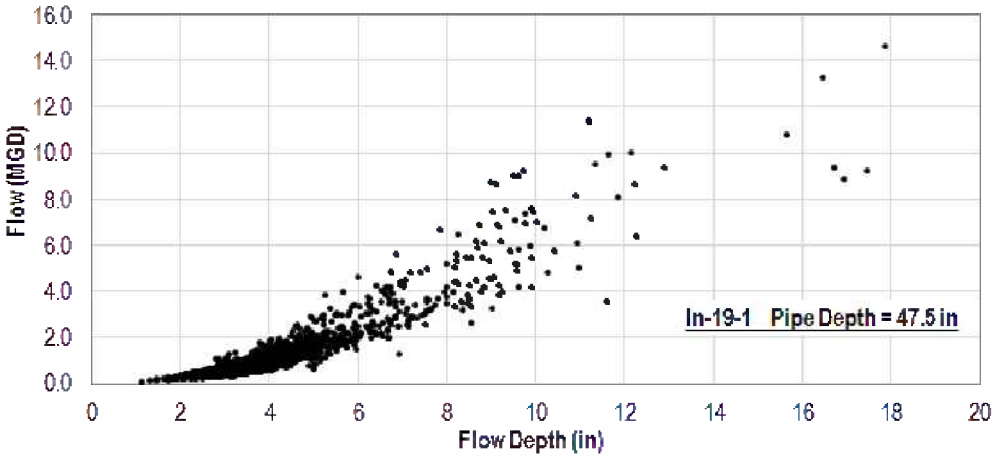


Figure 34: Flow Monitoring Data, In-19-1

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#19 Influent , Effluent and Overflow

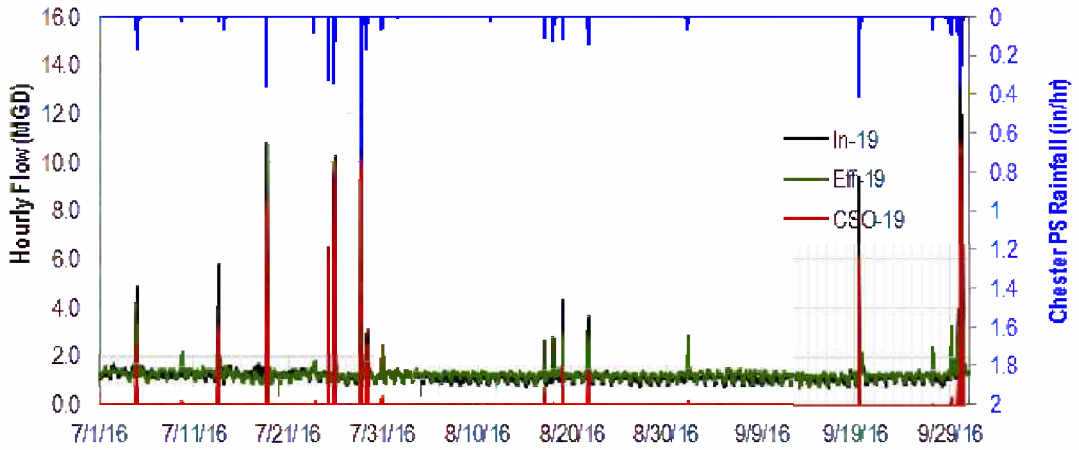


Figure 35: Flow Monitoring Data, In-19-2

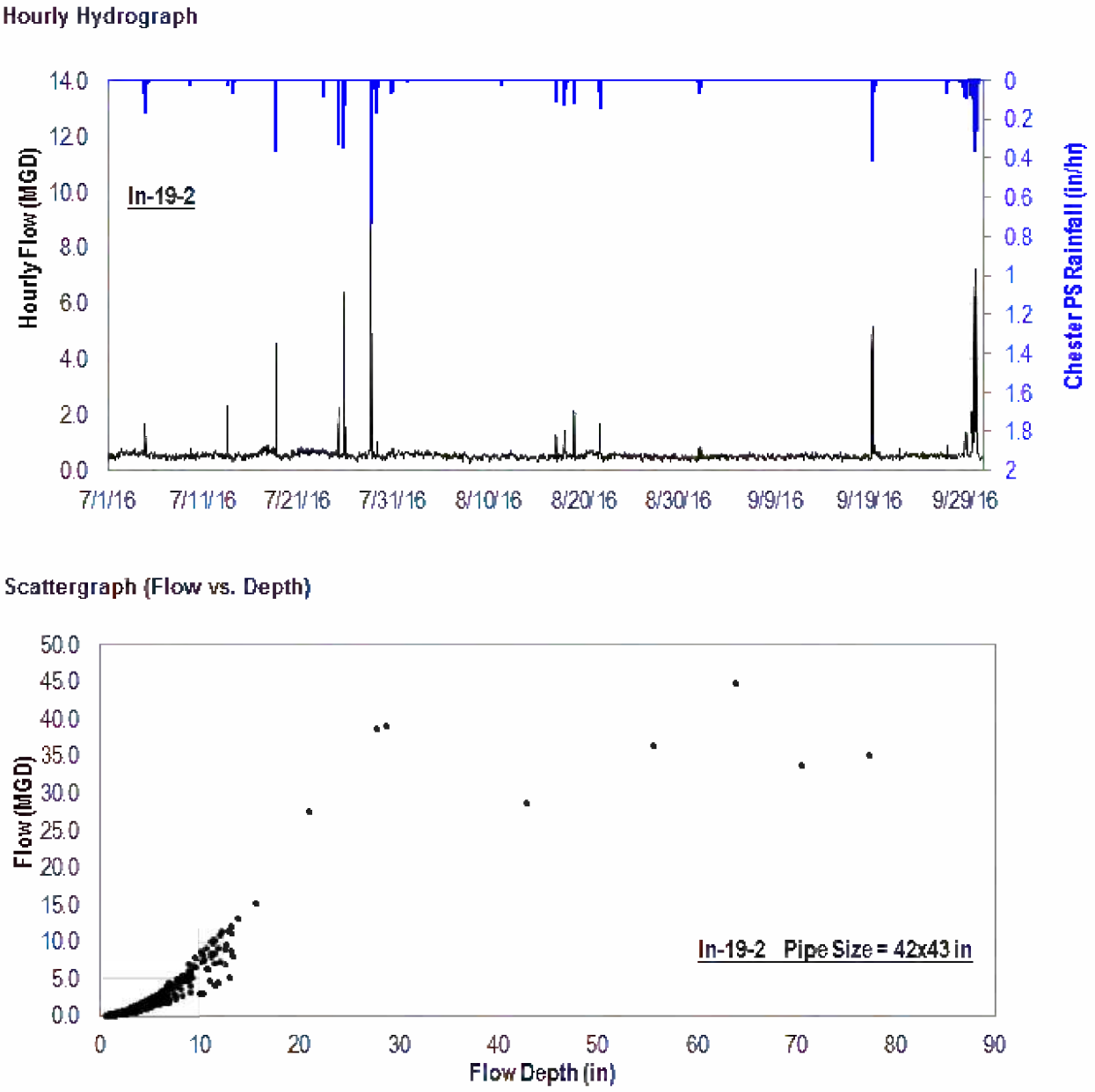


Figure 36: Flow Monitoring Data, Eff-19

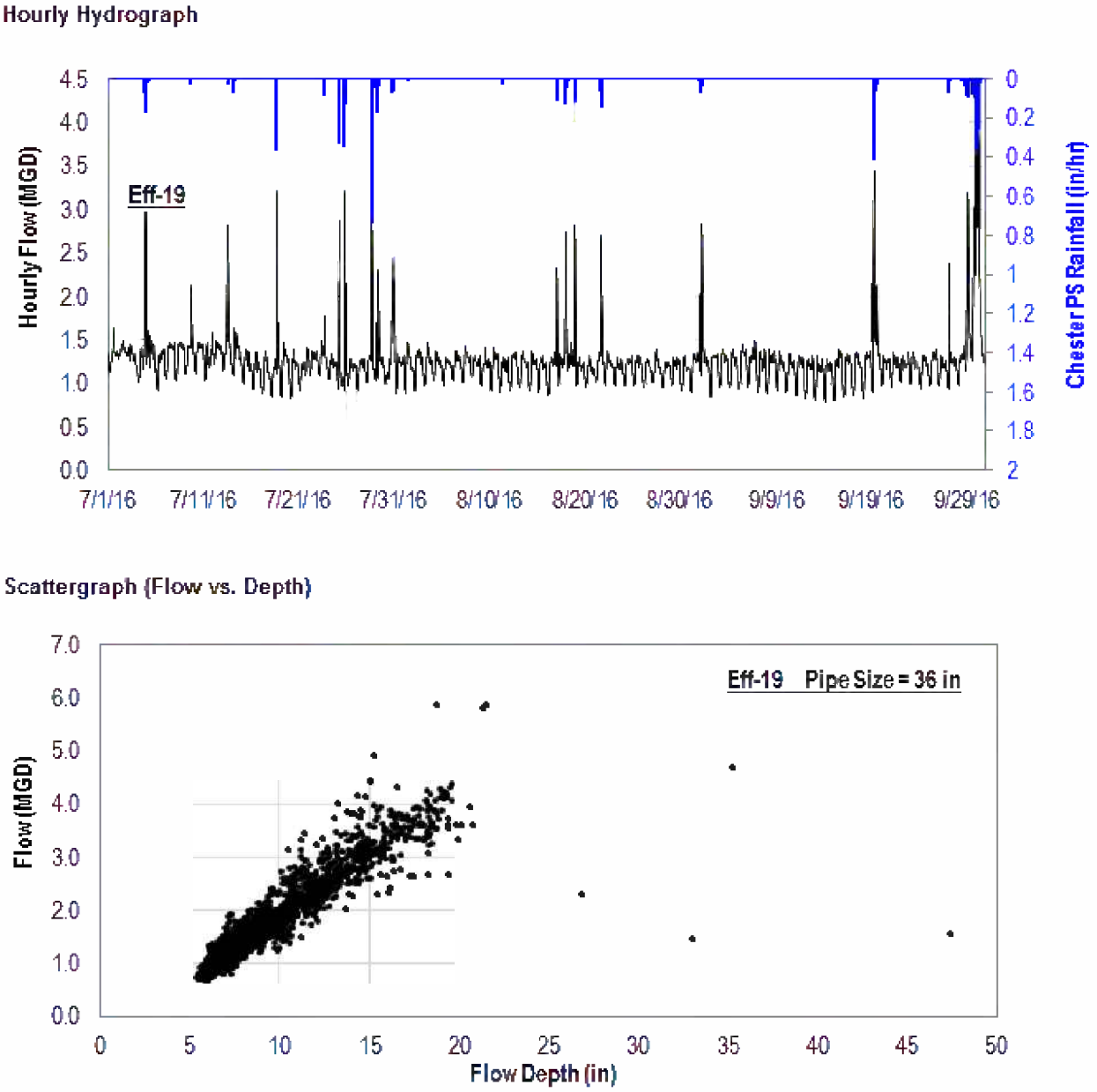


Figure 37: Flow Monitoring Data, CSO-19

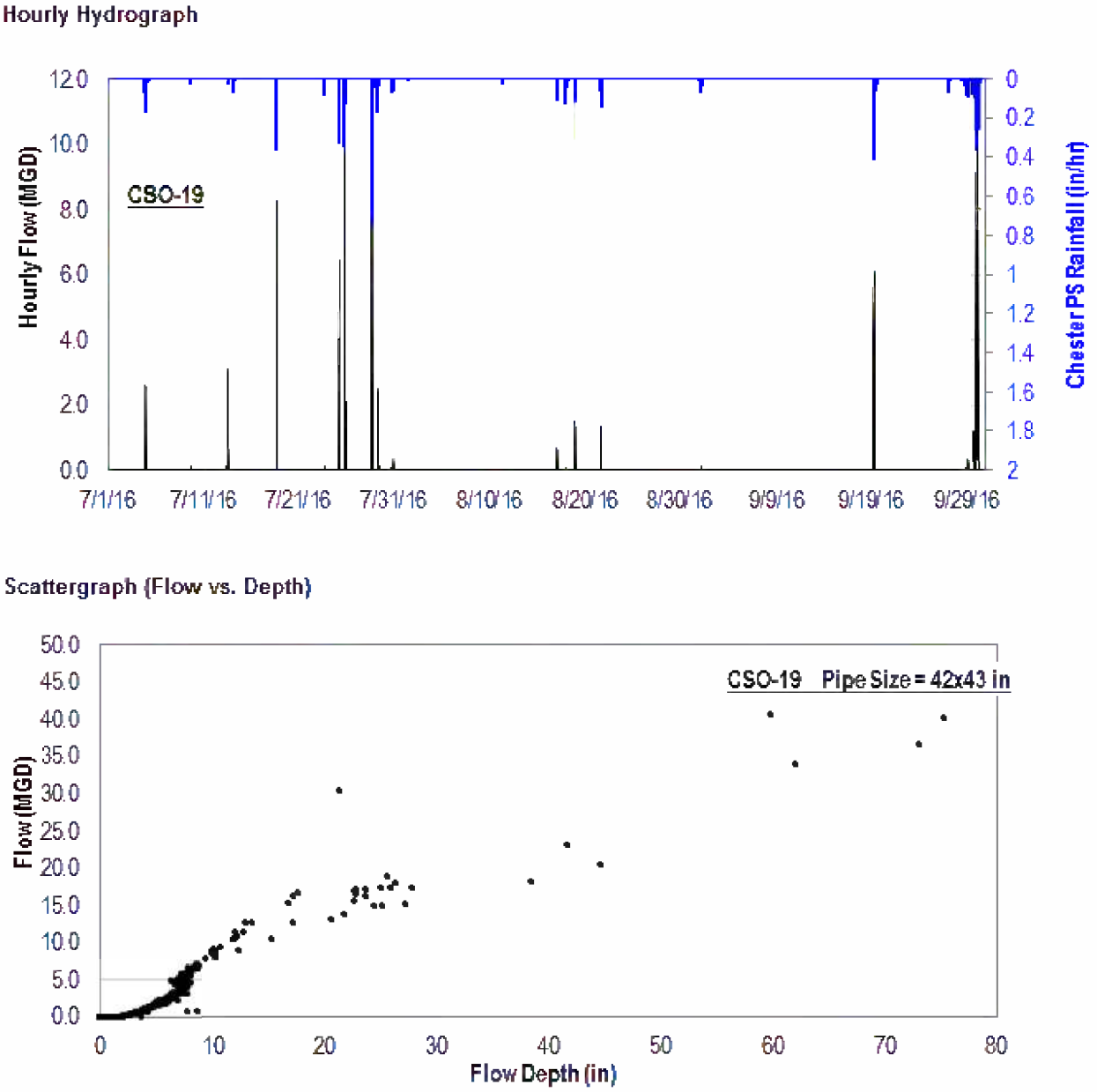


Figure 38: Flow Monitoring Data, In-25

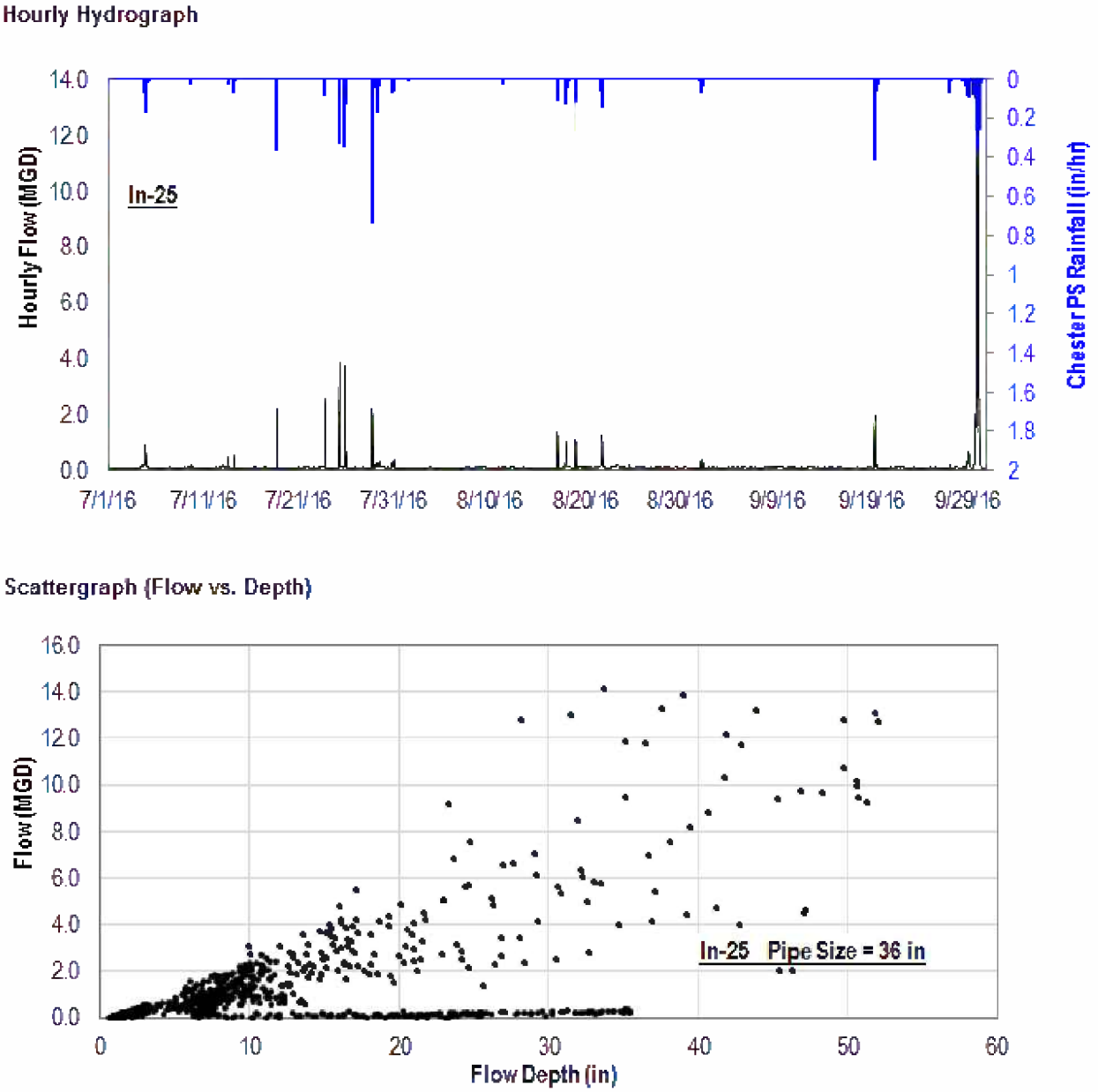


Figure 39: Flow Monitoring Data, In-26

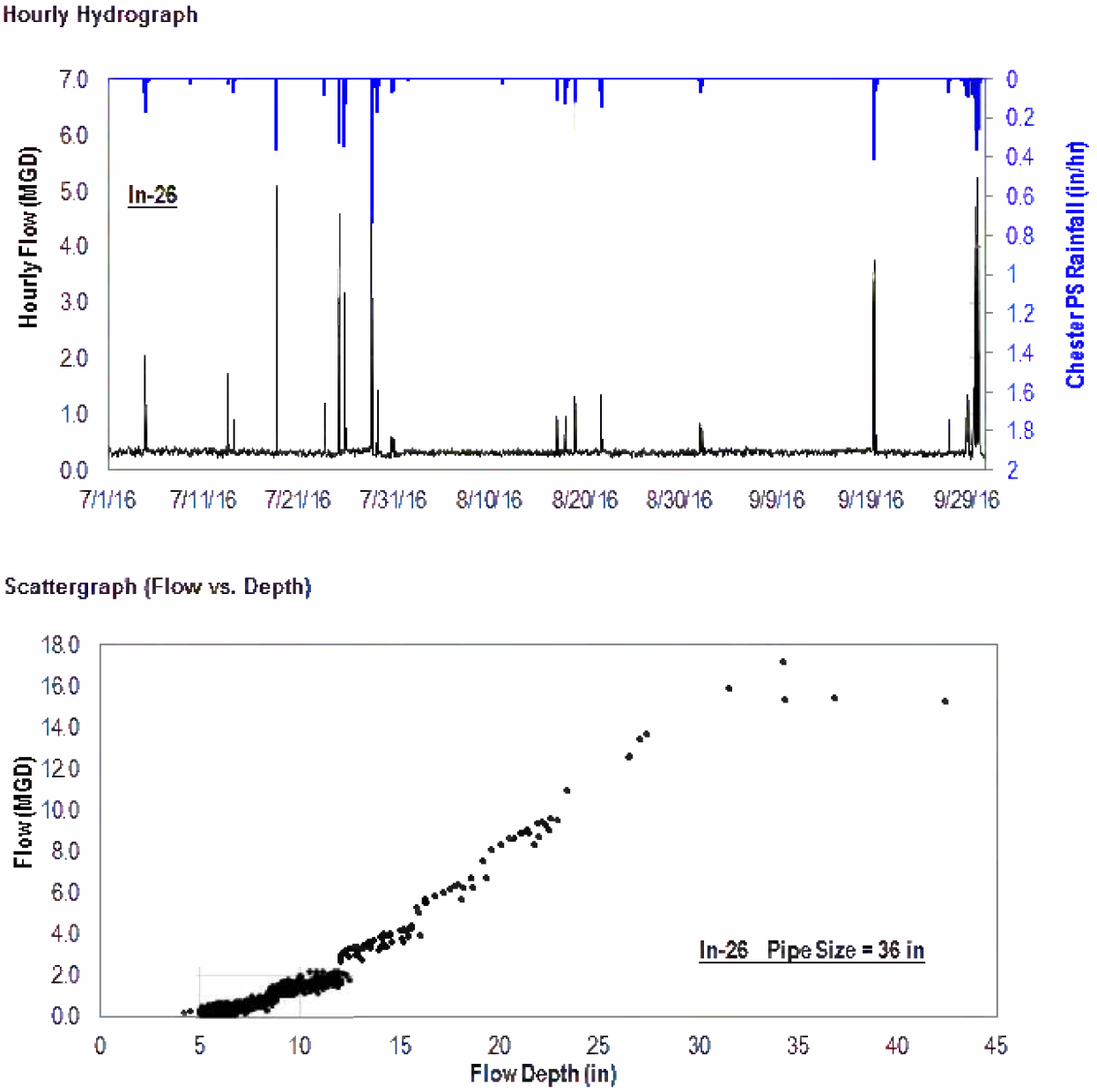


Figure 40: Flow Monitoring Data, INT-2nd St

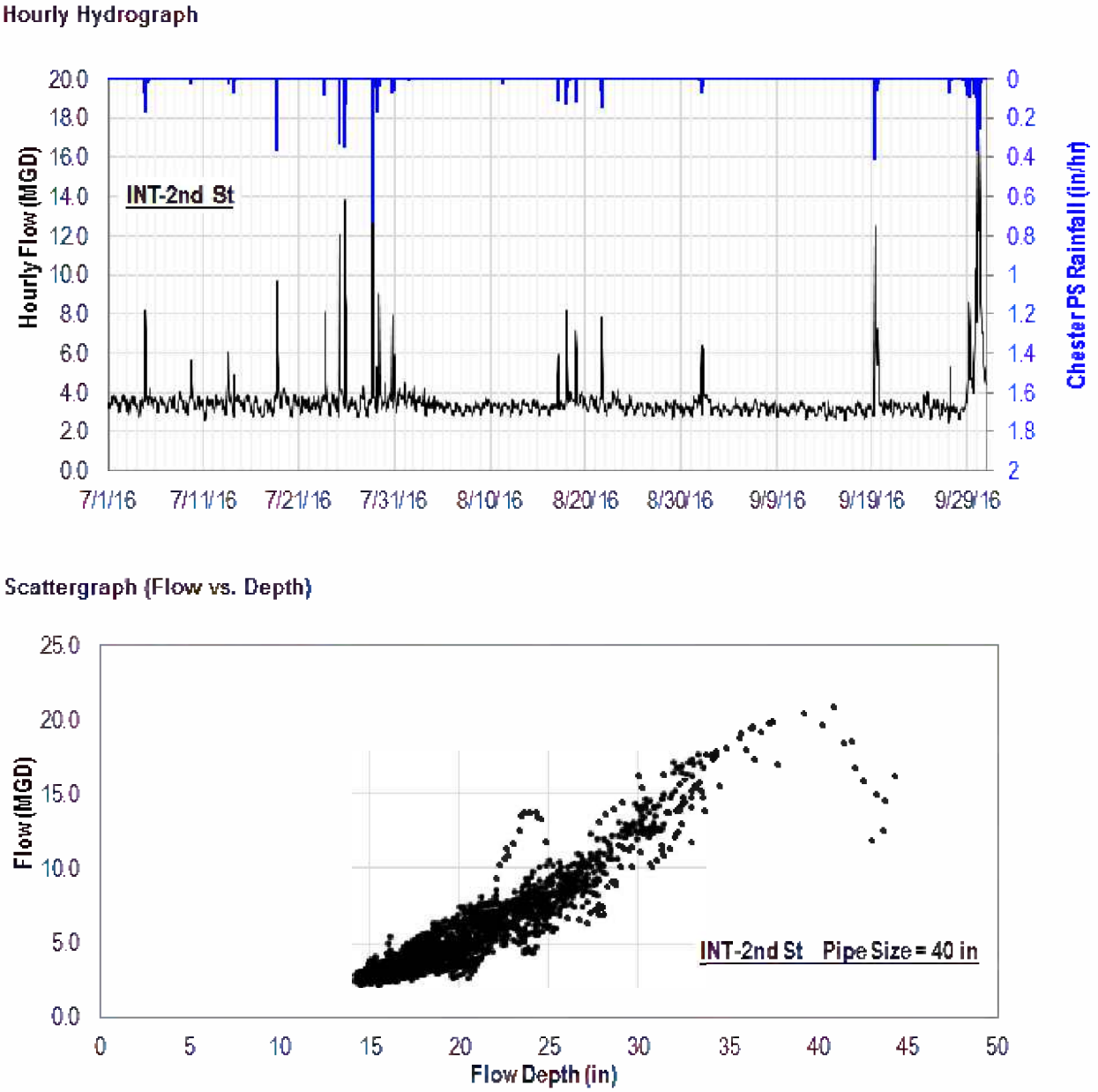


Figure 41: Flow Monitoring Data, INT-DRI

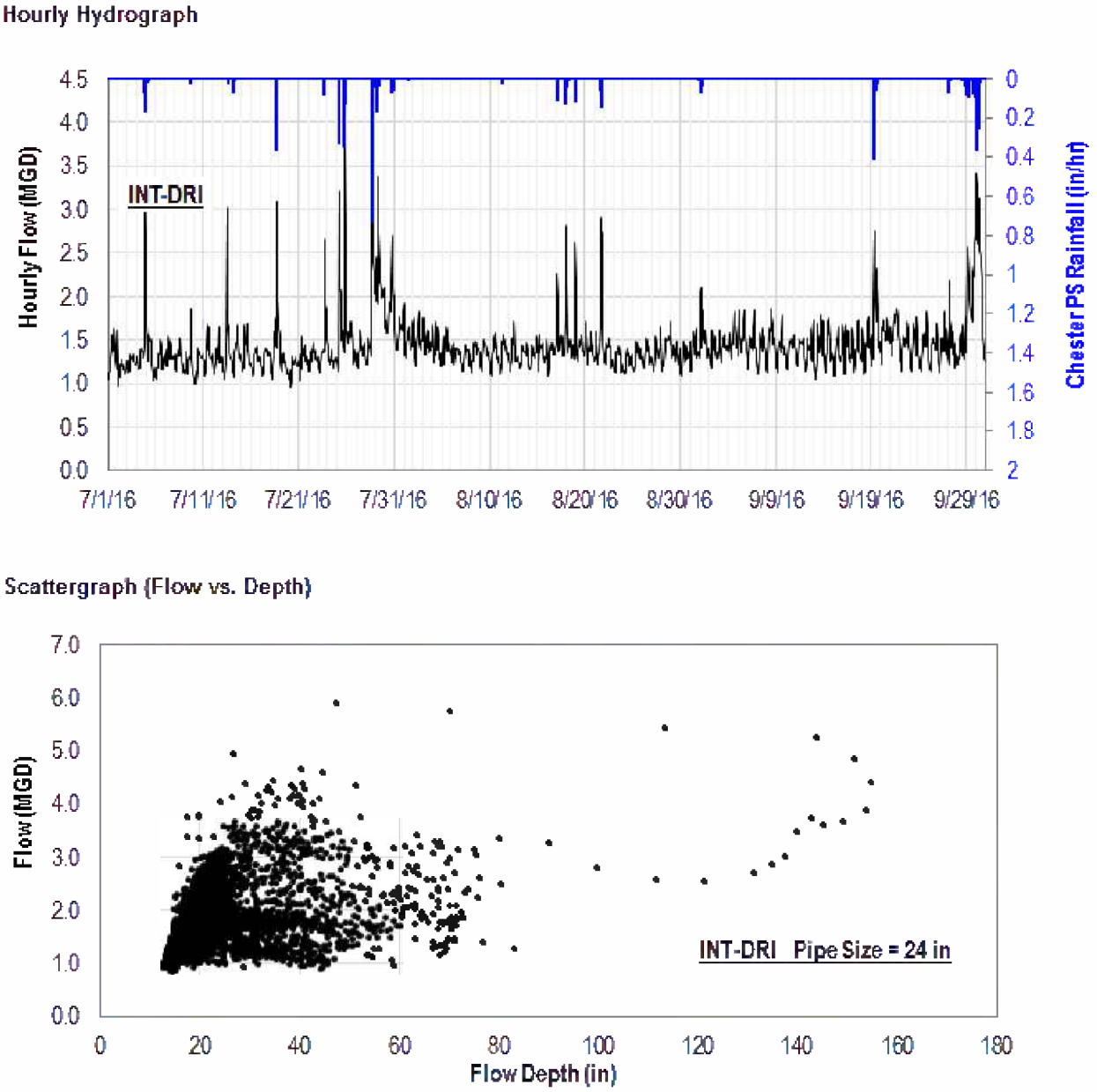
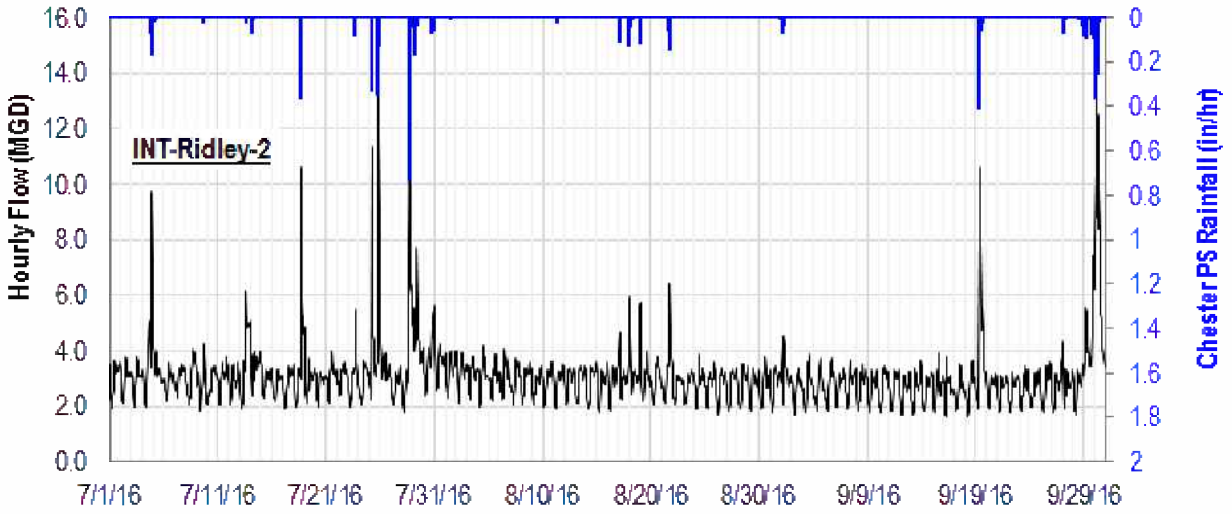


Figure 42: Flow Monitoring Data, INT-Ridley 2

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

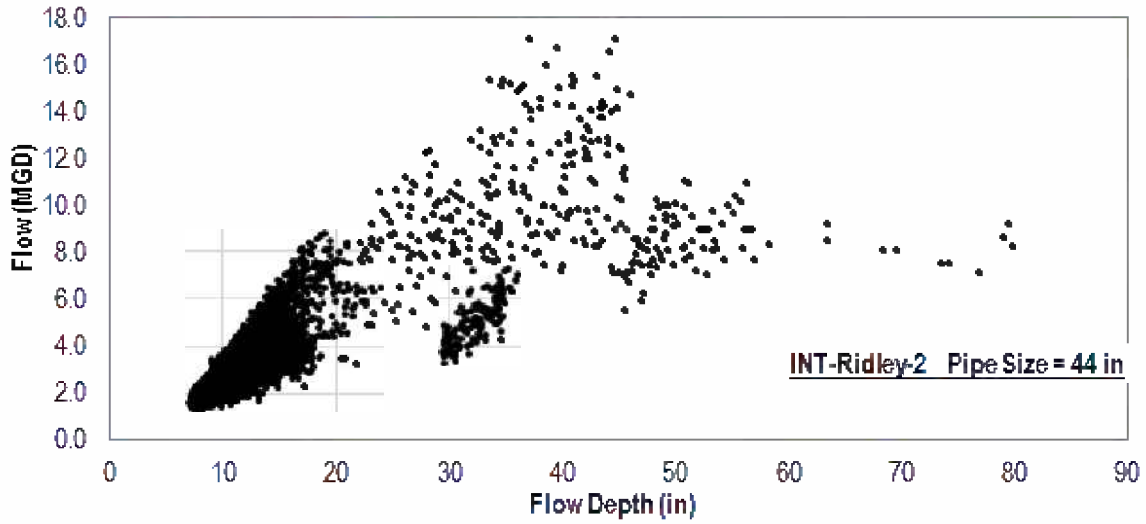
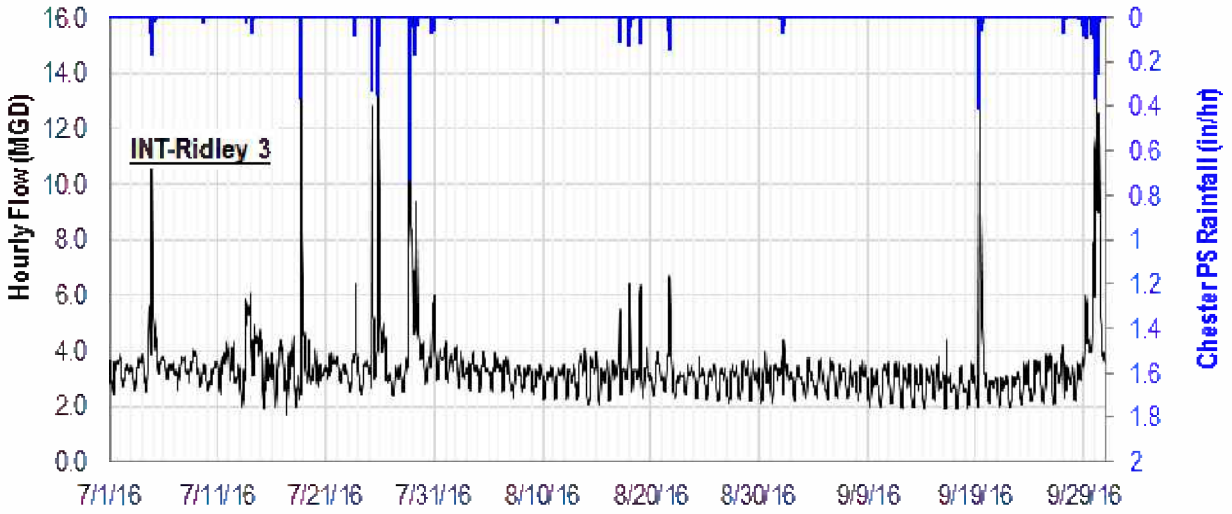


Figure 43: Flow Monitoring Data, INT-Ridley 3

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

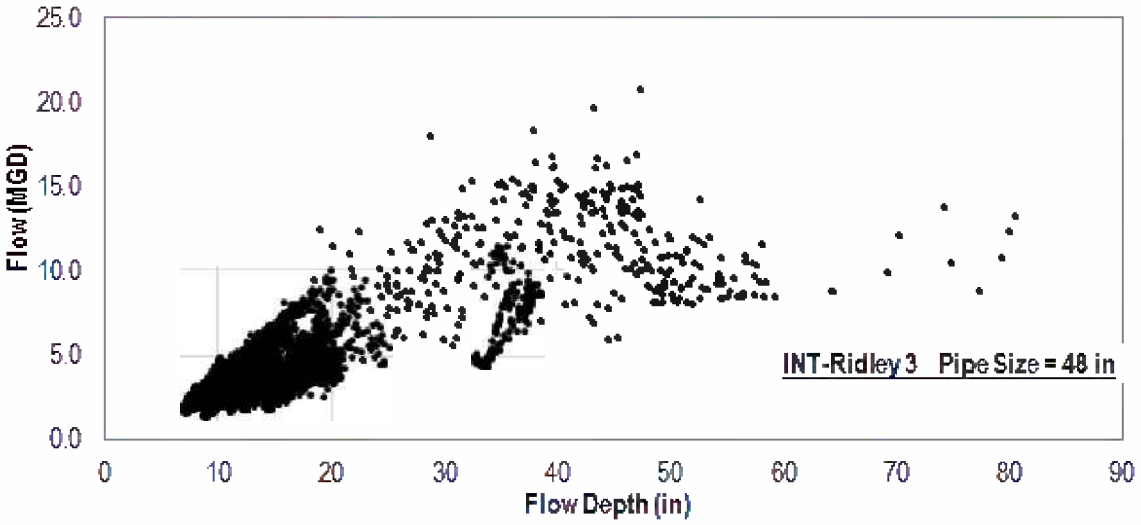


Figure 44: Flow Monitoring Data, INT-WEI

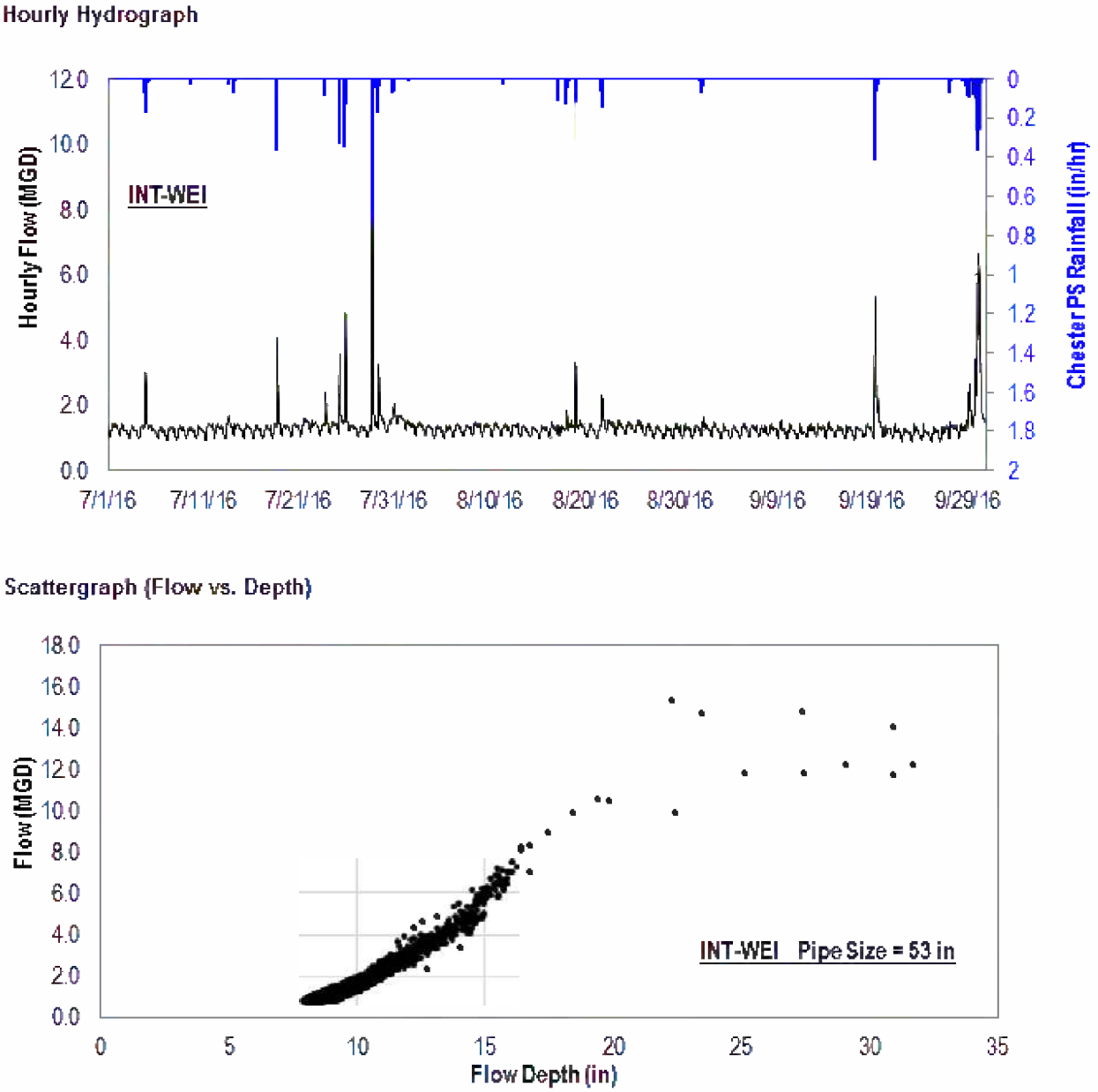


Figure 45: Flow Monitoring Data, Sep-1

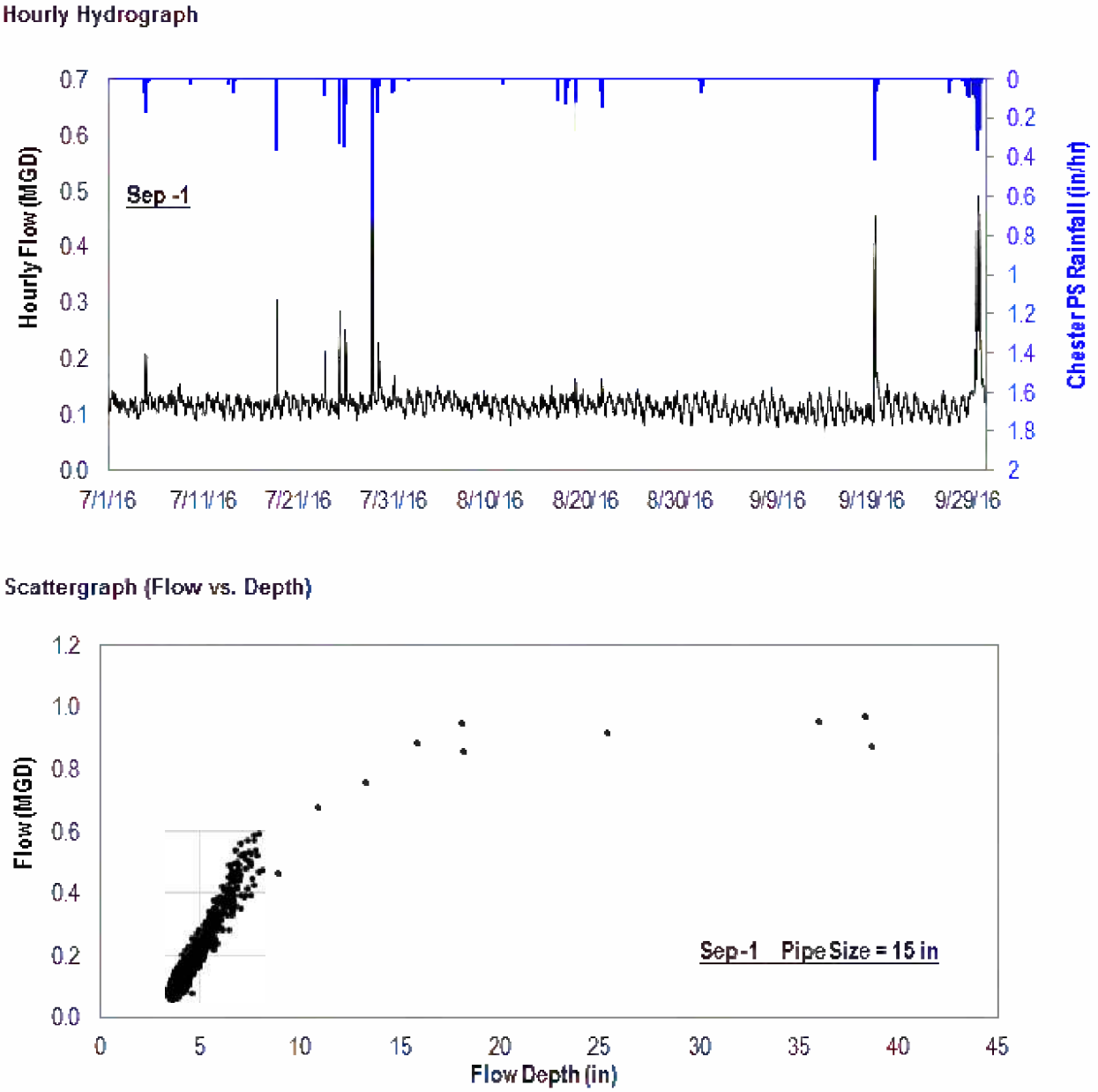


Figure 46: Flow Monitoring Data, Sep-2

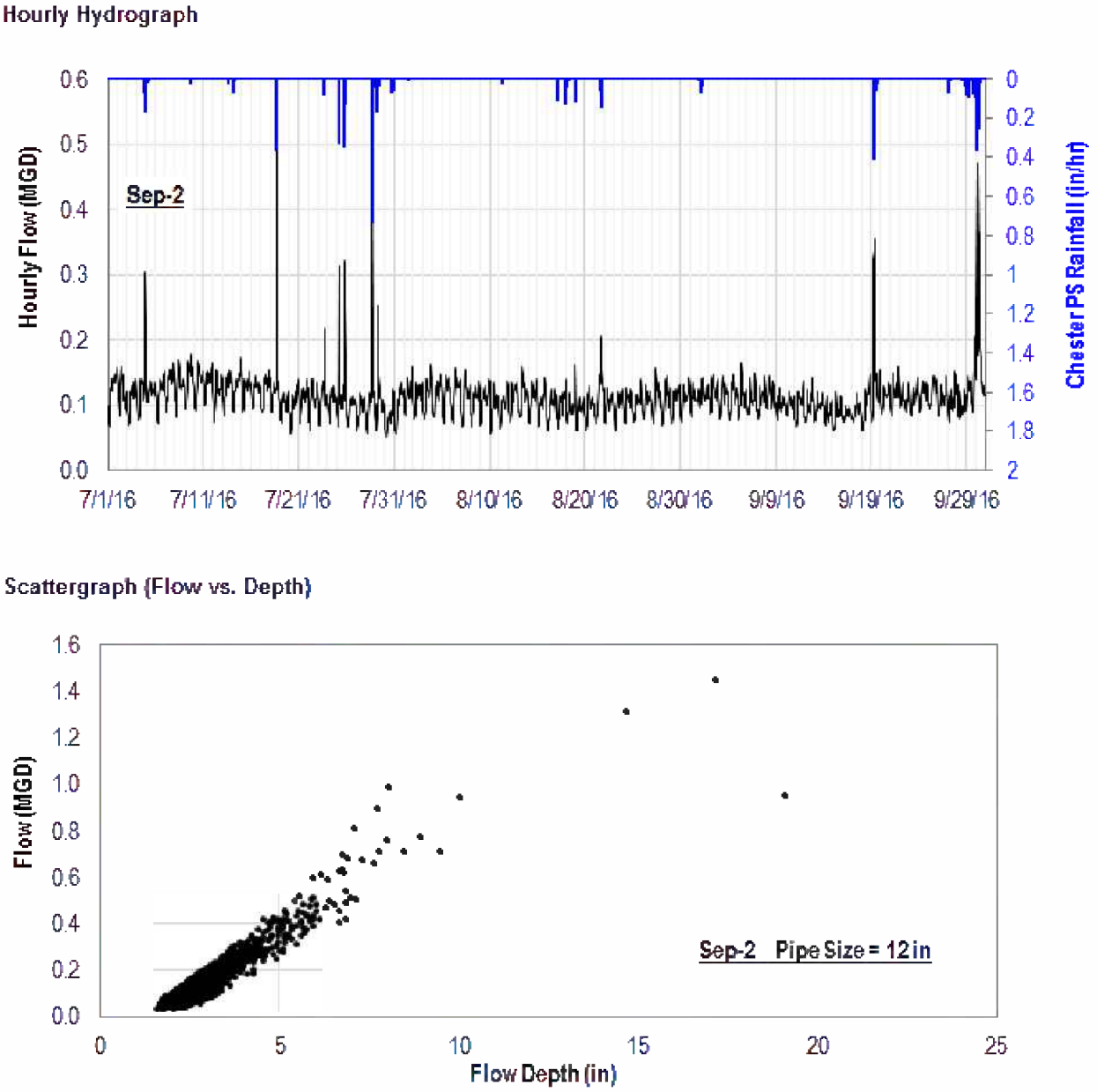


Figure 47: Flow Monitoring Data, Sep-3

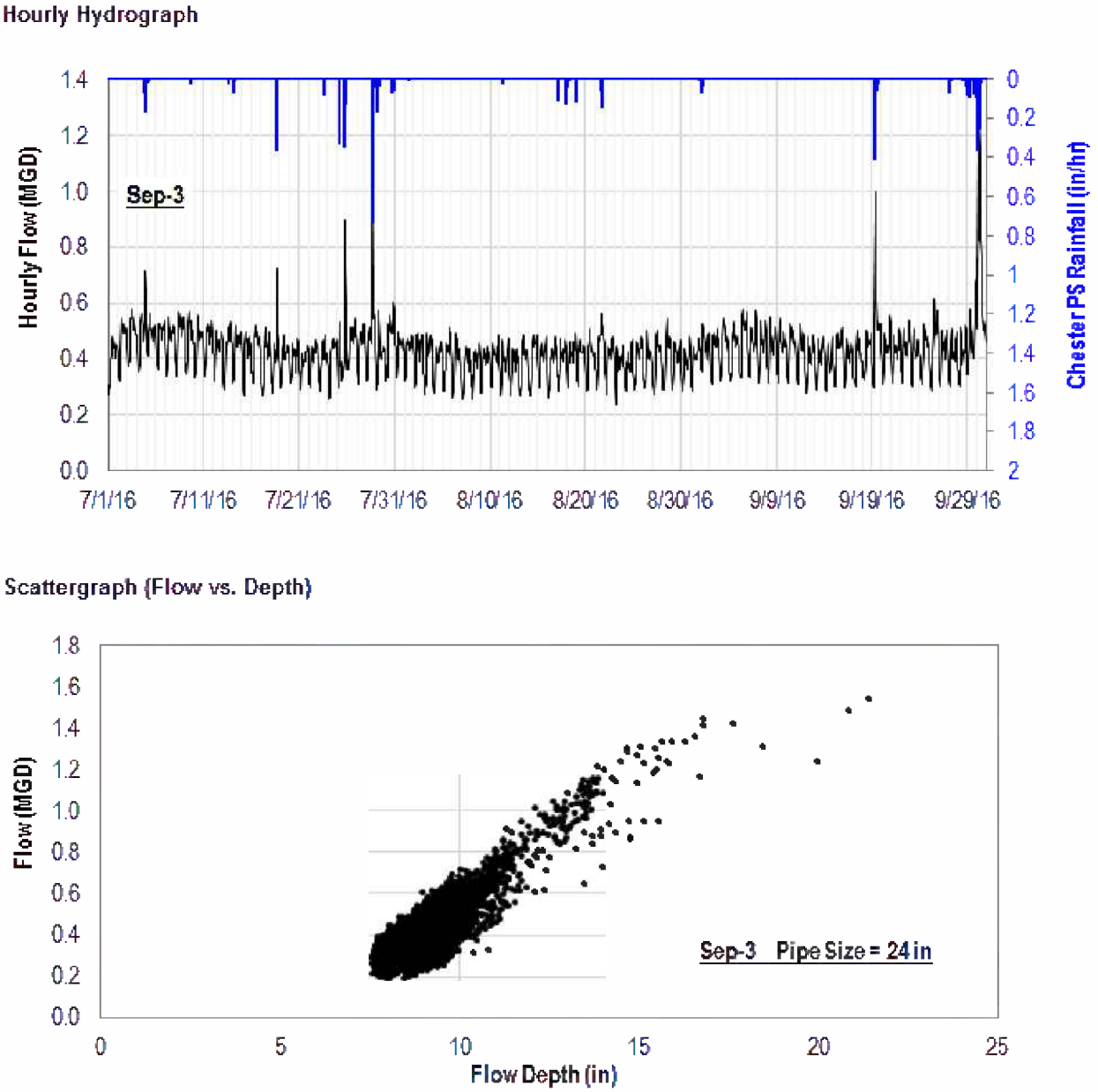
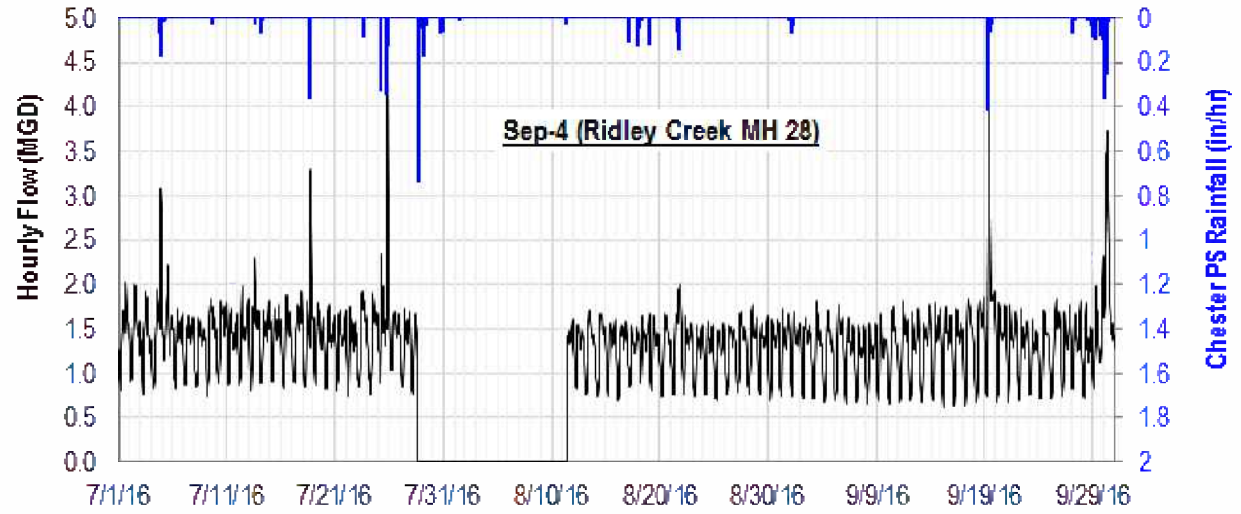


Figure 48: Flow Monitoring Data, Sep-4

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

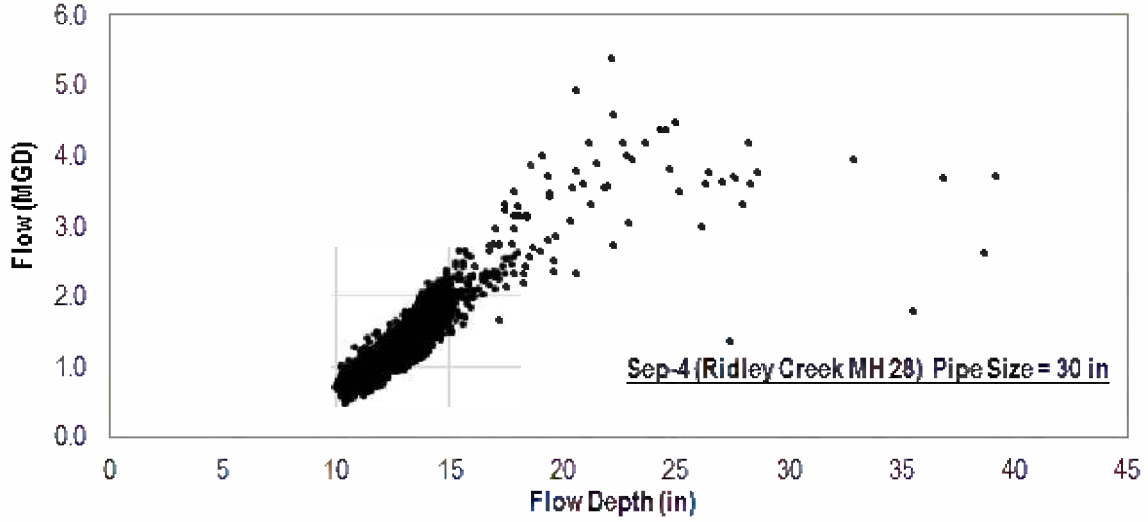


Figure 49: Flow Monitoring Data, Side-1

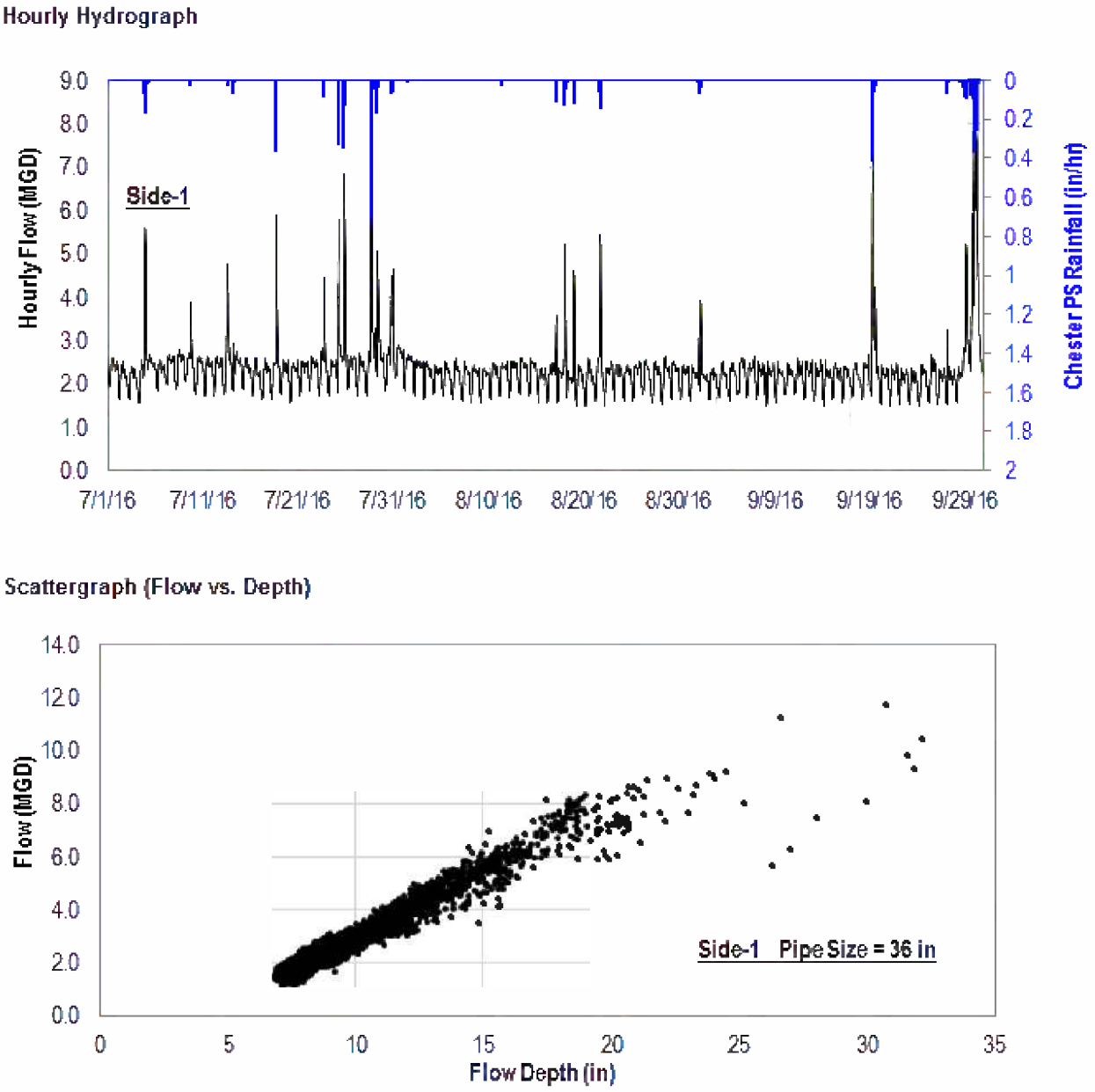
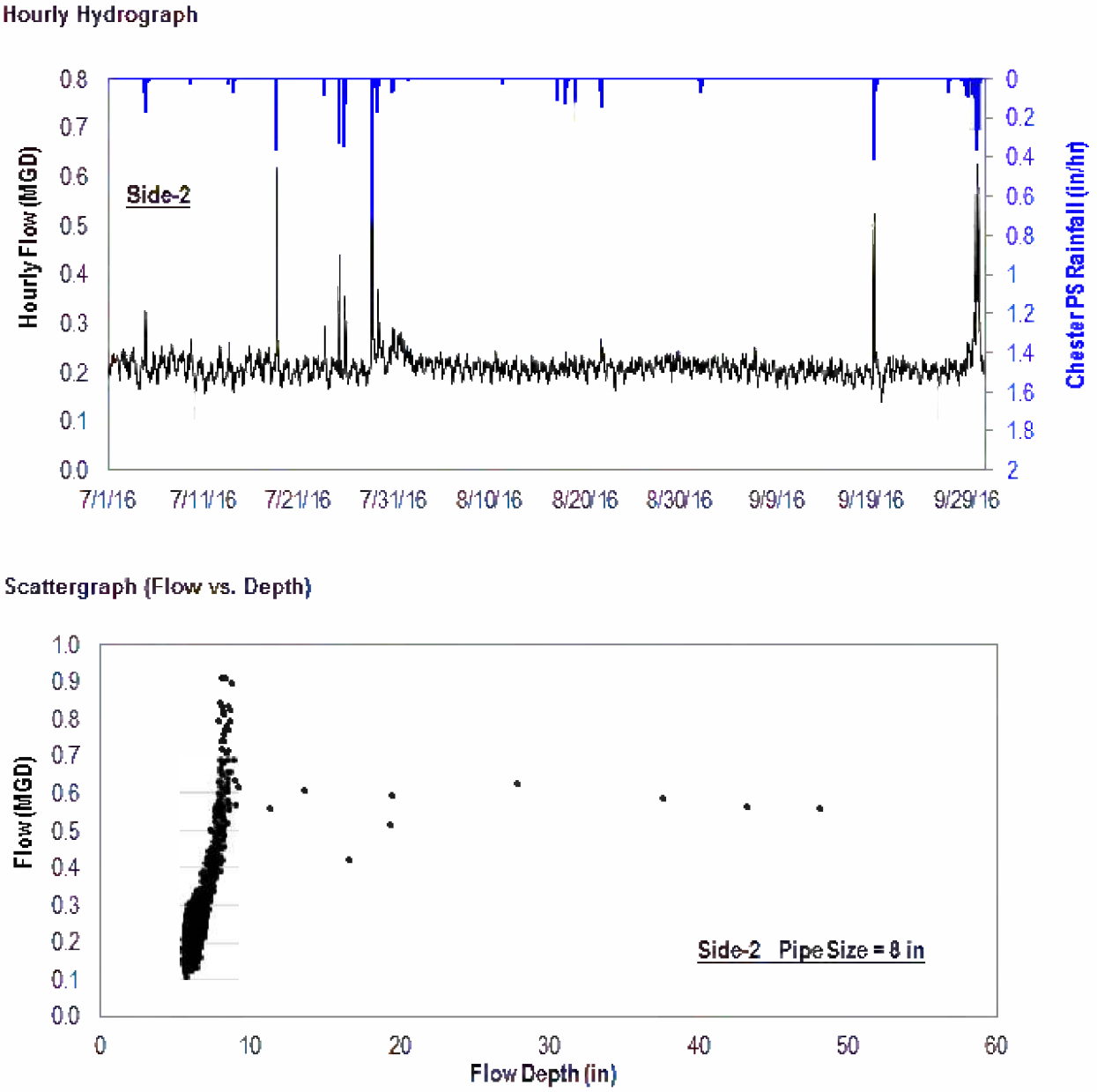


Figure 50: Flow Monitoring Data, Side-2



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Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Rainfall and Flow Monitoring Quarterly Report No. 3

(October 01, 2016 to December 31, 2016)

Final

January 2017

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Rainfall and Flow Monitoring Quarterly Report No. 3.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	*Signature*	1/25/17 *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	1/25/17 *Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	1/25/17 *Date*

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) entered into a Consent Decree (CD) with the United States Government in August 2015. The purpose of the Consent Decree is to establish a schedule for implementation of Long Term Control Plan Update (LTCPU) to achieve full compliance with the Clean Water Act and the regulations and Clean Streams Law and regulations. The lodging of this Consent Decree was entered by the court on August 17, 2015, it was signed and filed on November 10, 2015 by the United States District Court for the Eastern District of Pennsylvania.

According to the Consent Decree, DELCORA's Hydrologic and Hydraulic Model (H&H Model) must be updated to meet the requirements in Section V.A.14 of the Consent Decree. A detailed plan to update, calibrate and validate the H&H model has been submitted and approved by the USEPA on March 1, 2016. Additional rainfall and flow monitoring is required to calibrate and validate the H&H model. Requirements of rainfall and flow monitoring are detailed in the Consent Decree Section V.A.14.d and e, which is included in the following:

> "*d.* *Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve* ***(12) months****, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*
>
> *e.* *For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data."*

In summary, rainfall and flow monitoring shall be conducted for at least 12 months, and quarterly technical memoranda shall be submitted to Plaintiffs for review.

To satisfy the above mentioned rainfall and flow monitoring requirements, and in accordance with the submitted DELCORA H&H Model Update and Calibration Plan, DELCORA has installed 5 new rain gauges and 39 new flow meters in its sewer collection system. Starting from March 18, 2016, most of the newly installed rain gauges and flow meters were in service and began generating data.

This report is a summary of the Rainfall and Flow Monitoring during October 1, 2016 to December 31, 2016.

Section 2 Rainfall Monitoring

2.1 Rainfall Monitoring Locations

The site locations of the four existing and five newly installed rain gauges are shown in **Figure 1**. These rain gauges provide an effective spatial coverage of the entire WRTP's service area.

The four (4) existing rainfall gauges are in Delaware County that record precipitation in 15-minute increments. The gauges are located at the following DELCORA owned facilities:

- Western Regional Treatment Plant (WRTP, will be used for model calibration)
- Central Delaware County Pump Station (CDPS, will be used for model calibration)
- Muckinipates Pump Station (MPS, will be used for model calibration)
- Darby Creek Pump Station (DCPS, will NOT be used for model calibration)

The five (5) newly installed rain gauges are listed in **Table 1** with detail information of rain gauge location, service starting date, and data recording interval.

Table 1: Newly Installed Rain Gauges

	Rain Gauge ID	Location	Service Start Date	Data Interval
1	RG_Rose Valley	18 N. Longpoint Lane, Media, PA	3/05/16	5-minute
2	RG_Chester-PS	55 East 2nd Street, Chester, PA	3/05/16	5-minute
3	RG_NCPS	1628 Naamans Creek Rd., Marcus Hook, PA	3/05/16	5-minute
4	RG_Springfield	217 Saxer Avenue, Springfield, PA	4/03/16	5-minute
5	RG_UCT	1671 N. Upper Providence Road, Media, PA	4/16/16	5-minute

2.2 Rain Gauge Calibration/Verification Procedure

Rain Gauge calibrations were performed during the rain gauge installation. Additional calibrations will be performed to the manufacturer's specifications on a bi-annual basis or as needed if irregular data is observed. Rain gauges are routinely checked for debris, and cleared after snow/ice storms.

Each "tip" of the rain gauge bucket should correspond with 0.01" of rain. To ensure the modem is reading the tipping bucket pulse accurately, the tech will tip the bucket 10 times in rapid succession. The tech should see that 0.1" of rain is recorded.

2.3 Rainfall Event Summary

Rainfall events were analyzed for each individual rain gauge based on the inter-event time of 12 hours. In total there were 17 rainfall events during reporting period. **Table 2** lists all 13 rainfall events with total precipitation greater than 0.1 inch.

Figure 1: Rain Gauge Locations

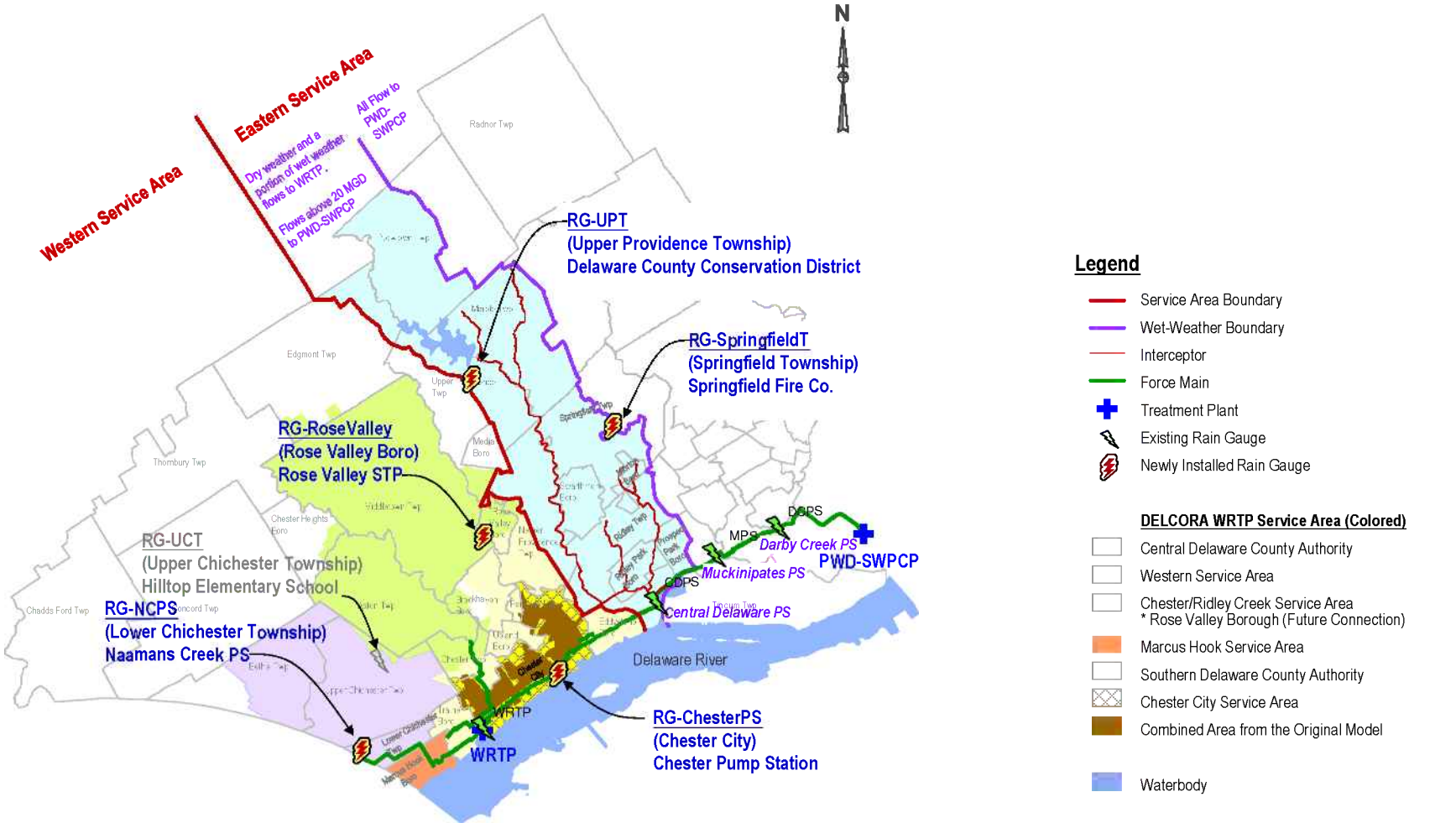


Figure 2 shows rainfall amounts at each rain gauge in each month for October, November and December. It is obvious that rainfall in the area has significant spatial and temporal variance. As an example, during this reporting period, the rain gauge at the Chester Pump Station (Chester PS) recorded a total rainfall of 6.65 inches while the gauge at the Upper Providence Township (UPT) recorded 8.52 inches. **Figure 3** shows the 1-hour rainfall profile for all of the 5 rain gauges.

Table 2: Rainfall Event Summary, 10/1/16 - 12/31/16

	Rain Event Starting Time	Rose Valley	Chester-PS	NCPS	Springfield	UPT
1	10/8/2016 13:25	0.91	1	1.1	0.82	1.05
2	10/21/2016 20:55	0.24	0.2	0.2	0.24	0.36
3	10/27/2016 8:30	0.45	0.54	0.71	0.32	0.43
4	10/30/2016 17:45	0.25	0.23	0.21	0.37	0.65
5	11/9/2016 7:25	0.26	0.23	0.31	0.29	0.33
6	11/19/2016 20:25	0.08	0.03	0.17	0.06	0.14
7	11/29/2016 5:30	1.74	1.84	2.13	2.39	2.37
8	12/5/2016 0:25	0.14	0.12	0.12	0.14	0.14
9	12/6/2016 13:35	0.8	0.69	0.22	0.92	0.99
10	12/12/2016 1:05	0.57	0.39	0.46	0.47	0.68
11	12/17/2016 7:20	0.82	0.79	0.89	0.85	0.61
12	12/24/2016 4:35	0.44	0.36	0.53	0.43	0.51
13	12/29/2016 6:30	0.31	0.23	0.28	0.25	0.26
	Subtotal (10/1/16-12/31/16)	**7.01**	**6.65**	**7.33**	**7.55**	**8.52**

Figure 2: Rainfall Event Summary, 10/1/16 - 12/31/16

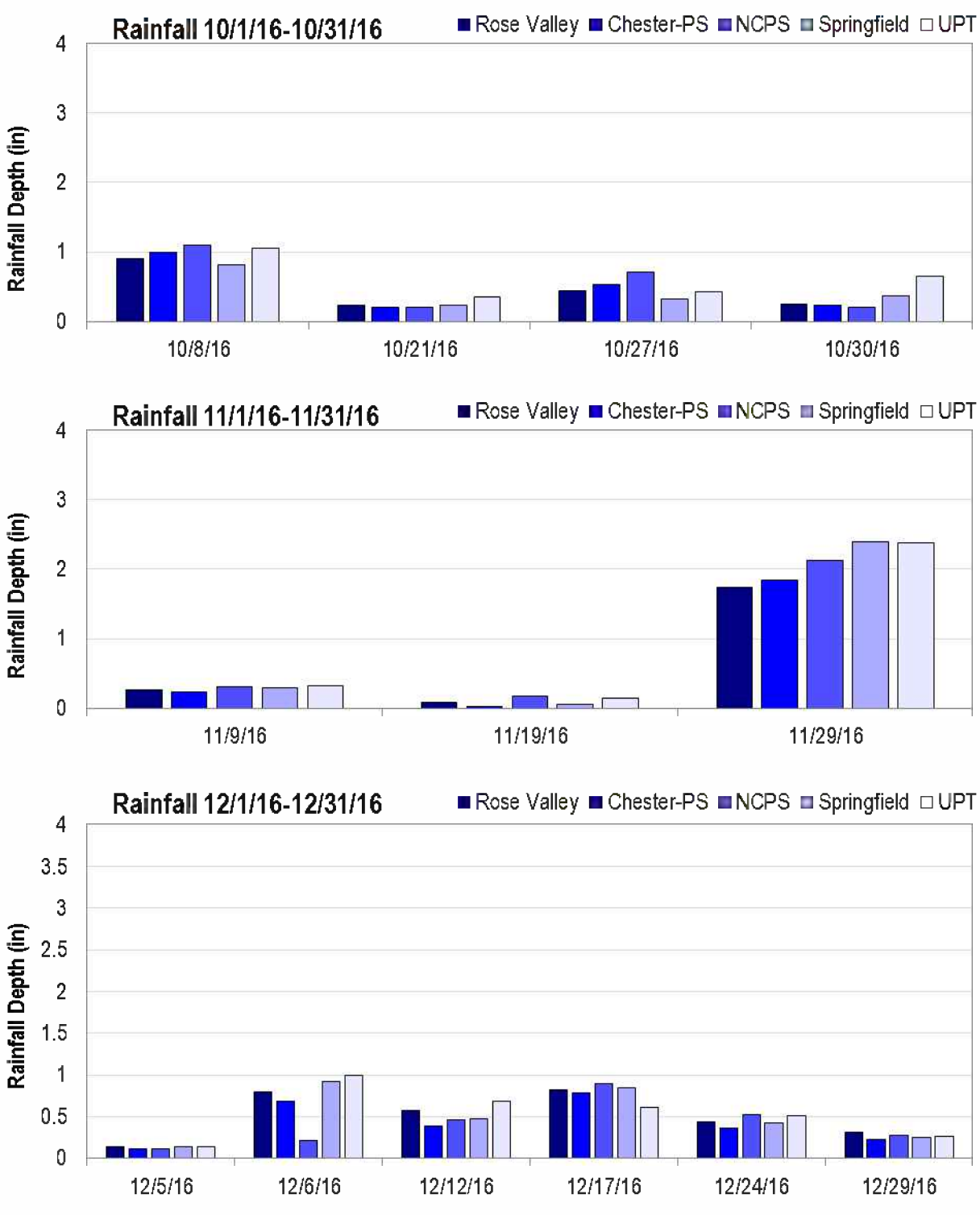
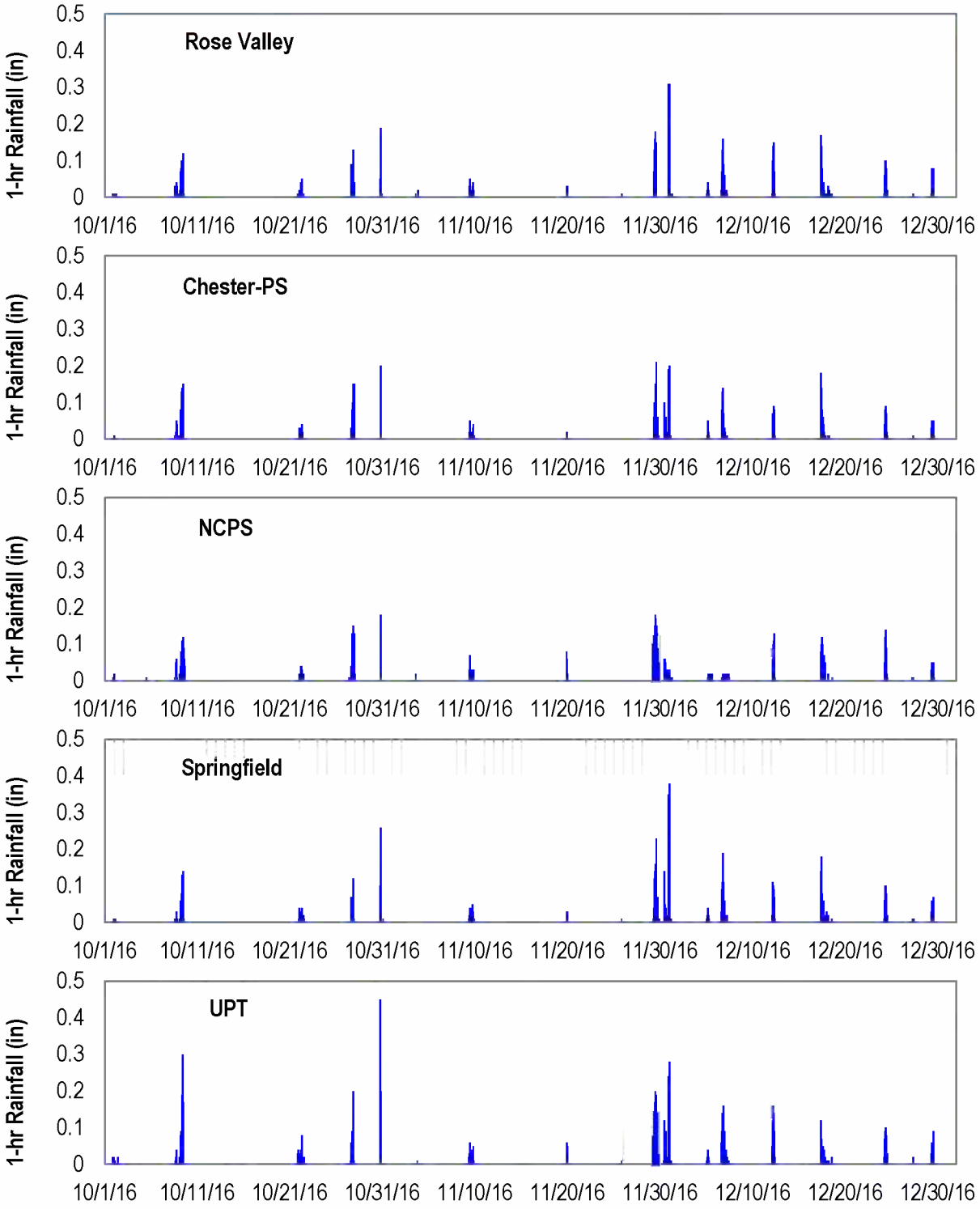


Figure 3: Hourly Rainfall Profile



2.3.1 Rainfall Return Frequency

Rainfall return frequency was analyzed for rain gauges RG_NCPS and RG_UPT because they usually record greater rainfall amounts than the others. The frequency analysis was also performed for RG_ChesterPS because it is located in the combined area.

Figure 4 shows Duration-Depth-Frequency (DDF) plot for RG_NCPS. Two storms were recorded with total precipitation volumes greater than 1 inch. Both events (10/8/17 and 11/29/17) are less than 1-year events.

Figure 4: Duration-Depth-Frequency (DDF) Plot, RG_NCPS

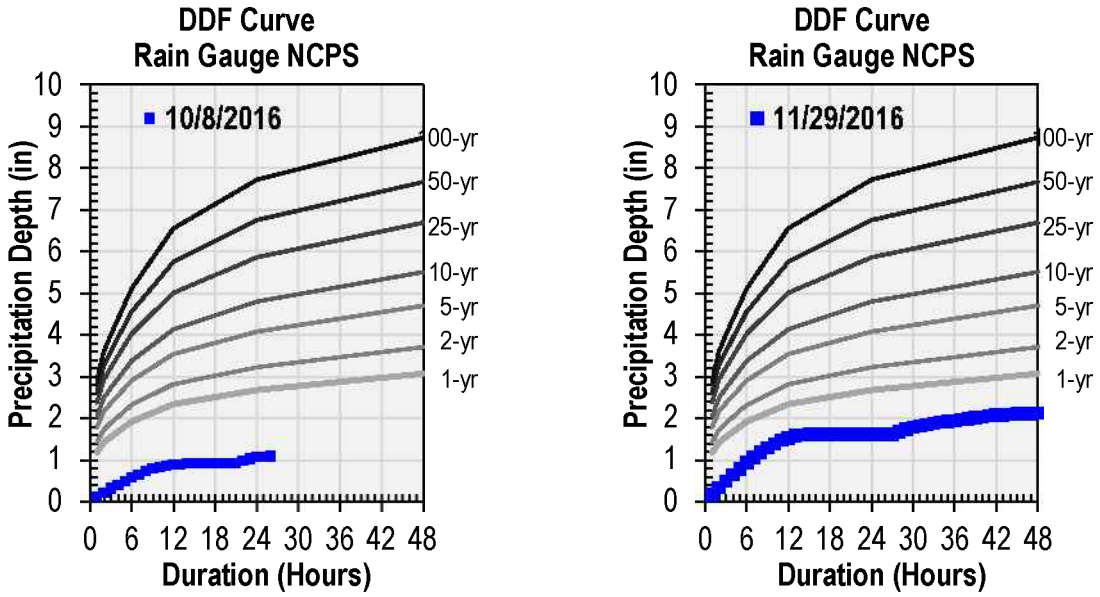


Figure 5 shows Duration-Depth-Frequency (DDF) plot for RG_UPT. Two storms were recorded with total precipitation volumes greater than 1 inch. Both events (10/8/17 and 11/29/17) are less than 1-year events.

Figure 5: Duration-Depth-Frequency (DDF) Plot, RG_UPT

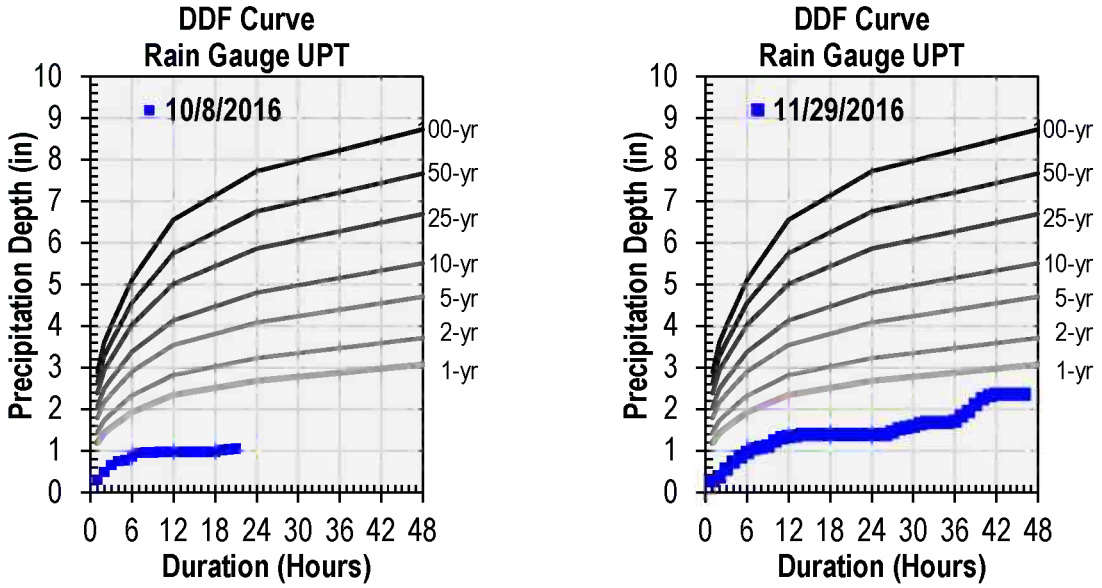
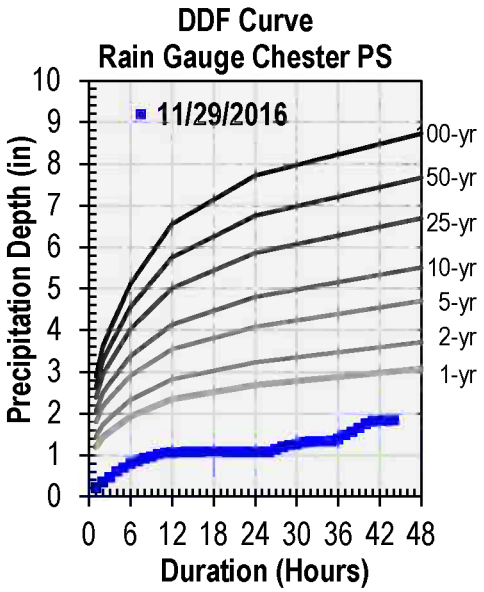


Figure 6 shows Duration-Depth-Frequency (DDF) plot for RG_ChesterPS. Only one storm (11/29/17) was recorded with a total precipitation volume greater than 1 inch. It is less than a 1-year event.

Figure 6: Duration-Depth-Frequency (DDF) Plot, RG_Chester PS



Section 3 Flow Meter Monitoring

3.1 Flow Monitoring Program

The site locations of the existing and newly installed flow meters are shown in **Figure 7**. **Figure 8** shows the newly installed flow meters on a larger scale, mostly in the combined area. These new meters were installed to investigate surface runoff from the combined area and CSO discharges, rainfall-derived inflow and infiltration (RDII) from the separated area, and system response to the wet weather conditions. The schematic of the newly installed flow meters is included in **Figure 9**.

The newly installed flow meter locations are categorized into the following four types:

- Category 1: Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
- Category 2: Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
- Category 3: Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.
- Category 4: Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
- Category 5: Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

One meter was proposed at manhole MH3029 to measure flow from the separated area upstream of the combined area (CSO#018). The site was severely surcharged during field investigation. Meanwhile it was found that at manhole MH3002 (four manholes upstream of MH3029, approximately 800 feet upstream) another CSL flow meter (Ridley Creek MH-28) was already installed for DELCORA. It was determined that instead of installing a new flow meter around the site, the team will use the existing meter Ridley Creek MH-28 for this flow monitoring program.

In total, 39 flow meters are included in this monitoring program. Details of the installed flow meters are included in **Table 3**.

3.2 Flow Meters Field Calibration/Verification Procedures

As part of the operation of flow meters, verifications of meter accuracy are performed on a regular basis. Calibrations are performed at a minimum every eight weeks, or more as needed.

The procedure used for performing meter calibrations is outlined below. This procedure only defines the required result. Any specific equipment function issues should be referred to the equipment manual or the manufacturer's technical support department.

Table 3: Details of the Newly Installed Flow Meters

Meter ID	GIS ID	Location	Pipe Size (in)	Material	Evidence of Surcharge	Category
CSO 02	3462	DS	36	Brick	Yes	2
CSO 03	2726	DS	38	Brick	Yes	2
CSO 05	2634	DS	48	Concrete	Yes	2
CSO 08	3463	DS	60	Concrete	Yes	2
CSO 14	3481	DS	45"x53"	Brick	Yes	2
CSO 19	690	DS	42"x43"	Concrete	Yes	2
Eff-02	3460	US	8	Clay	Yes	2
Eff-03	3454	DS	14.25	Concrete	Yes	2
Eff-05	2635	DS	12	Concrete	Yes	2
Eff-08	2246	DS	18.2	PVC	Yes	2
Eff-14	3482	DS	18	Concrete	Yes	2
Eff-19	***	DS	36	Concrete	Yes	2
In-03	2721	US	36	Brick	Yes	1
In-05	2634	US	28	Brick	Yes	1
In-08	3463	US	60	Concrete	Yes	1
In-09	1987	US	48	Cast Iron	Yes	1
In-10	1670	US	36	Brick	Yes	1
In-11	1770	US	49	Cast Iron	Yes	1
In-13	3479	US	48	Concrete	Yes	1
In-14	3481	DS	43"x47"	Brick	Yes	1
In-16	752	US	60	Concrete	No	1
In-17	691	US	36	Brick	Yes	1
In-18	3033	US	66"x43"	Concrete	Yes	1
In-19-1	625	DS	49"x47.5"	Clay	No	1
In-19-2	688	US	42"	Concrete	Yes	1
In-2	2751	DS	36	Corrugated PVC	No	1
In-25	3502	US	36	Concrete	Yes	1
In-26	1192	US	36	Brick	No	1
INT- 2nd St	1548	DS	40	Concrete	No	5
INT-DRI	2743	US	24	Clay	Yes	5
INT-Ridley 2	1487	US	44	Concrete	Yes	5
INT-Ridley 3	1509	US	48	Concrete	Yes	5
INT-WestEnd	2755	US	53	Concrete	No	5
Sep-1	2135	US	15	Clay	Yes	4
Sep-2	2134	DS	12	Clay	No	4
Sep-3	798	US	24	Clay	No	4
Sep-4 (Existing, Ridley Creek MH-28)			30	Concrete	No	4
Side-1	1571	US	36	Concrete	No	3
Side-2	2135	US	8	Clay	Yes	3

Figure 7: Existing and Newly Installed Flow Meter Locations

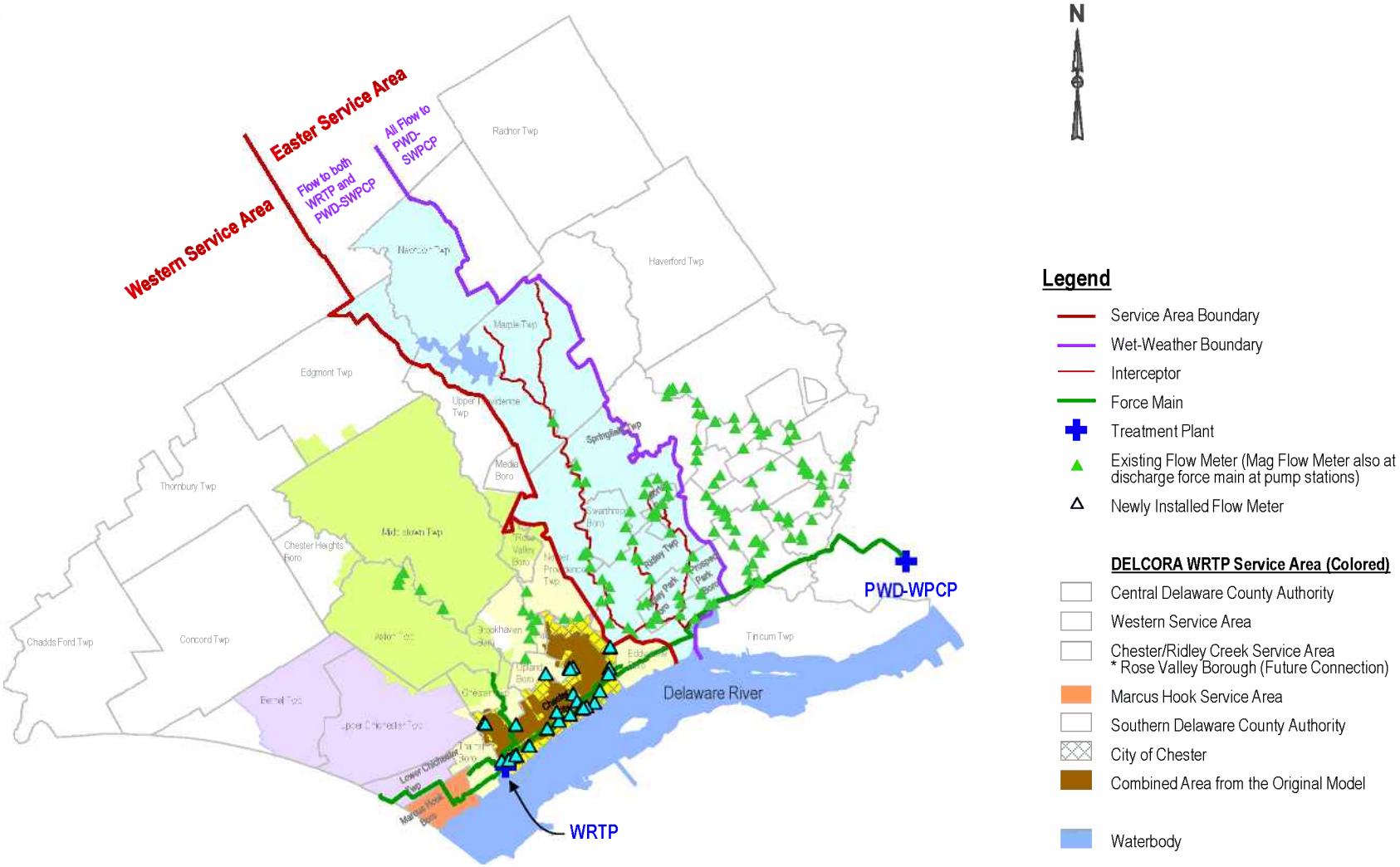


Figure 8: Newly Installed Flow Meter Locations

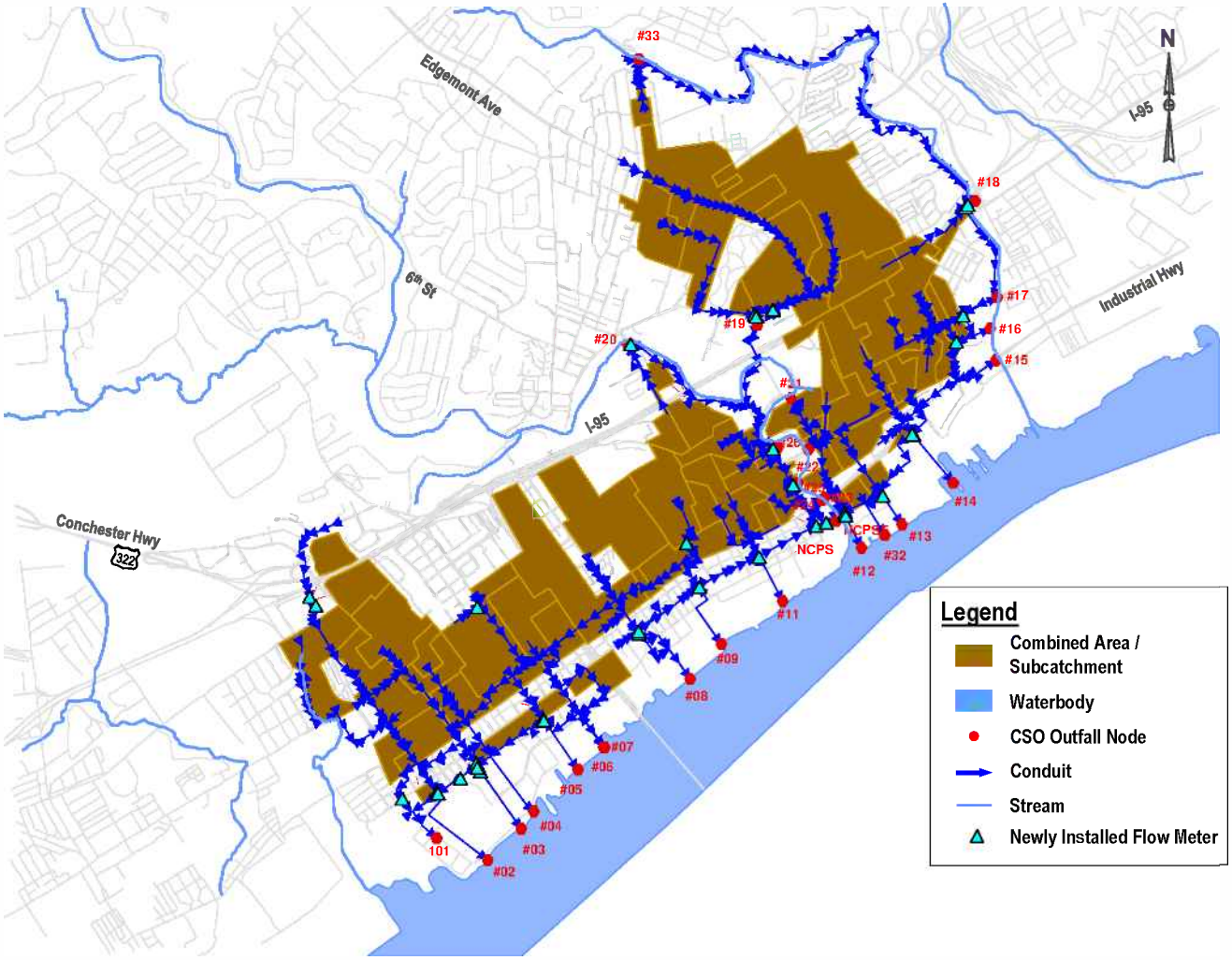
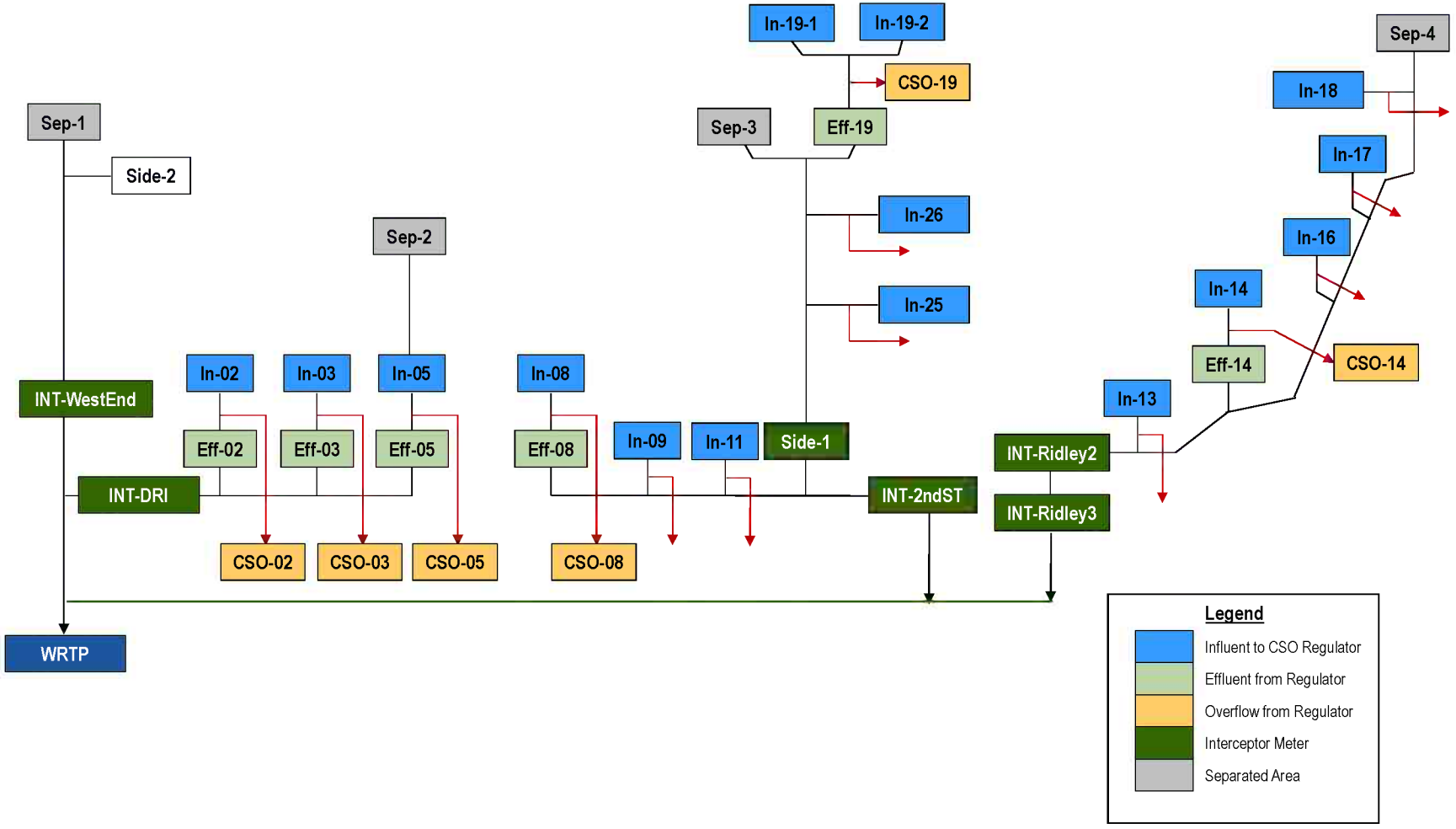


Figure 9: Flow Monitoring Schematic



Manually Downloaded Meters
This method is used for any meter that cannot be interrogated remotely by the data analyst. Field technicians use the *Daily Field Download Sheet* for recording the calibration results.

- Record the date.
- Record the field time, which is the local time.
- Record the meter time.
- Record the instantaneous depth reading from the meter.
- Measure the peak velocity.
- Record the instantaneous average or peak, whichever is applicable.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Remote Connection Meters
This method is used for any meter that can be interrogated remotely. The data analyst uses the *Daily Field Download Sheet* for single depth and velocity meters and the *Multi- Sensor Calibration Sheet* for meter types that record multiple depth and/or velocity readings.

- Fill all site visit information fields on form.
- Have the field tech measure the depth of flow and record with time.
- Record the time and instantaneous depth reading from the meter or the depth sensor, whichever is applicable. All available depth sensors should be activated and compared to the field measurement.
- Have the field tech measure the peak the velocity or have them perform a velocity profile if the depth is sufficient then record with time.
- Record the time and instantaneous velocity reading from the meter or the velocity sensor, whichever is applicable. All available velocity sensors should be activated and compared to the field measurement.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Special Cases

- Blind Verifications: A blind verification occurs when a field technician's only role is to measure the depth and velocity of the flow and report the values to the data analyst. In these cases, the crew is "blind" to what the meter is reading. The data analyst will then compare the readings to current/recent data or live readings. Should the blind verification be out of tolerance, the analyst can direct the crew to perform additional blind verifications or perform a conventional verification and/or troubleshoot as necessary.

- Installations/Removals: When installing or removing meters, the above calibration method should be used for three consecutive verifications, performed at 5 minute intervals.
- Third Party Audit: When performing a calibration at a meter that is not maintained by CSL and where CSL is to verify the meter function, the CSL Audit report should be used.

3.3 Flow Monitoring Data Summary

Flow, level and velocity data are received for each flow monitoring site at 5-minute intervals (Sep-4 has 15-min interval data). Metering data is analyzed for dry weather flows (DWF), hourly peak flows, and hourly peaking factors for each monitoring site. A "dry weather" condition was defined as a period with no precipitation that begins three days after the last wet weather event and lasts until the beginning of the next precipitation event.

Table 4 shows dry weather flow (DWF), hourly peak flow, hourly peaking factor and flow condition observations.

The dry weather flows are also shown in the schematic in **Figure 10**. Generally the downstream dry weather flow is greater than the upstream locations for all of the meters. For meters immediately upstream and downstream of CSO regulators, the upstream and downstream dry weather flows should be similar. **Figure 11** shows the influent and effluent from CSO#08 as an example to indicate that the dry weather of the two are similar.

The hourly peaking factor in the combined area is in the range of 7 to 99 and average at 27. The hourly peaking factor for the interceptor is between 2.8 and 5.2 with an average of 3.9. The hourly peaking factor is between 2.7 and 3.6 for the separated area, with an average of 3.1.

A detailed hydrograph and scattergraph for each flow monitoring site is shown in **Figure 12** to **Figure 50**, each includes:

- The flow hydrographs show hourly flow and rainfall profile. Hourly Rainfall data is included for the convenience of reviewing flow response to the wet weather conditions. Hourly flow and rainfall were calculated from the 5-min interval.
- The scattergraphs (based on 5-min data, excepting 15-min data for Sep-4) are essentially a plotting of flow rate versus depth. This plotting helps to understand the flow patterns and conditions on the individual monitored sewer pipes.
- For CSOs 02, 03, 05, 08, 14, & 19, flows including influent, effluent and overflows were plotted in the same plot.

Table 4: Flow Monitoring Summary

Meter ID	Hourly Peak (MGD)DWF	DWF (MGD)	Hourly Peaking Factor	Comments
In-02	6.25	0.29	21.7	Free flow most of the time
Eff-02	1.19	0.26	4.5	Surcharged under common conditions
CSO-02	5.01	0.04		Free flow most of the time
In-03	9.46	0.28	33.6	Free flow most of the time
Eff-03	1.52	0.24	6.2	Surcharged under large storms
CSO-03	8.85	0.03		Free flow most of the time
In-05	22.65	0.86	26.4	Backwater observed
Eff-05	2.30	0.75	3.1	Severely surcharged under common conditions
CSO-05	18.83	0.10		Free flow most of the time, backwater observed
In-08	21.99	0.80	27.5	Free flow most of the time
Eff-08	5.21	0.69	7.5	Free flow most of the time
CSO-08	22.36	0.11		Free flow most of the time
In-09	7.09	0.13	53.8	Free flow most of the time
In-10	4.55	0.18	25.6	Free flow most of the time
In-11	9.04	0.22	41.2	Free flow most of the time
In-13	28.52	0.34	82.8	Free flow most of the time, backwater during large storms
In-14	14.44	0.43	34.0	Backwater observed
Eff-14	4.22	0.38	11.0	Free flow mostly, backwater and surcharge during large storms
CSO-14	11.33	0.03		Free flow most of the time
In-16	12.95	0.33	38.7	Free flow most of the time, backwater during large storms
In-17	6.90	0.17	41.2	Backwater observed
In-18	10.05	0.16	61.7	Free flow most of the time
In-19-1	6.24	0.69	9.1	Free flow most of the time
In-19-2	11.62	0.57	20.2	Free flow most of the time
Eff-19	4.02	1.27	3.2	Free flow most of the time
CSO-19	10.72	0.07		Free flow most of the time
In-25	12.55	0.15	84.7	Free flow mostly, backwater observed
In-26	5.80	0.36	16.1	Free flow mostly
INT-2nd St	18.15	3.59	5.1	Free flow mostly, surcharge and backwater during large storms
INT-DRI	4.08	1.46	2.8	Severe surcharge and backwater observed
INT-Ridley 2	14.26	3.11	4.6	Free flow mostly, surcharge and backwater observed
INT-Ridley 3	13.94	3.35	4.2	Free flow mostly, surcharge and backwater observed
INT-WEI	11.34	1.34	8.5	Free flow mostly
Sep-1	0.65	0.12	5.5	Free flow mostly
Sep-2	0.54	0.11	4.8	Free flow mostly
Sep-3	1.26	0.43	2.9	Free flow mostly
Sep-4	4.29	1.35	3.2	Free flow mostly
Side-1	8.44	2.35	3.6	Free flow mostly, surcharge and backwater observed
Side-2	0.68	0.21	3.2	Free flow mostly

Figure 10: Dry Weather Flow Balance Schematic

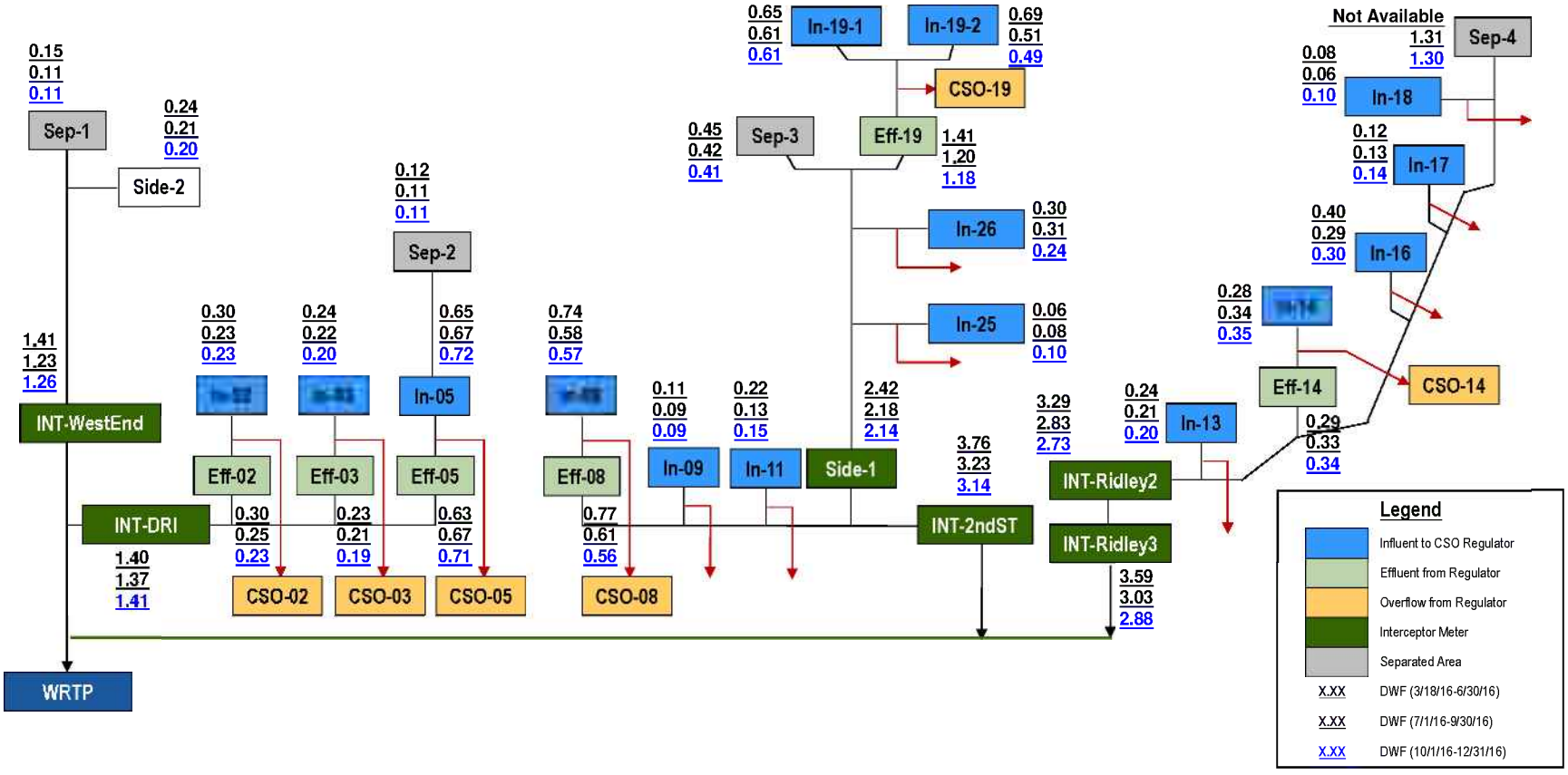


Figure 11: Flow Hydrograph In-08 and Eff-08

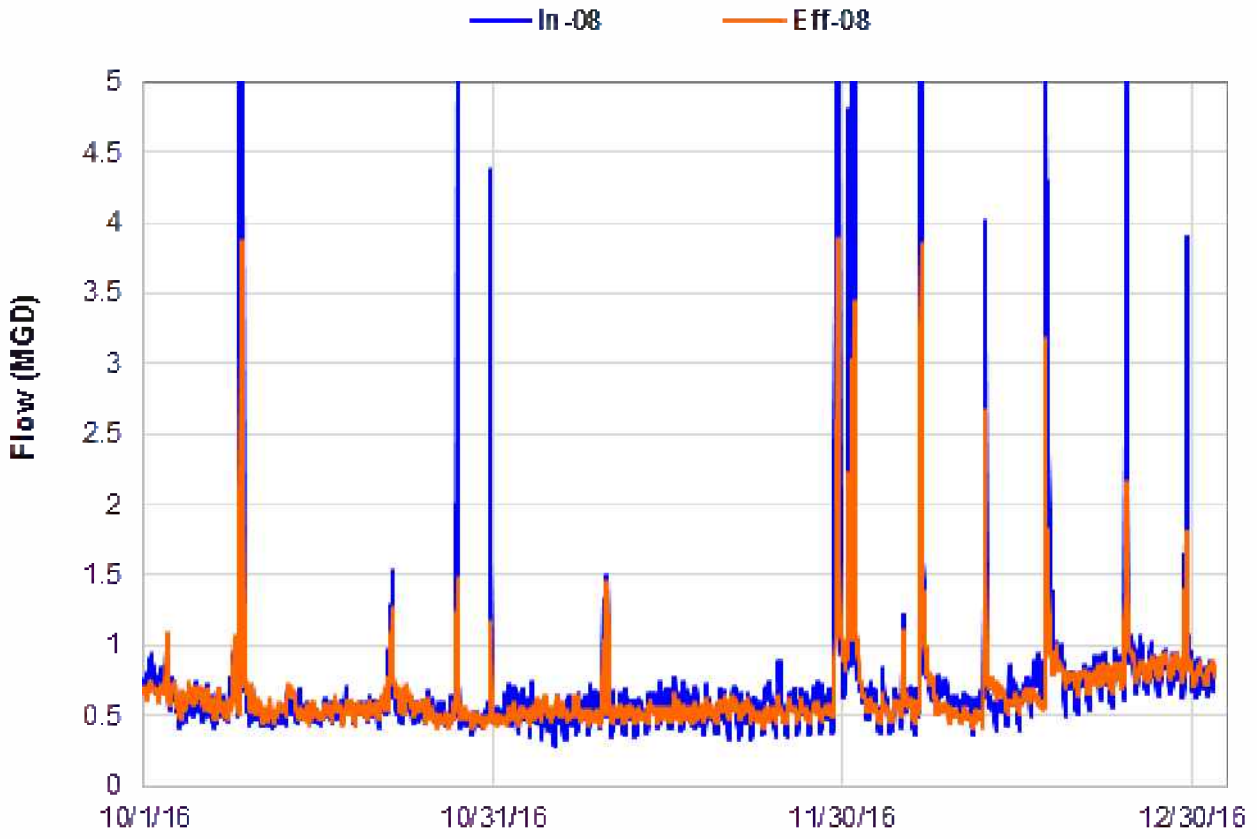
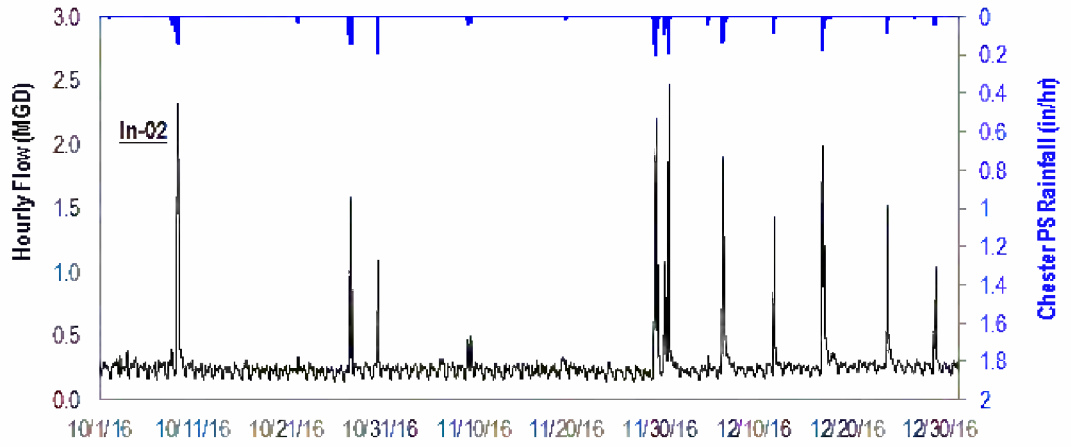
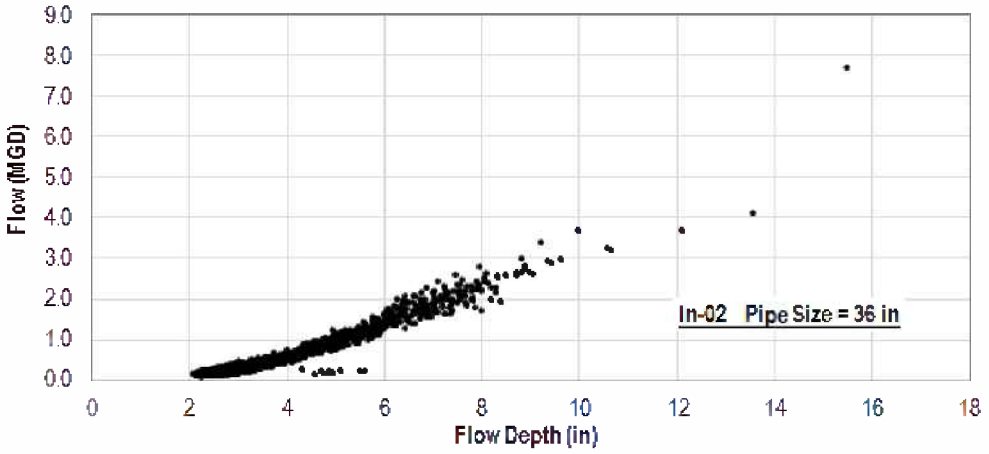


Figure 12: Flow Monitoring Data, In-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#02 Influent , Effluent and Overflow

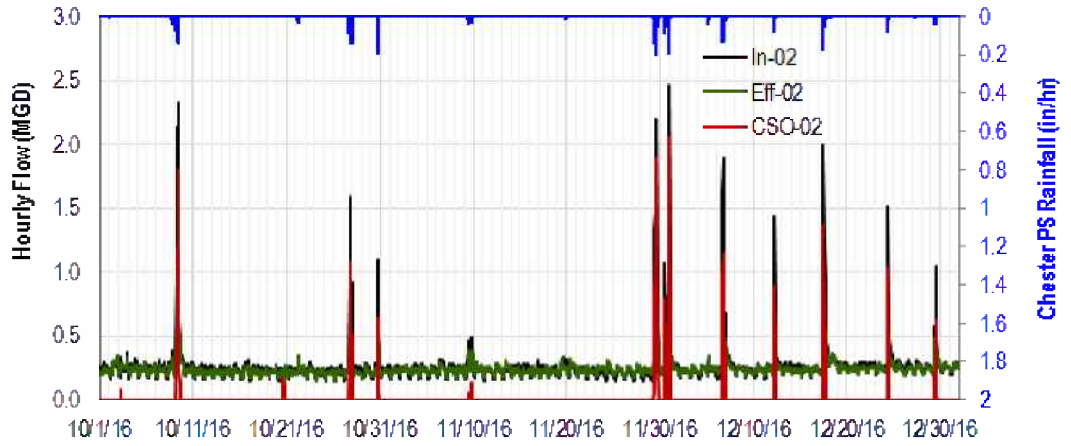


Figure 13: Flow Monitoring Data, EFF-02

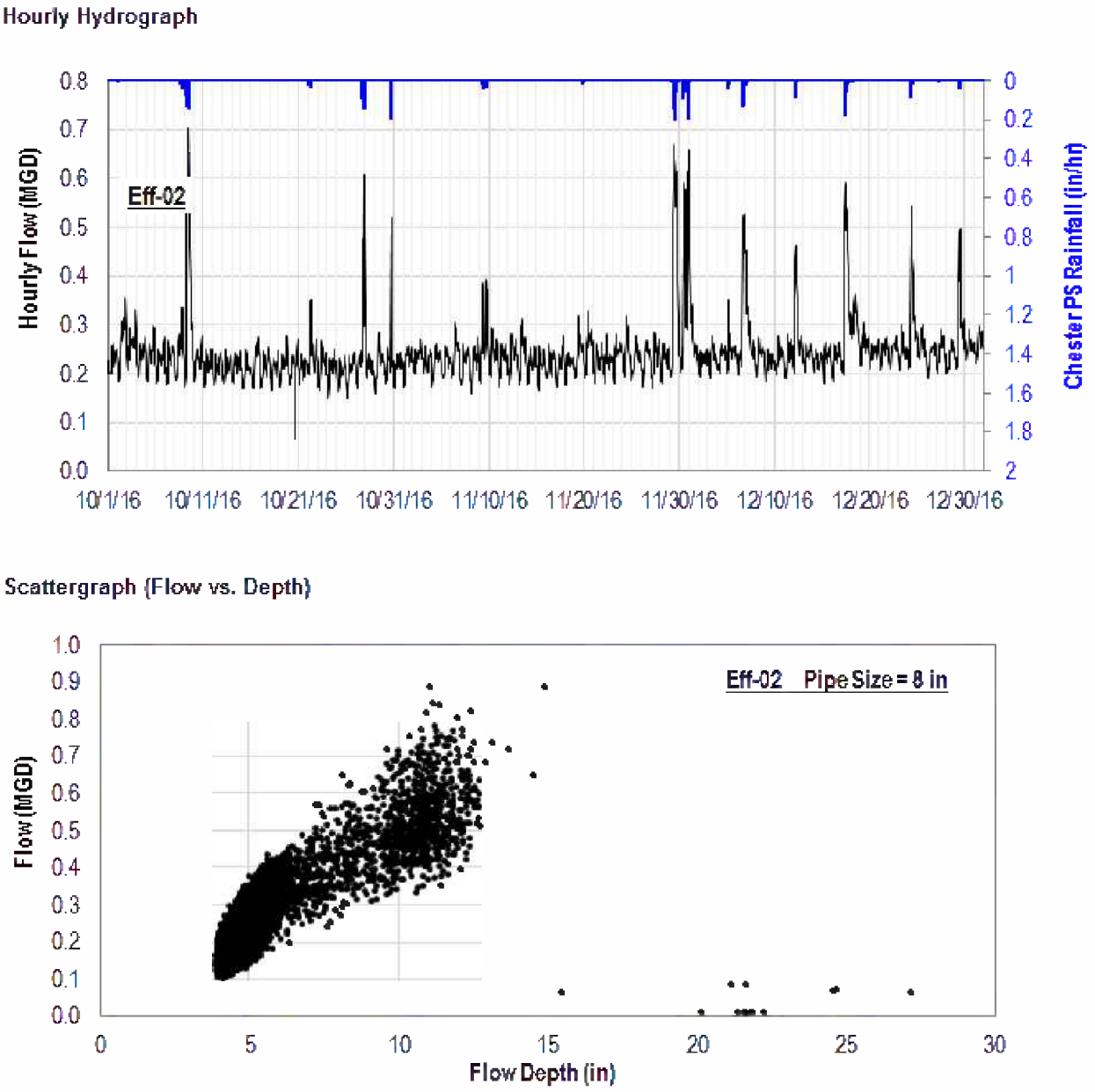
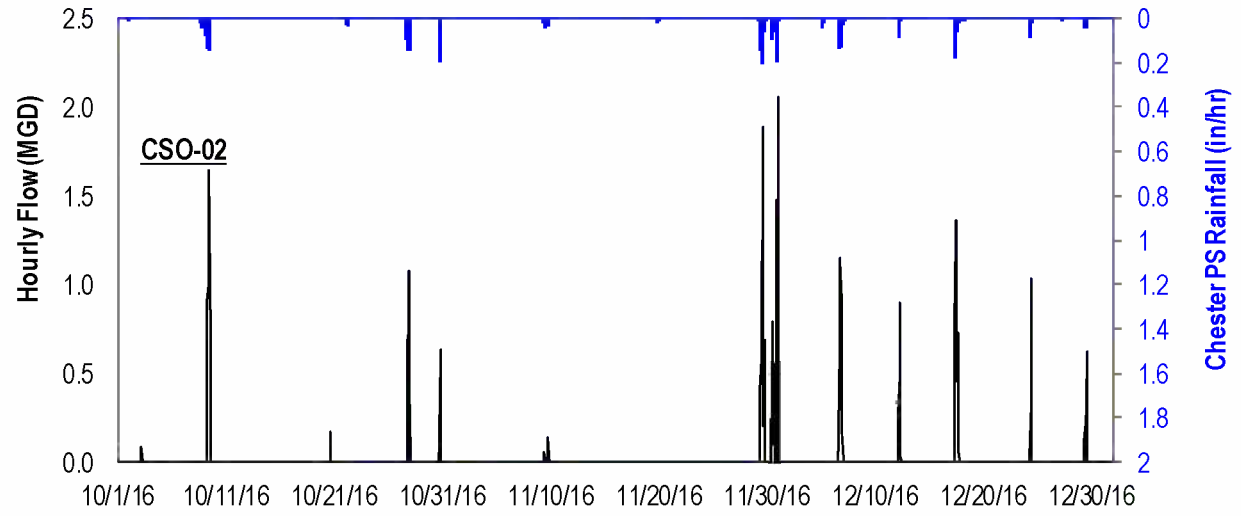


Figure 14: Flow Monitoring Data, CSO-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

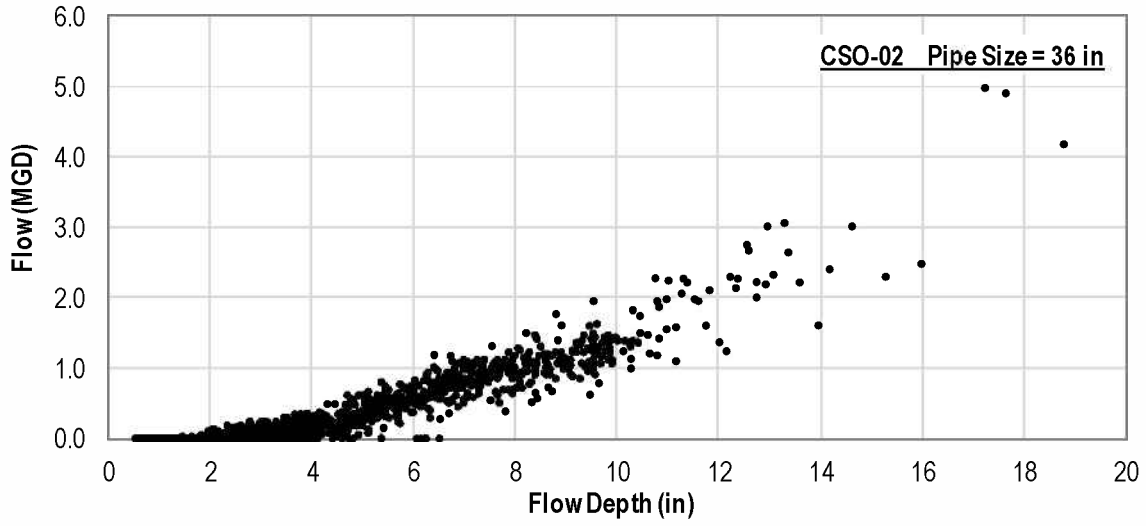
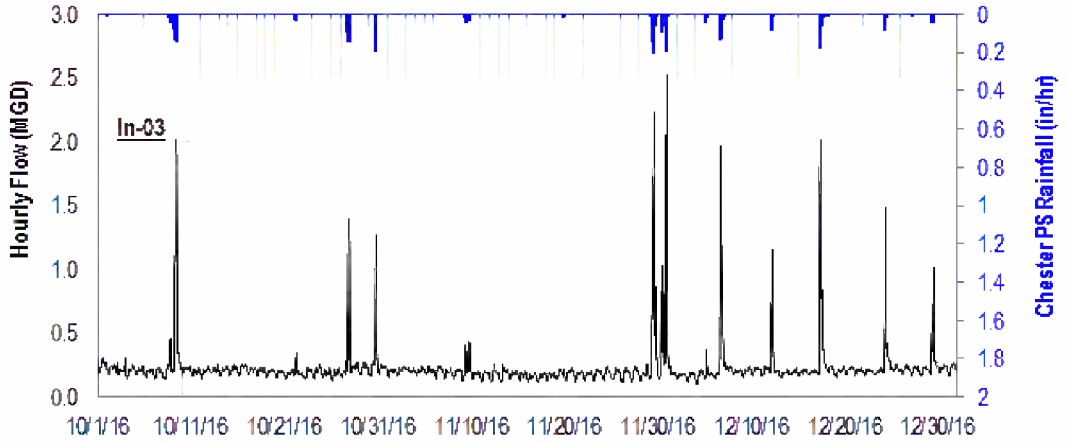
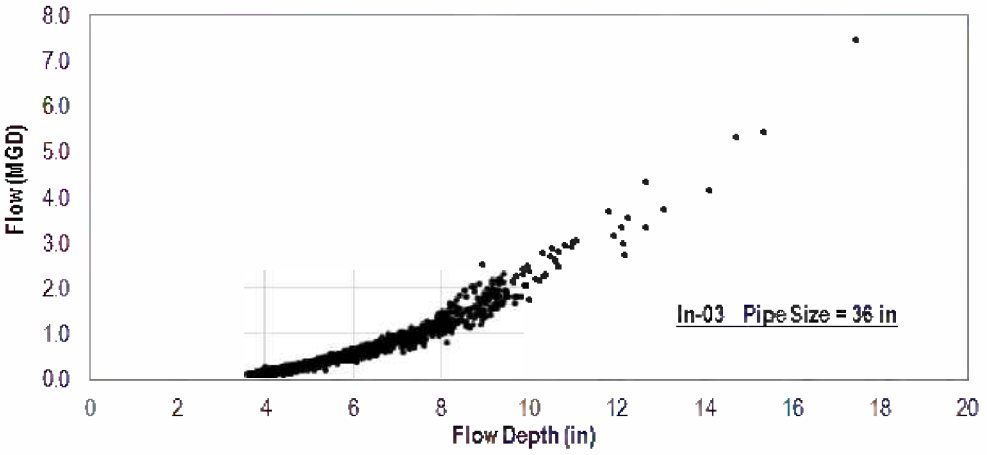


Figure 15: Flow Monitoring Data, IN-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

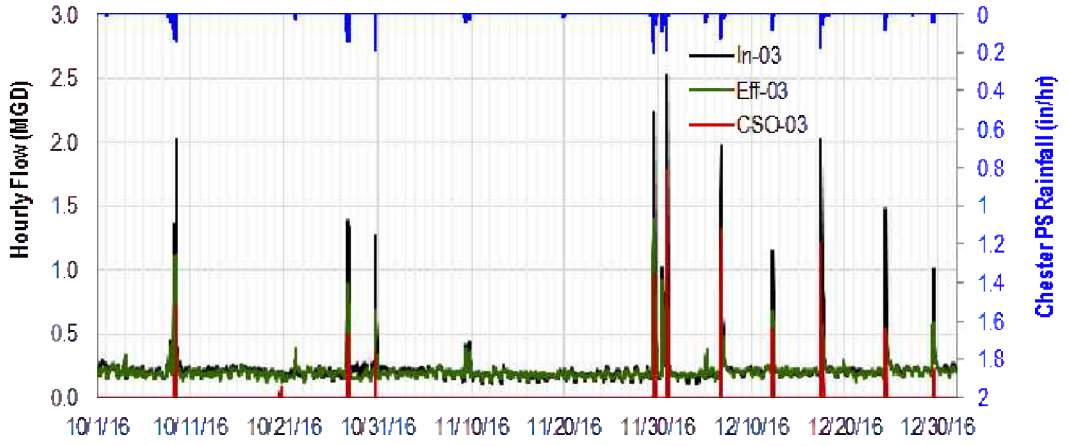


Figure 16: Flow Monitoring Data, Eff-03

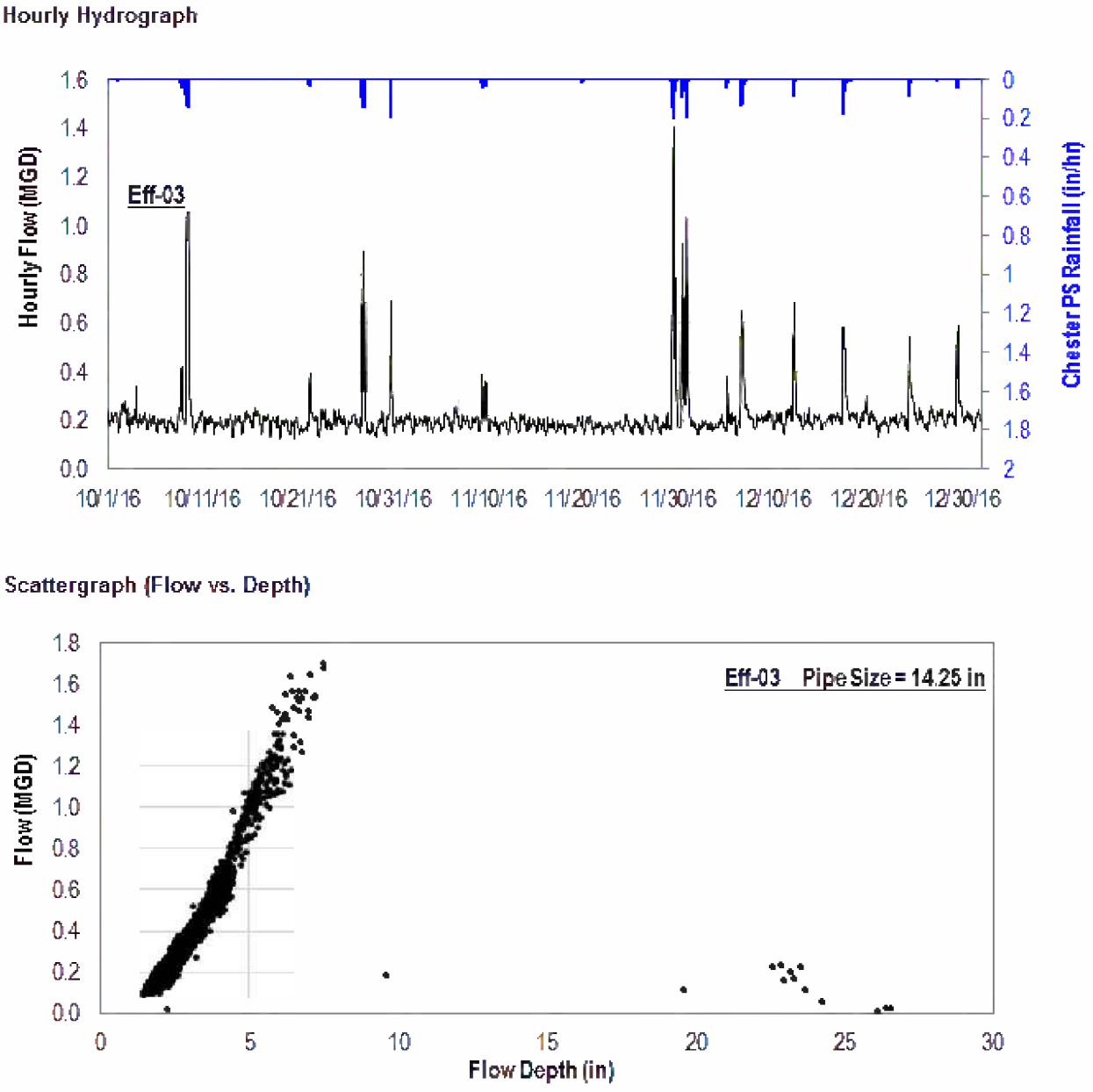


Figure 17: Flow Monitoring Data, CSO-03

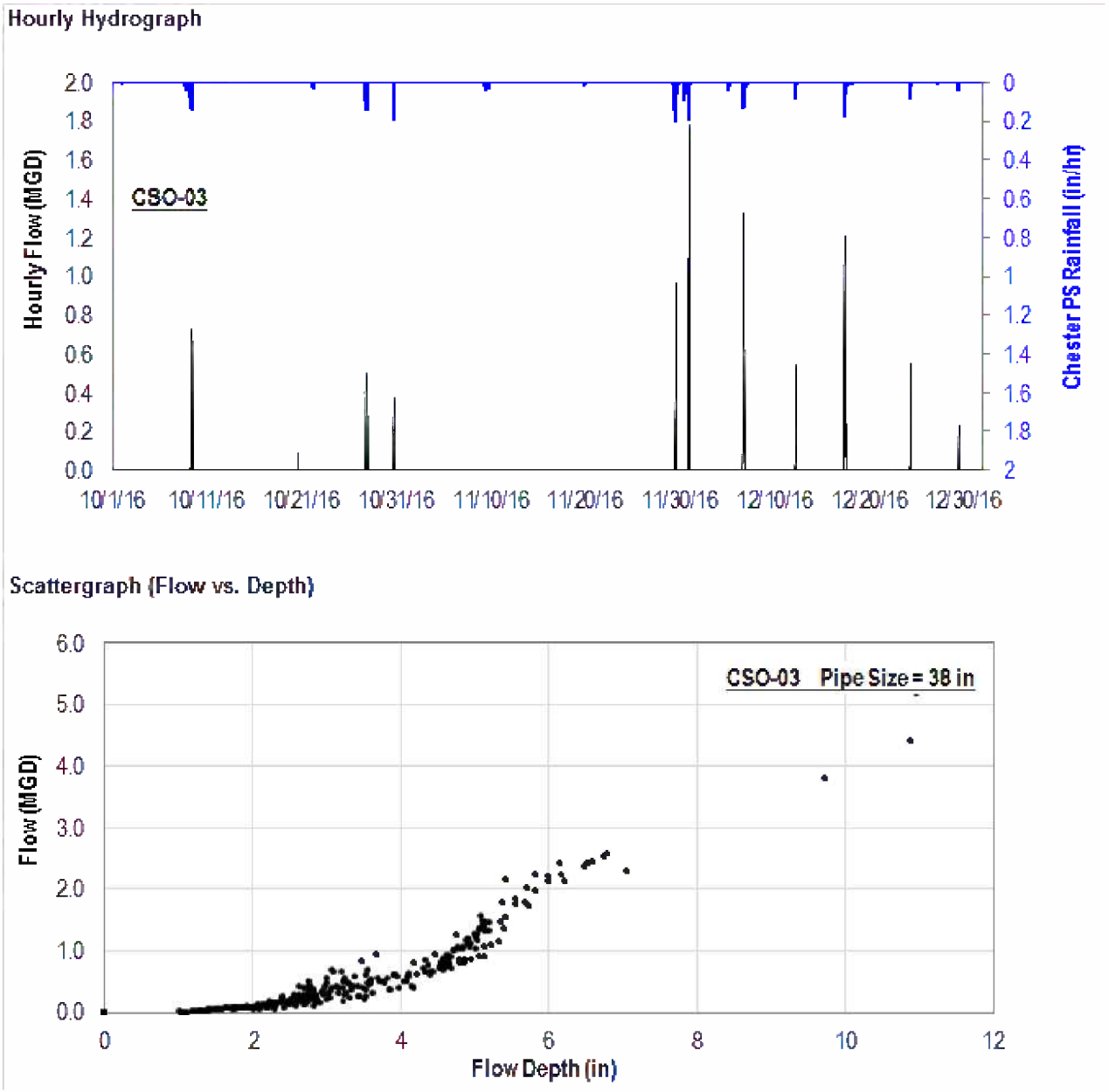


Figure 18: Flow Monitoring Data, IN-05

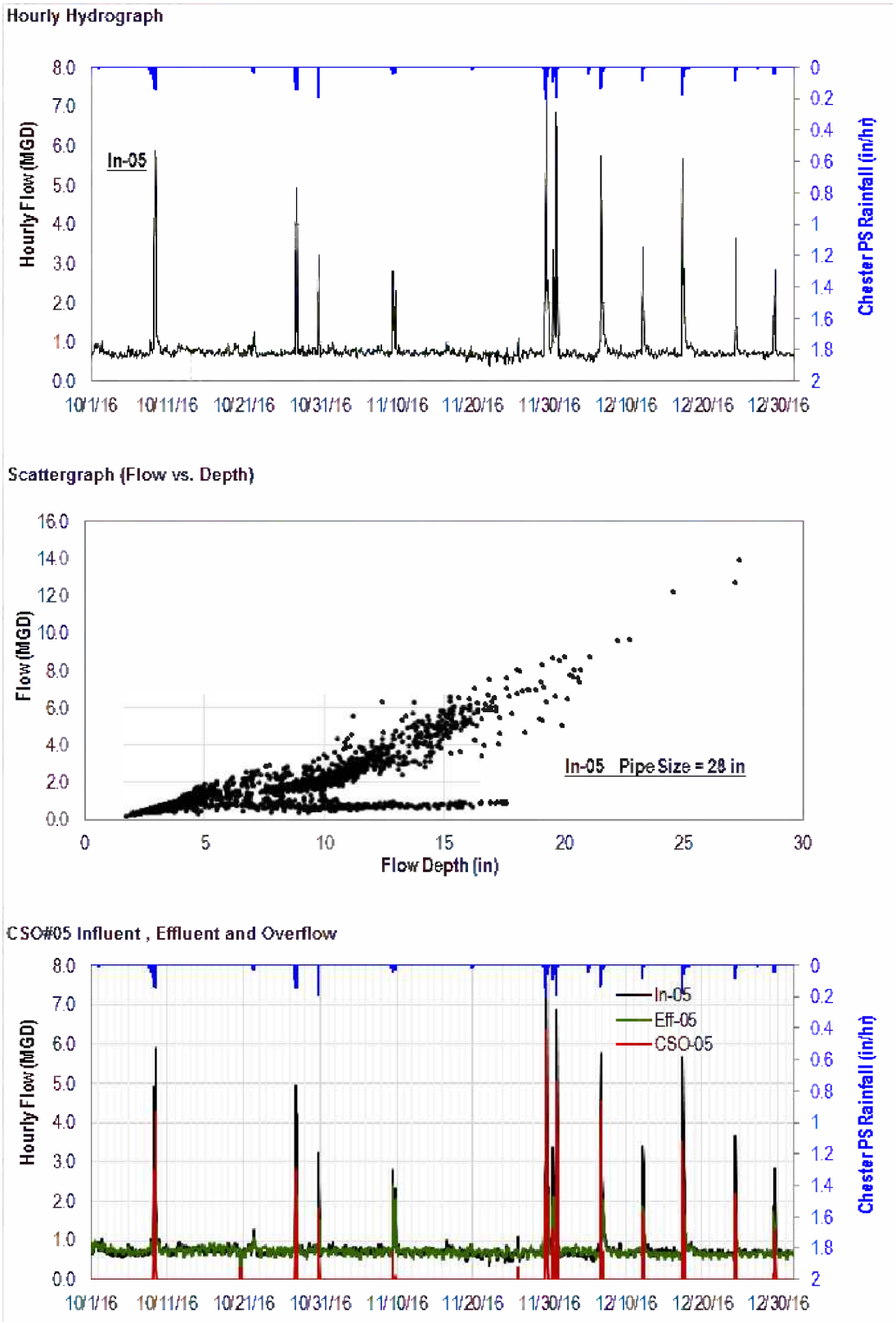


Figure 19: Flow Monitoring Data, Eff-05

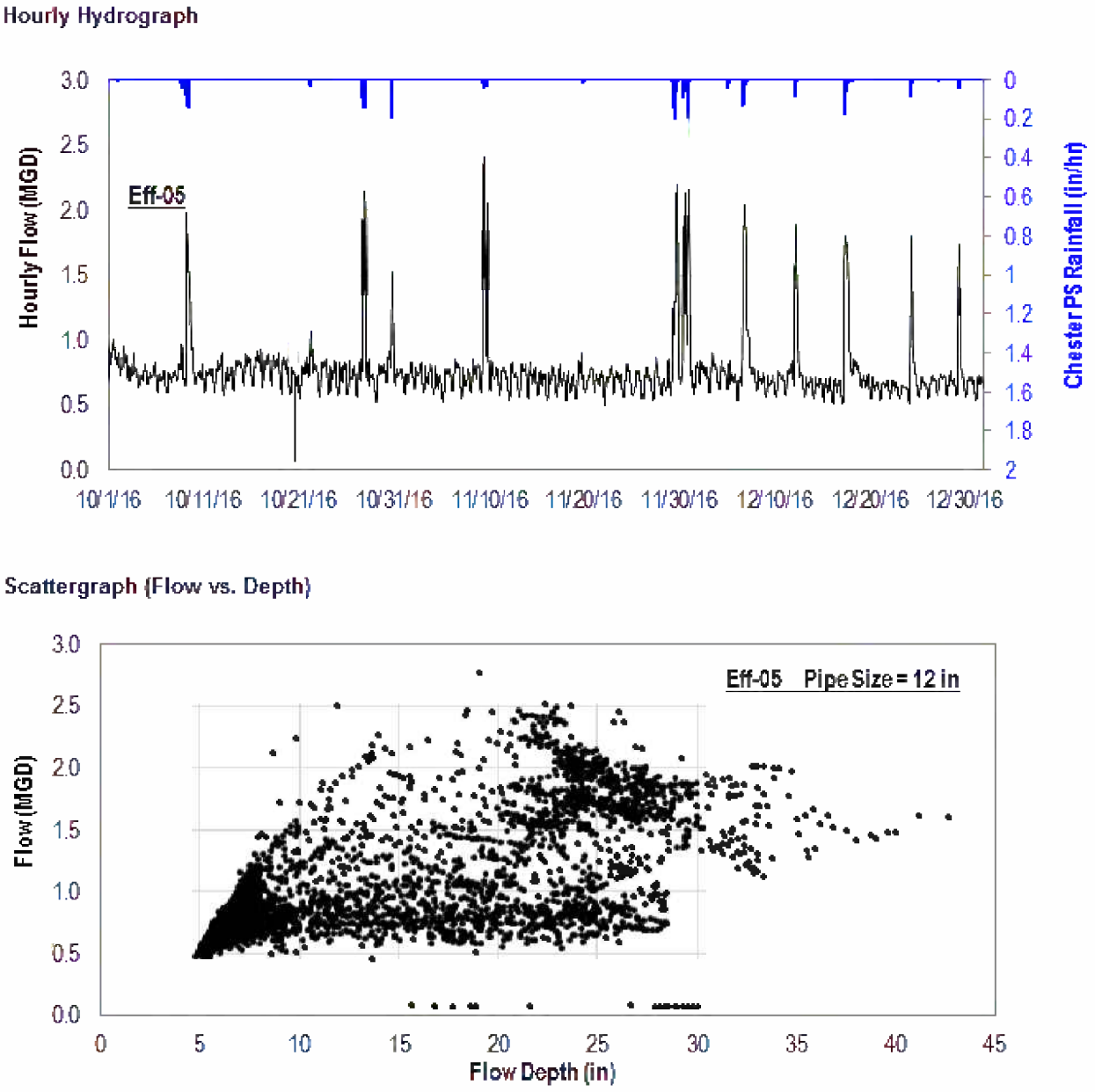


Figure 20: Flow Monitoring Data, CSO-05

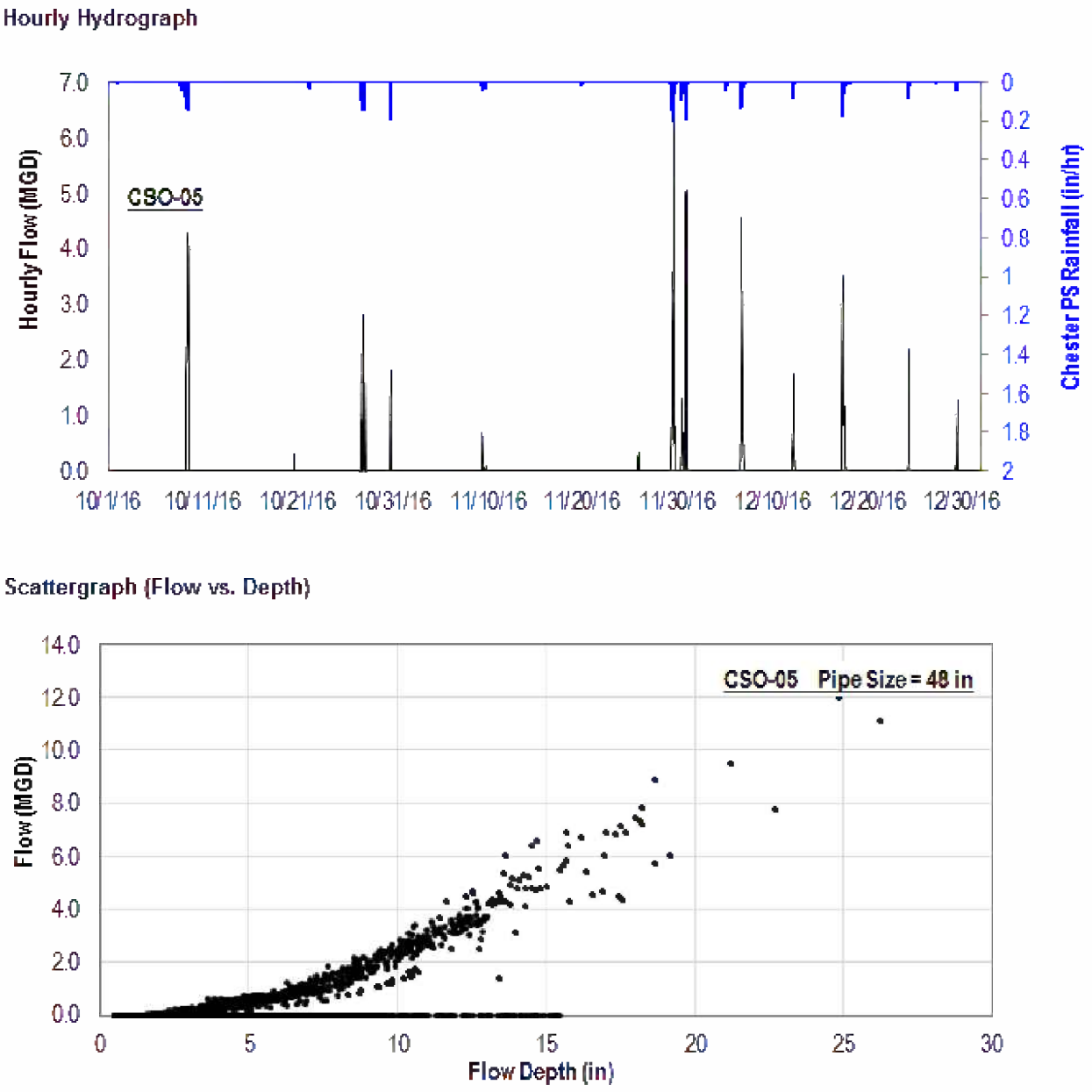


Figure 21: Flow Monitoring Data, IN-08

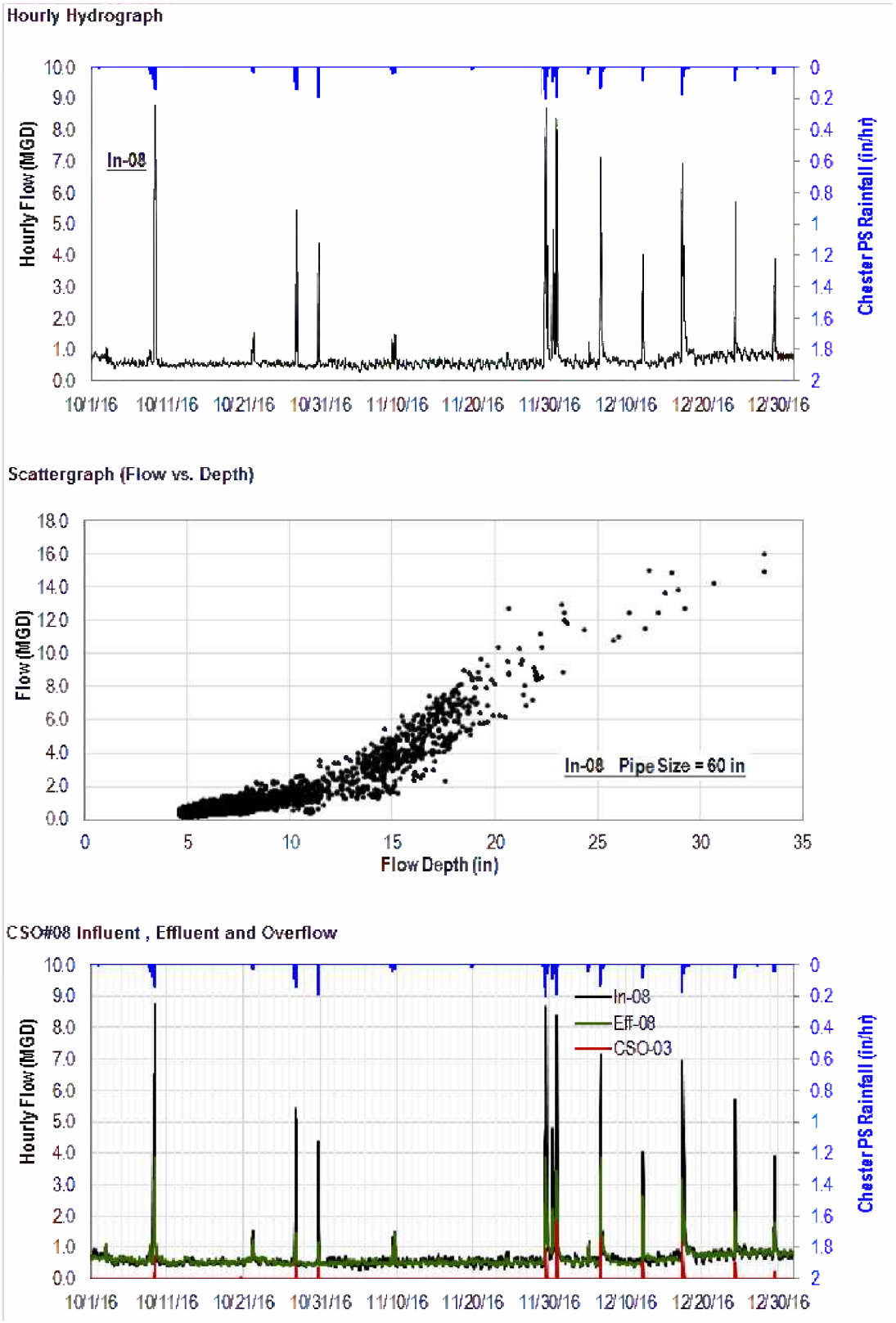


Figure 22: Flow Monitoring Data, Eff-08

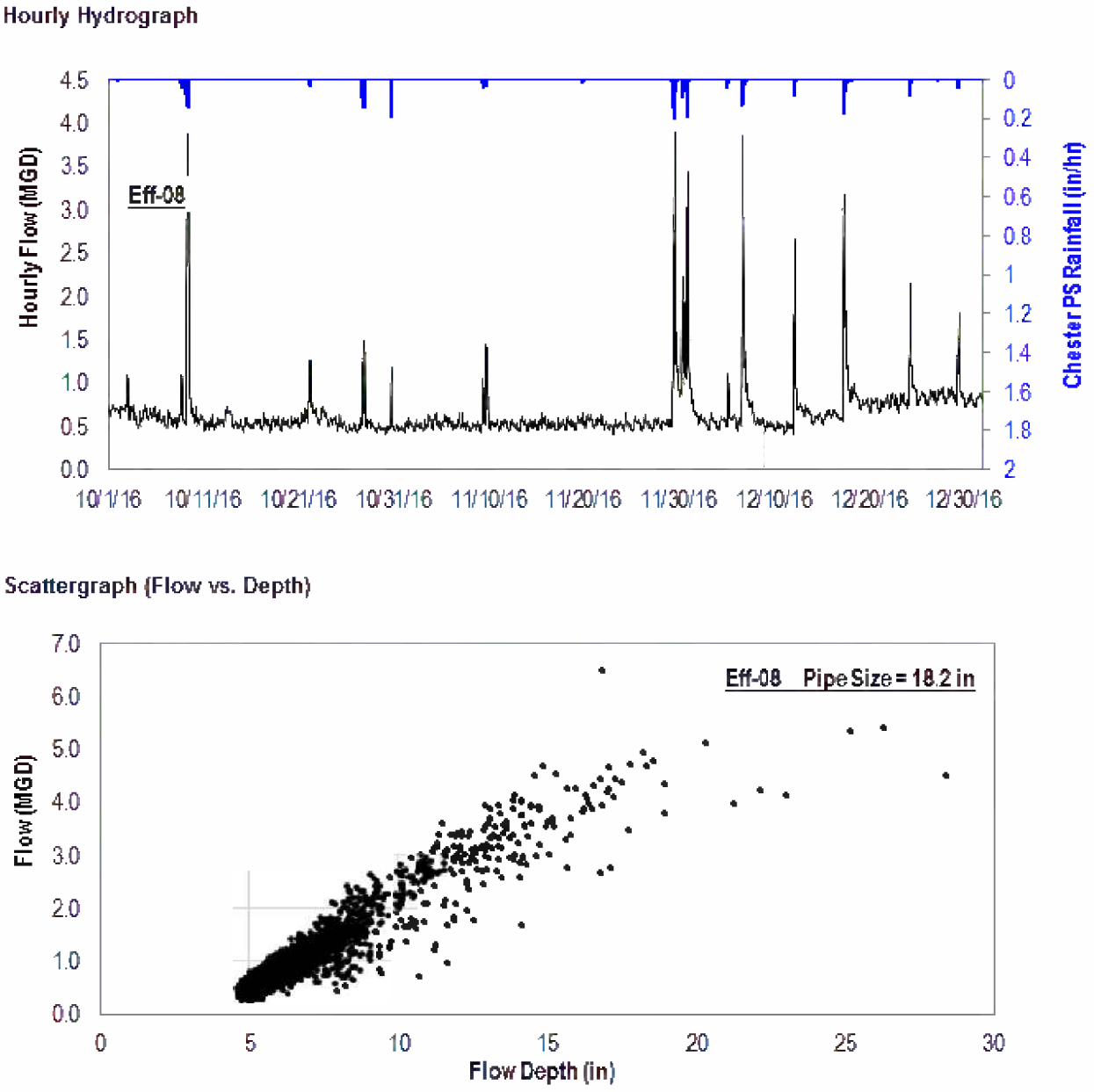
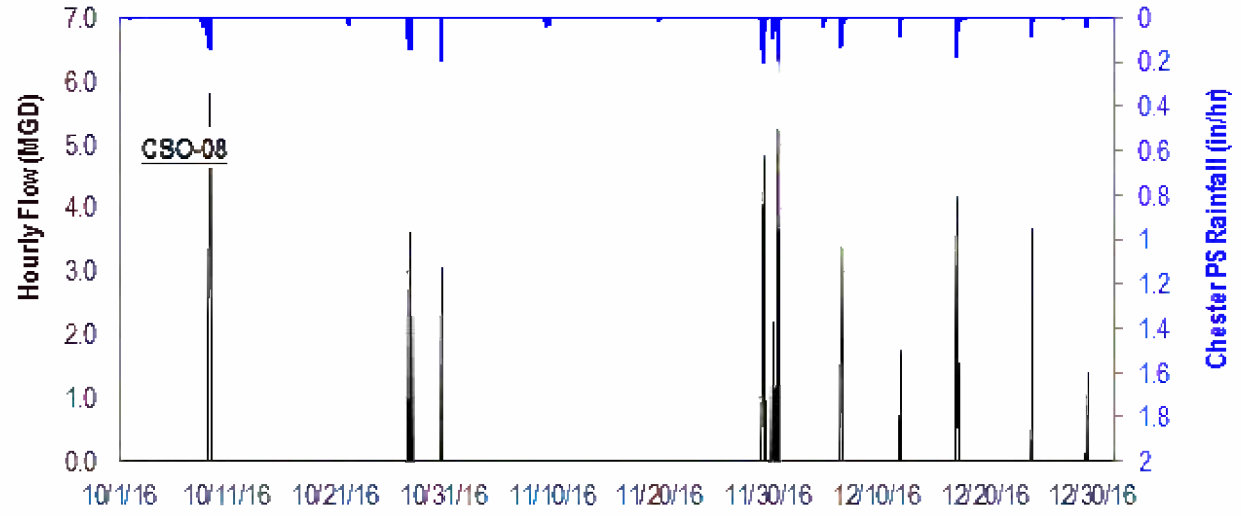


Figure 23: Flow Monitoring Data, CSO-08

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

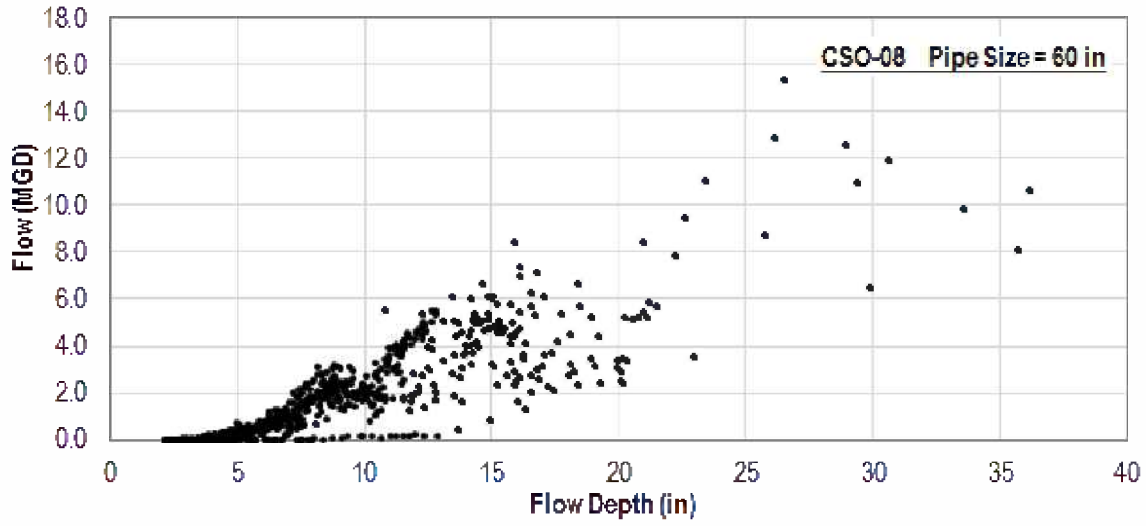


Figure 24: Flow Monitoring Data, In-09

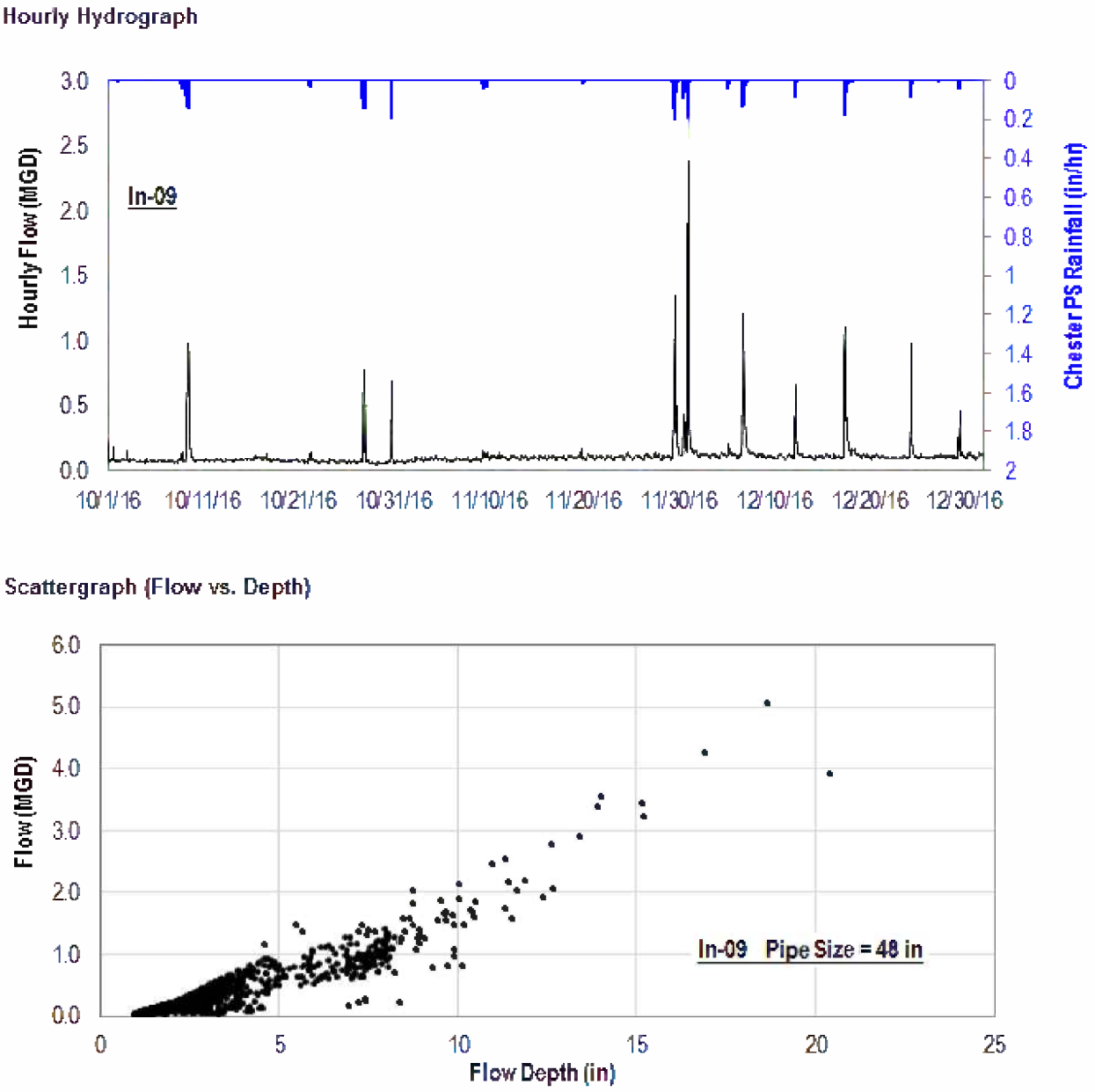


Figure 25: Flow Monitoring Data, In-10

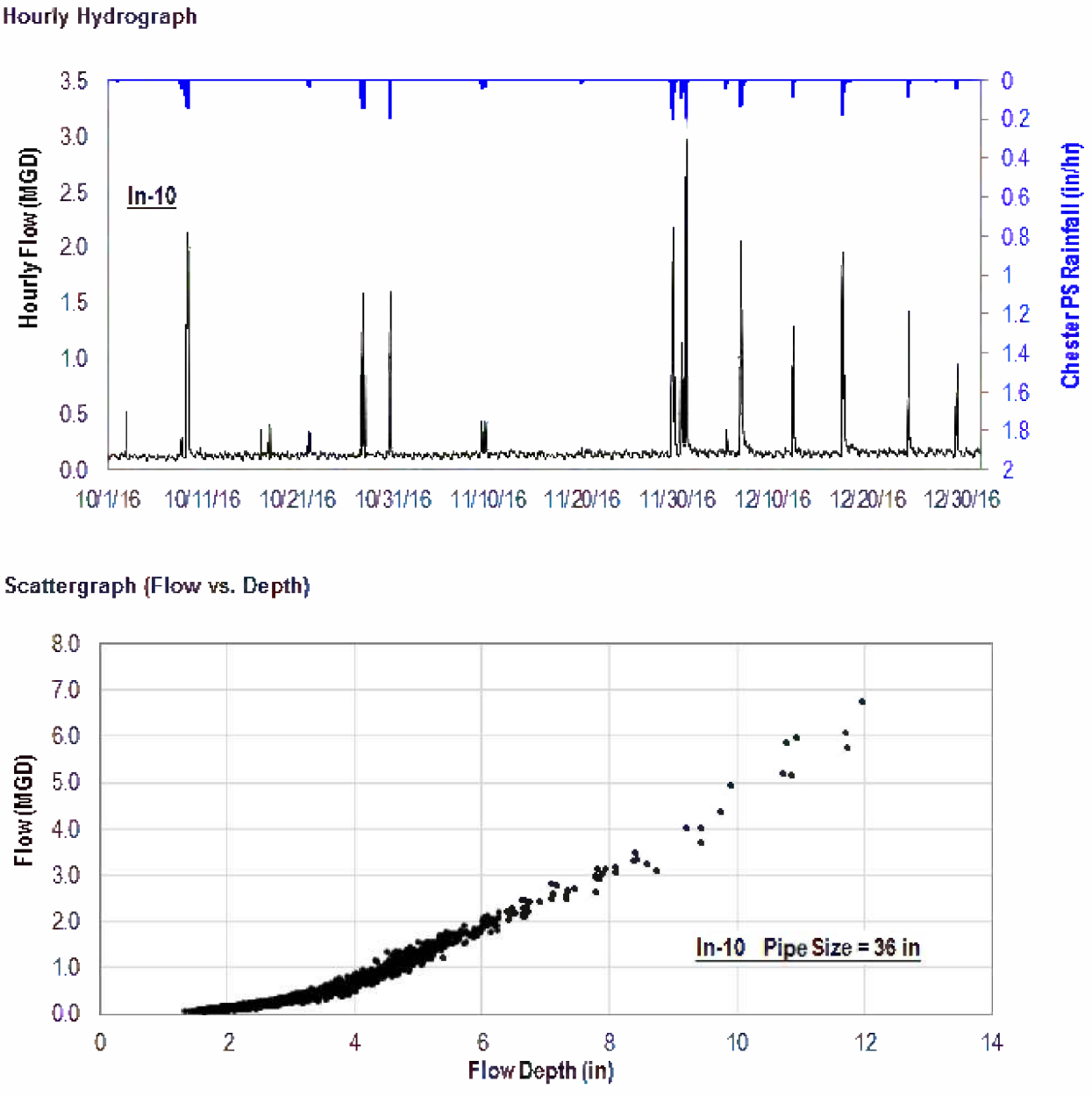


Figure 26: Flow Monitoring Data, In-11

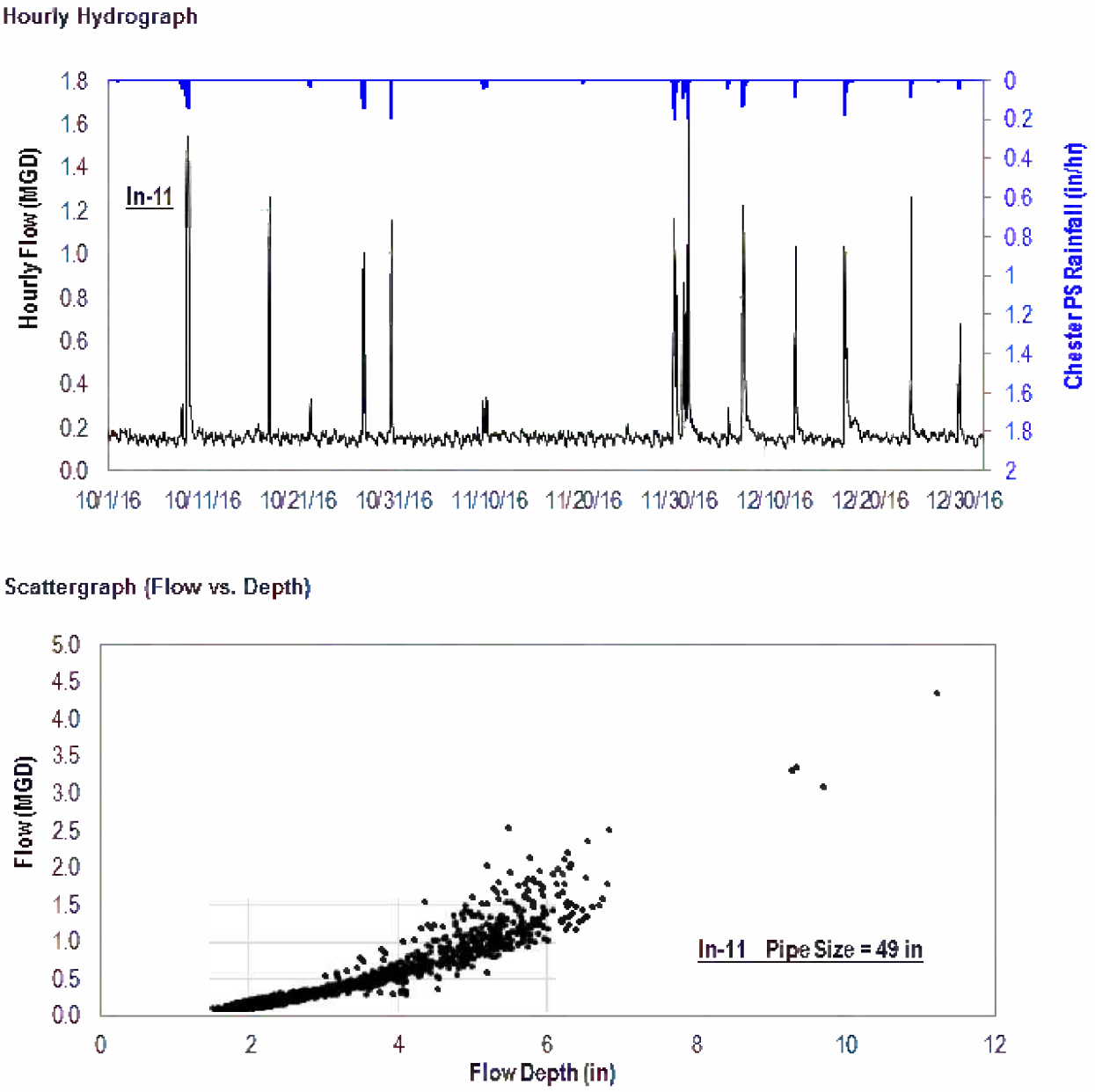


Figure 27: Flow Monitoring Data, In-13

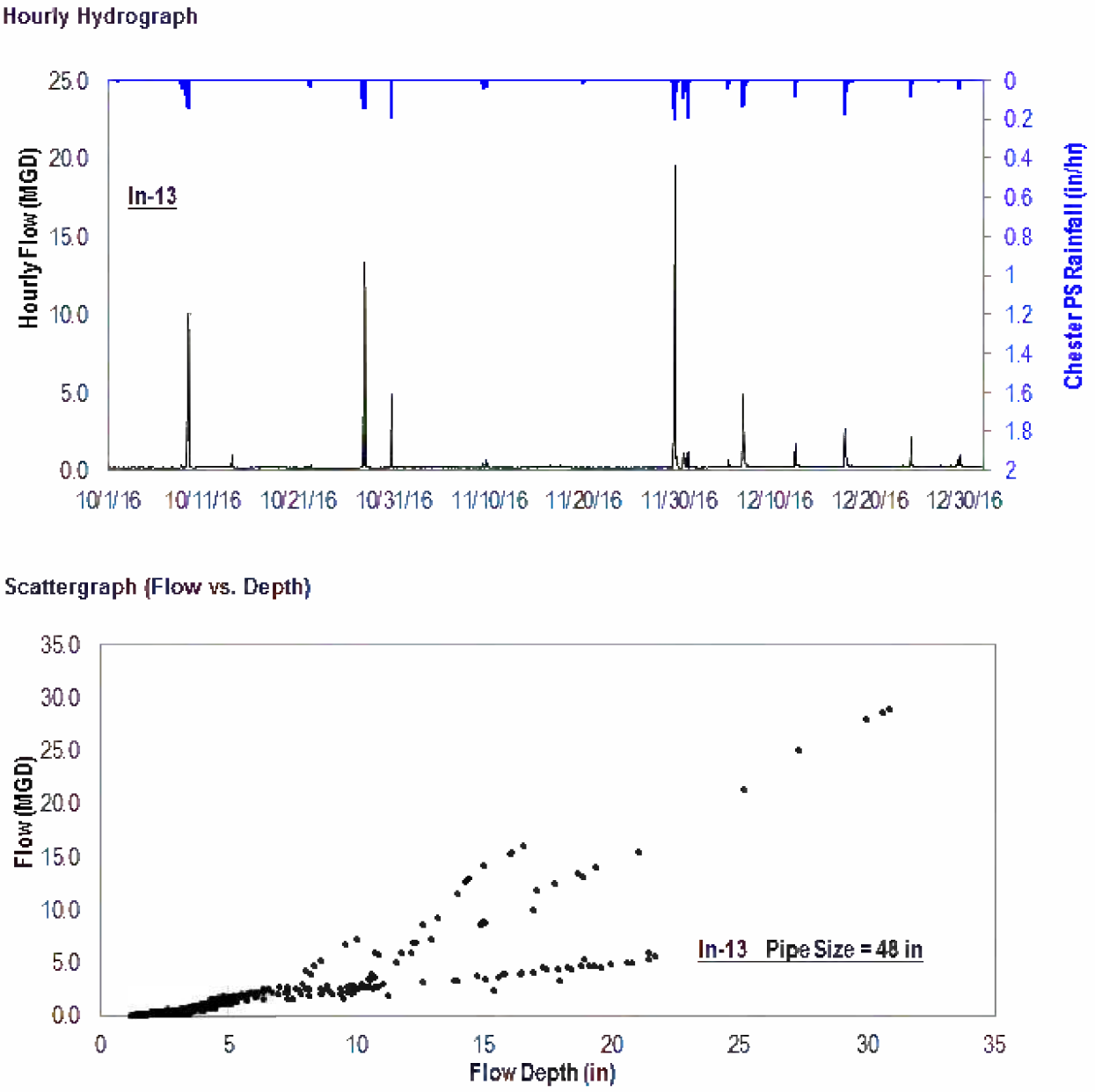
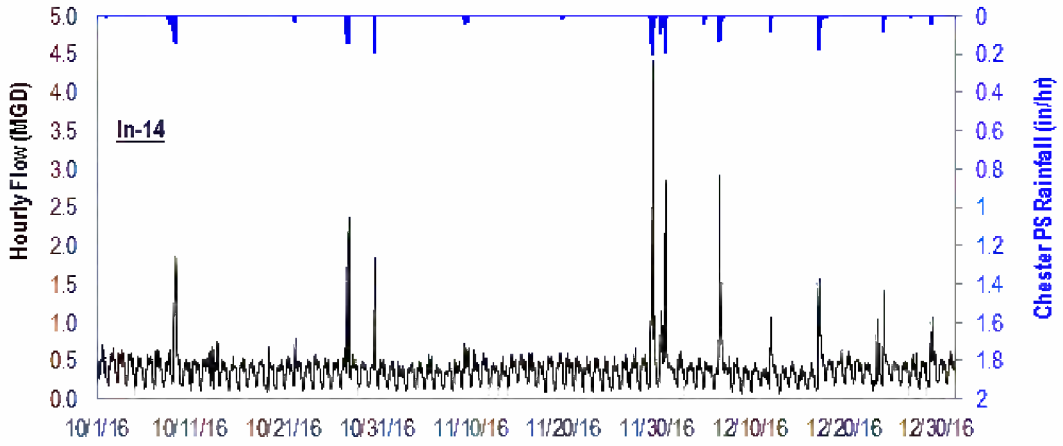
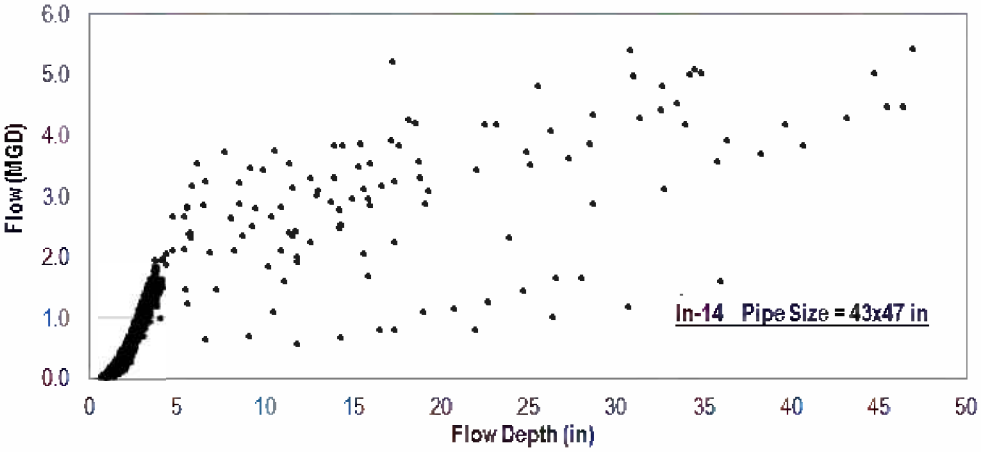


Figure 28: Flow Monitoring Data, In-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#14 Influent , Effluent and Overflow

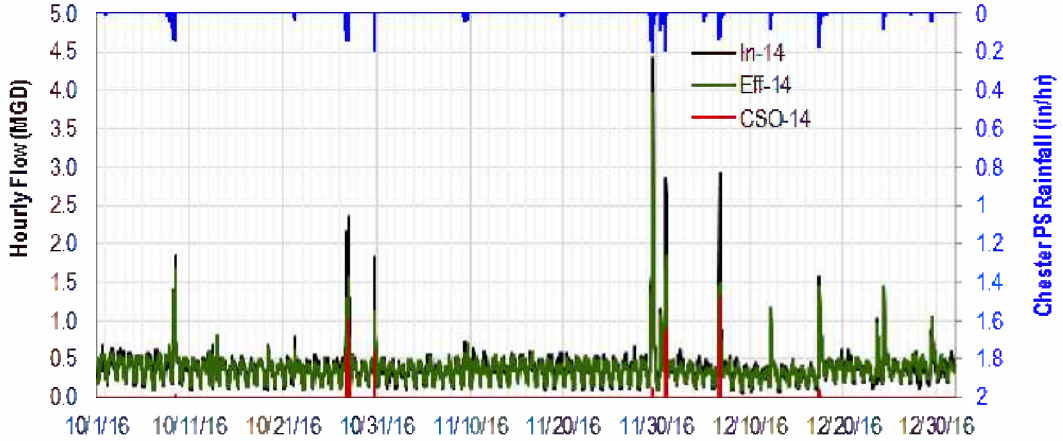


Figure 29: Flow Monitoring Data, Eff-14

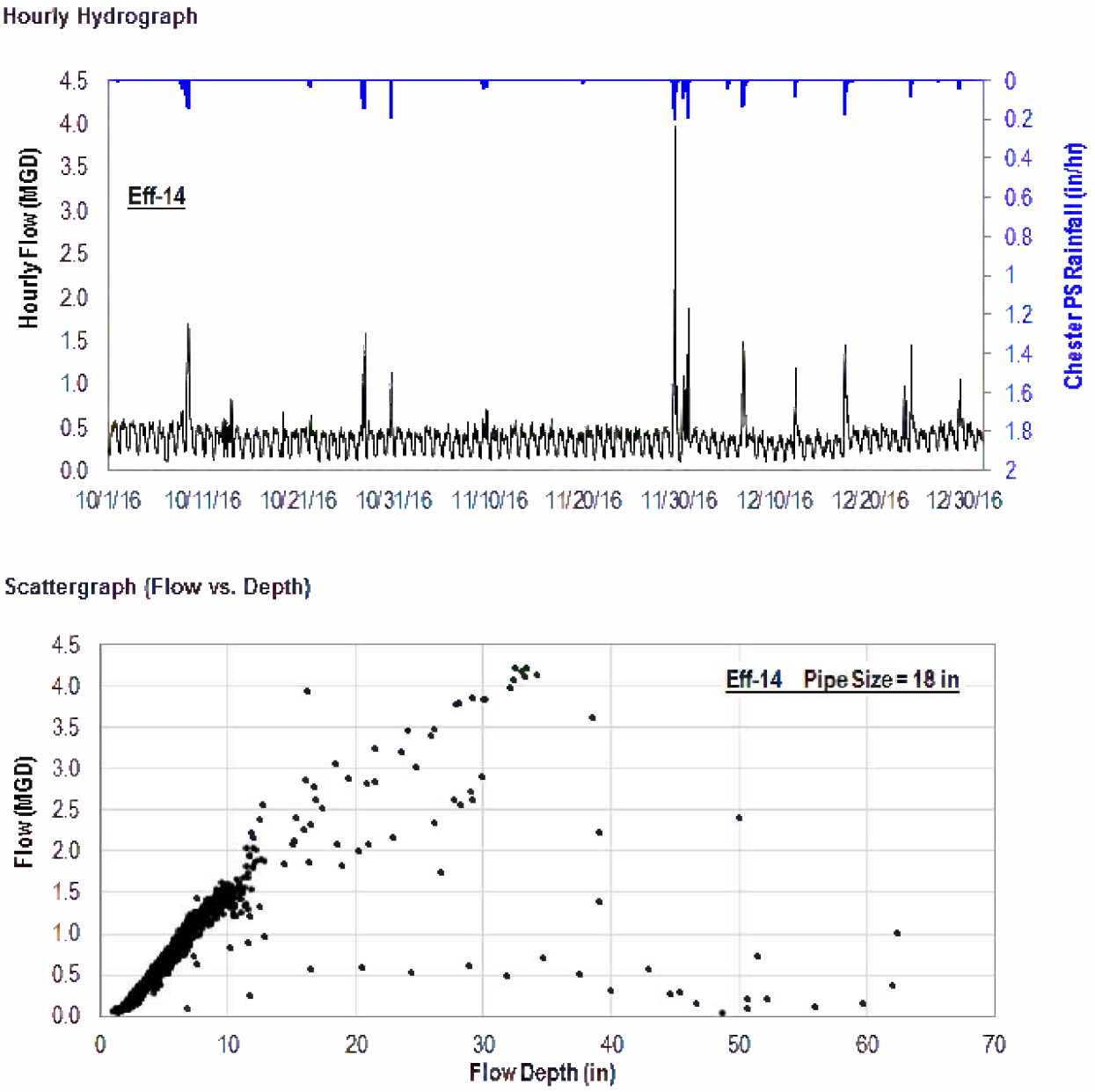


Figure 30: Flow Monitoring Data, CSO-14

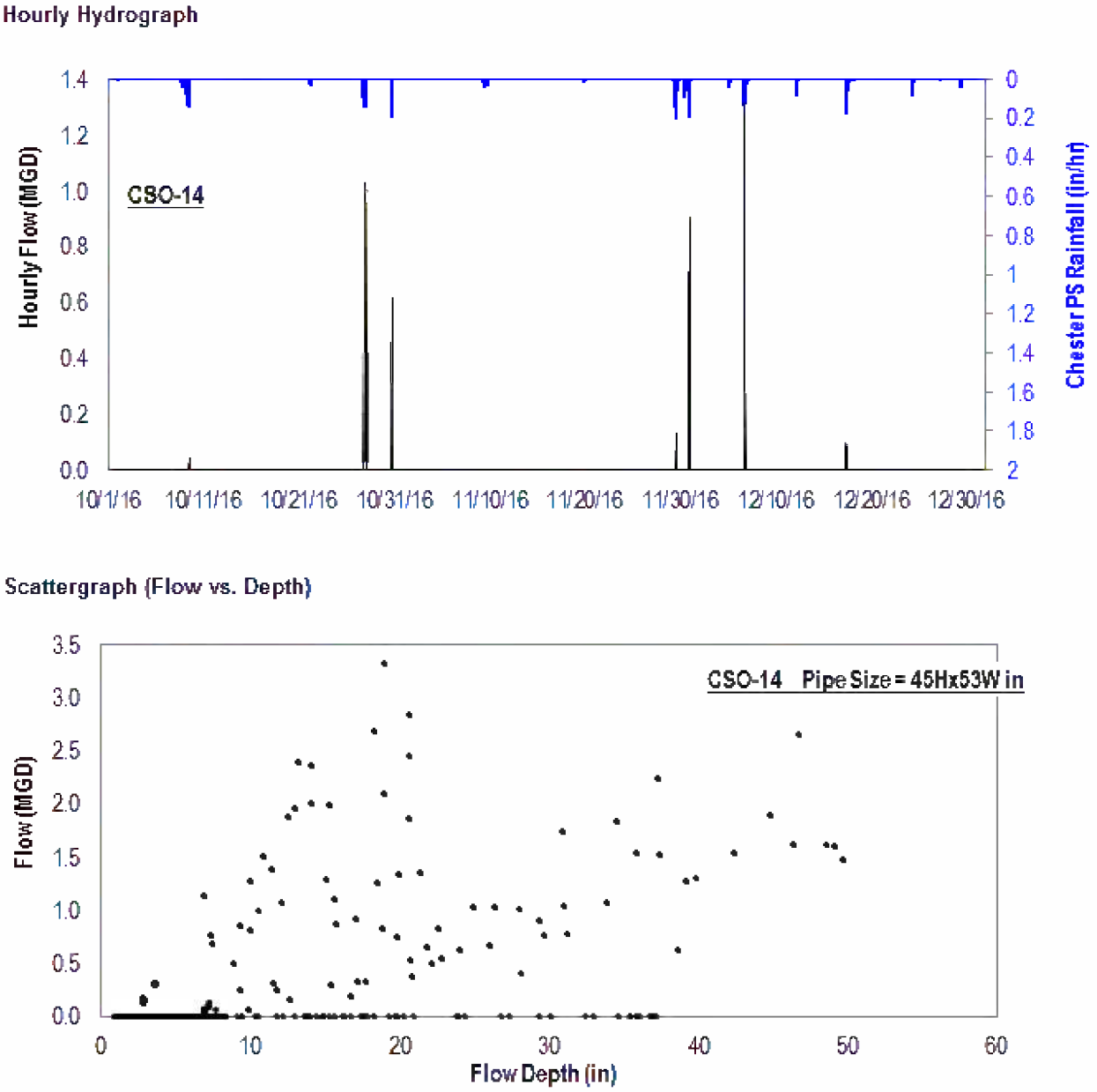


Figure 31: Flow Monitoring Data, In-16

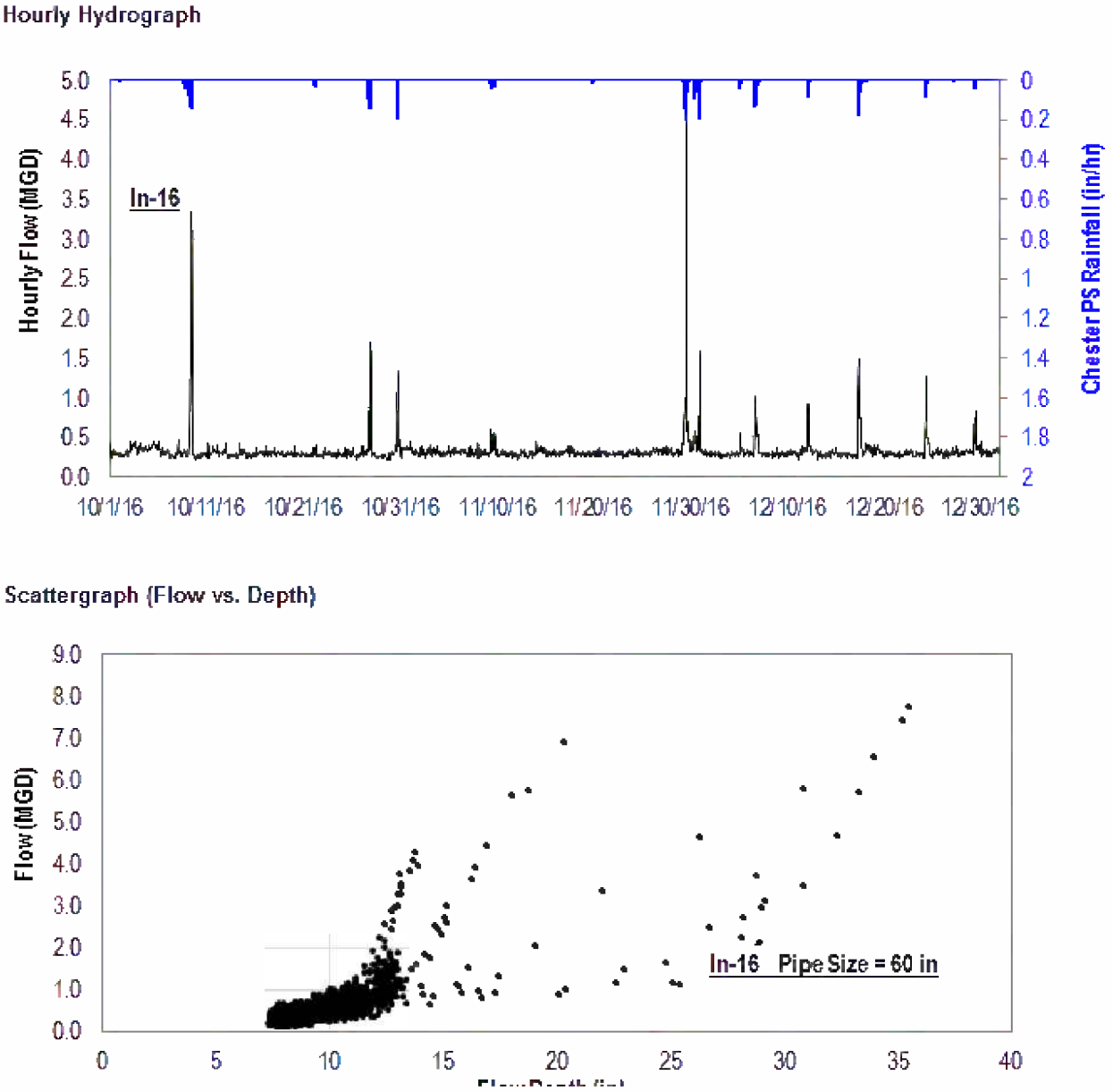


Figure 32: Flow Monitoring Data, In-17

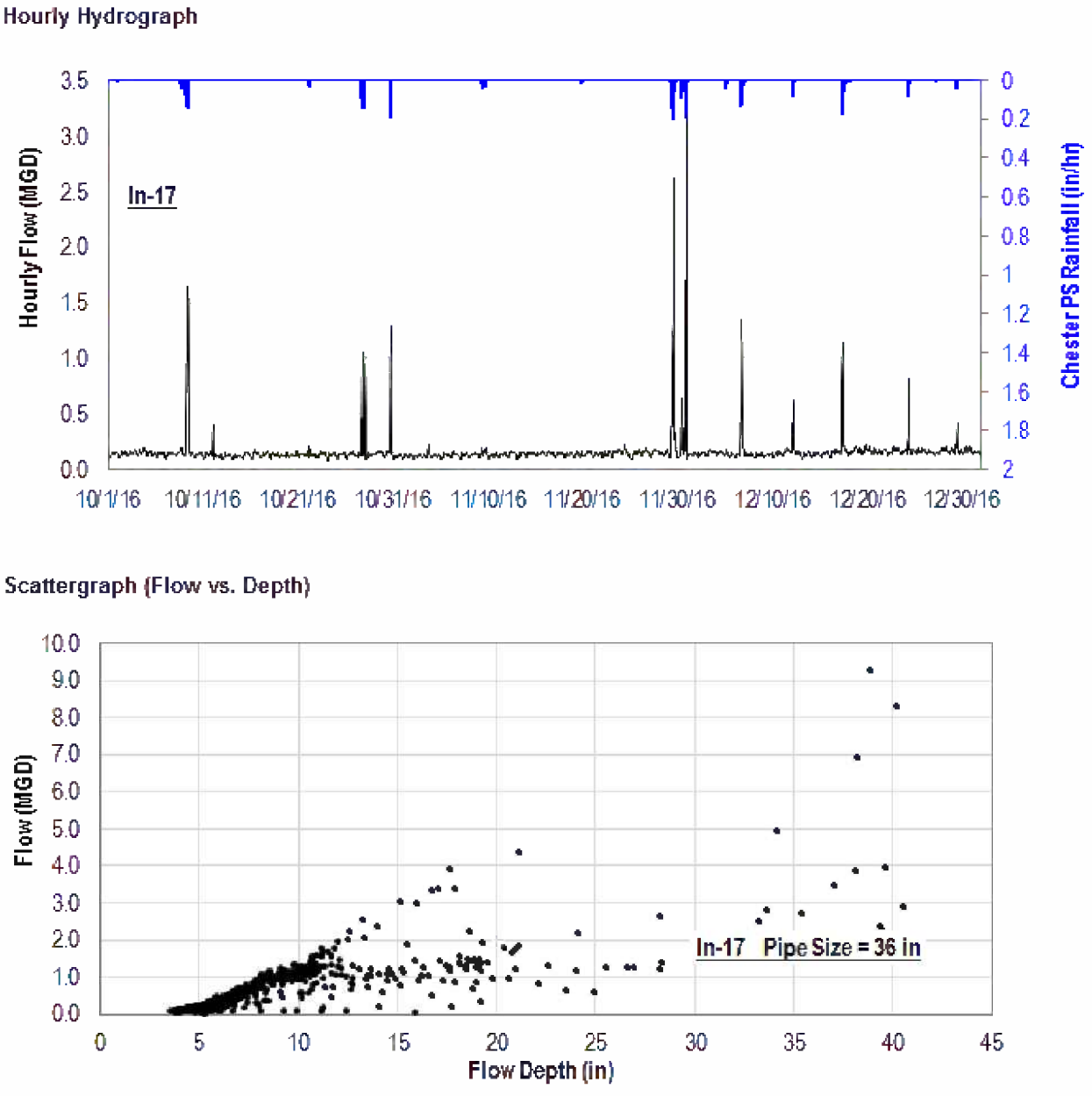


Figure 33: Flow Monitoring Data, In-18

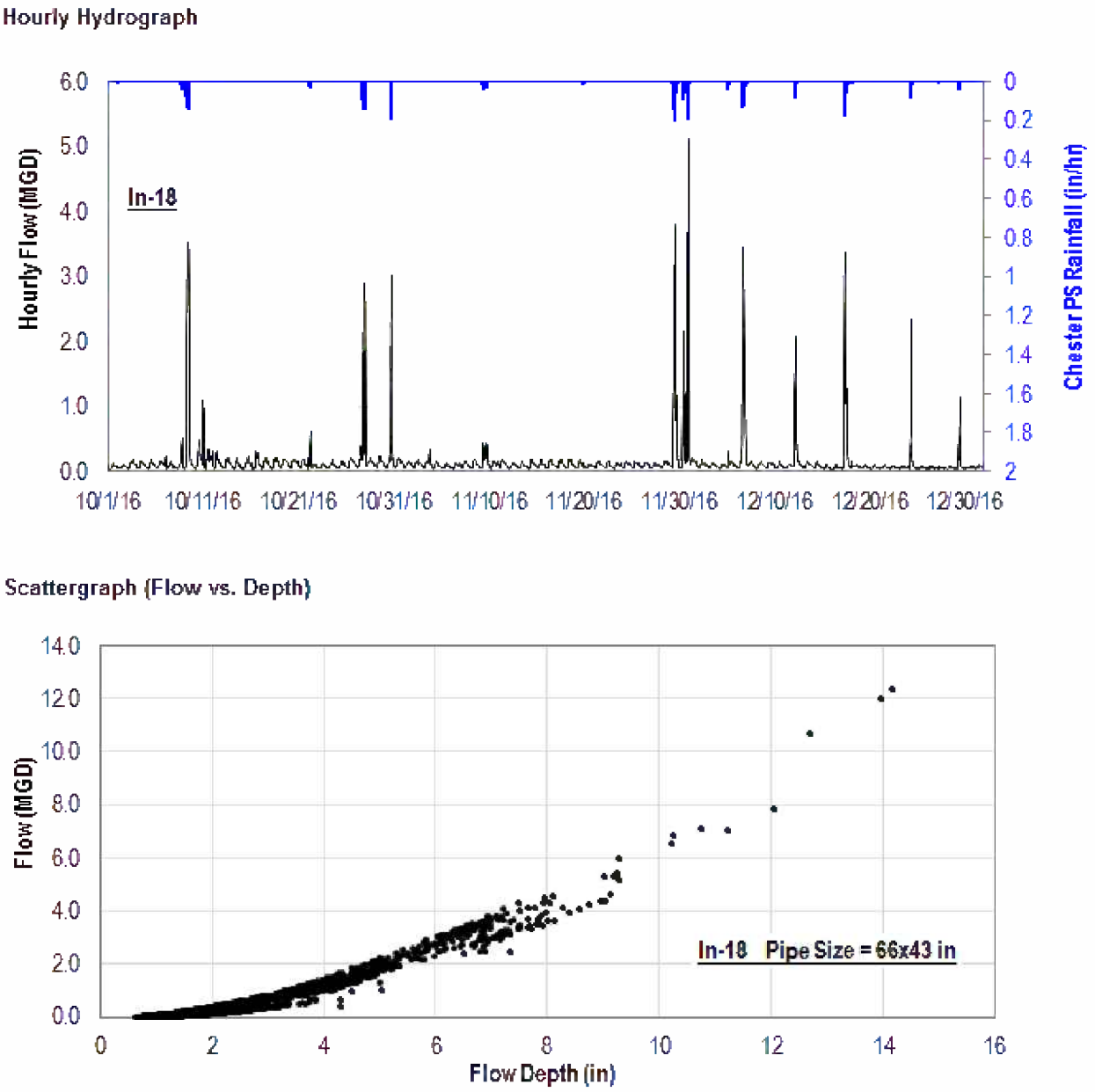
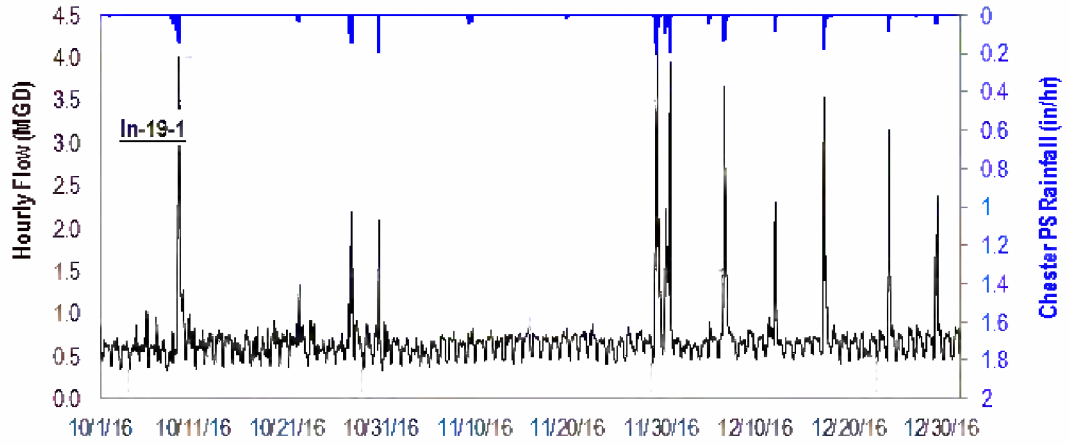
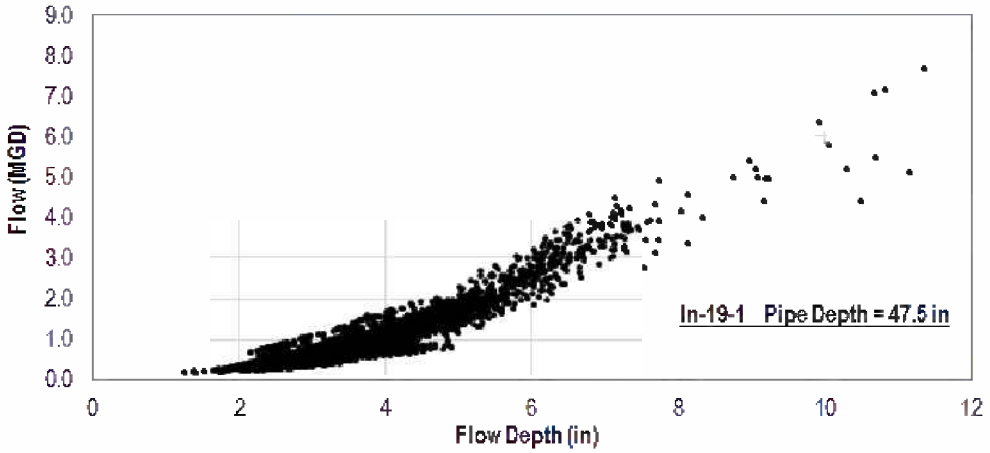


Figure 34: Flow Monitoring Data, In-19-1

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#19 Influent , Effluent and Overflow

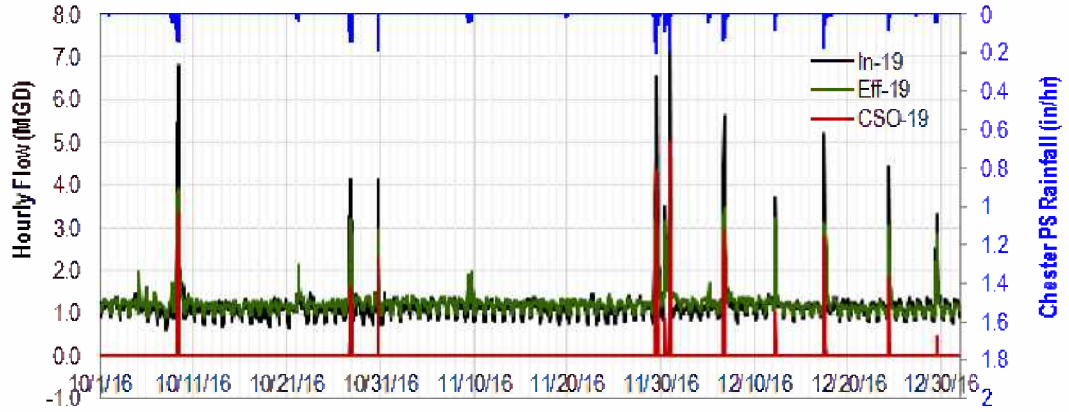
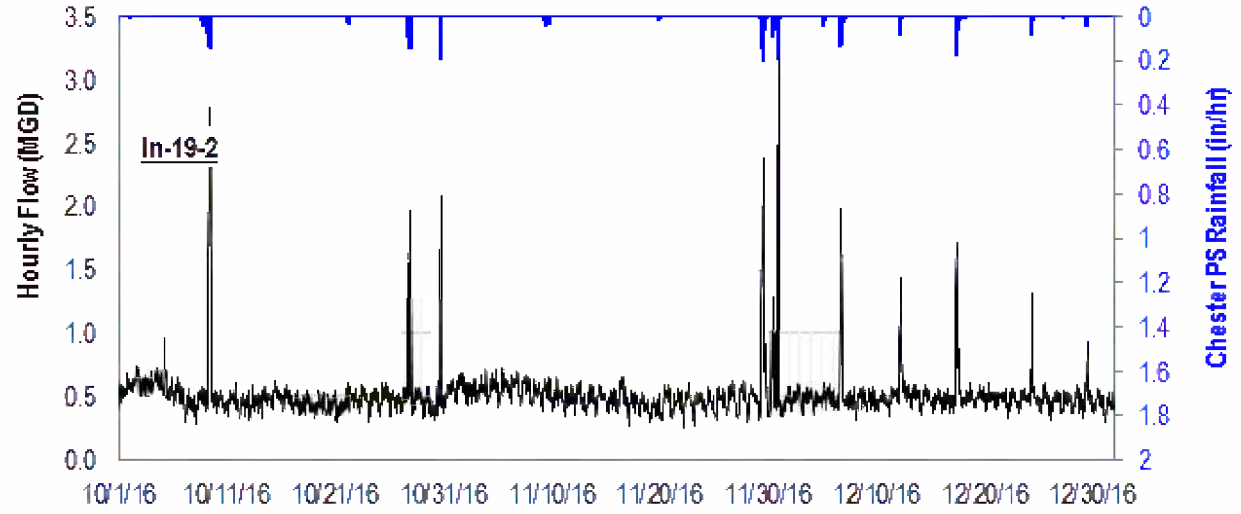


Figure 35: Flow Monitoring Data, In-19-2

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

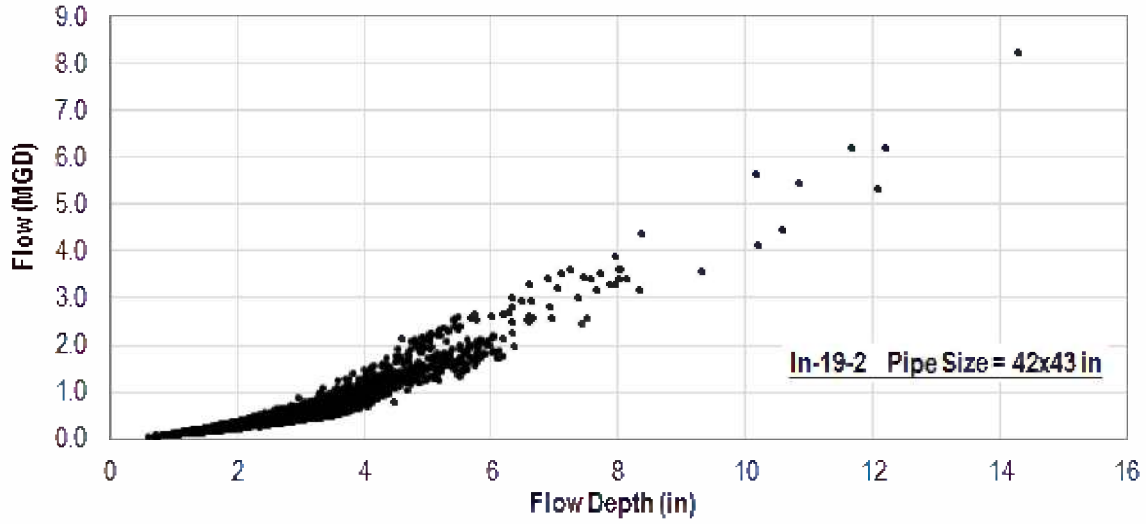


Figure 36: Flow Monitoring Data, Eff-19

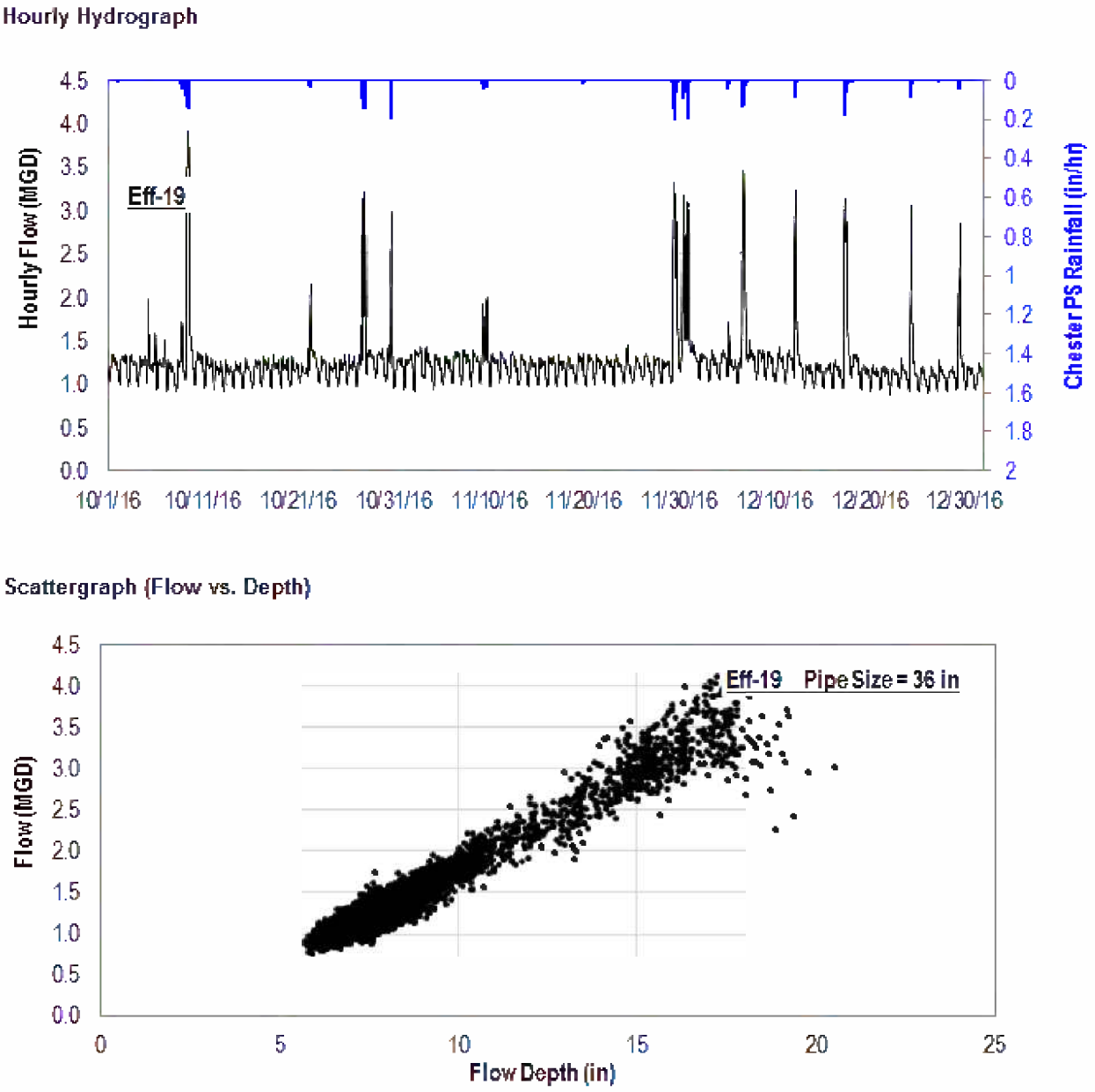


Figure 37: Flow Monitoring Data, CSO-19

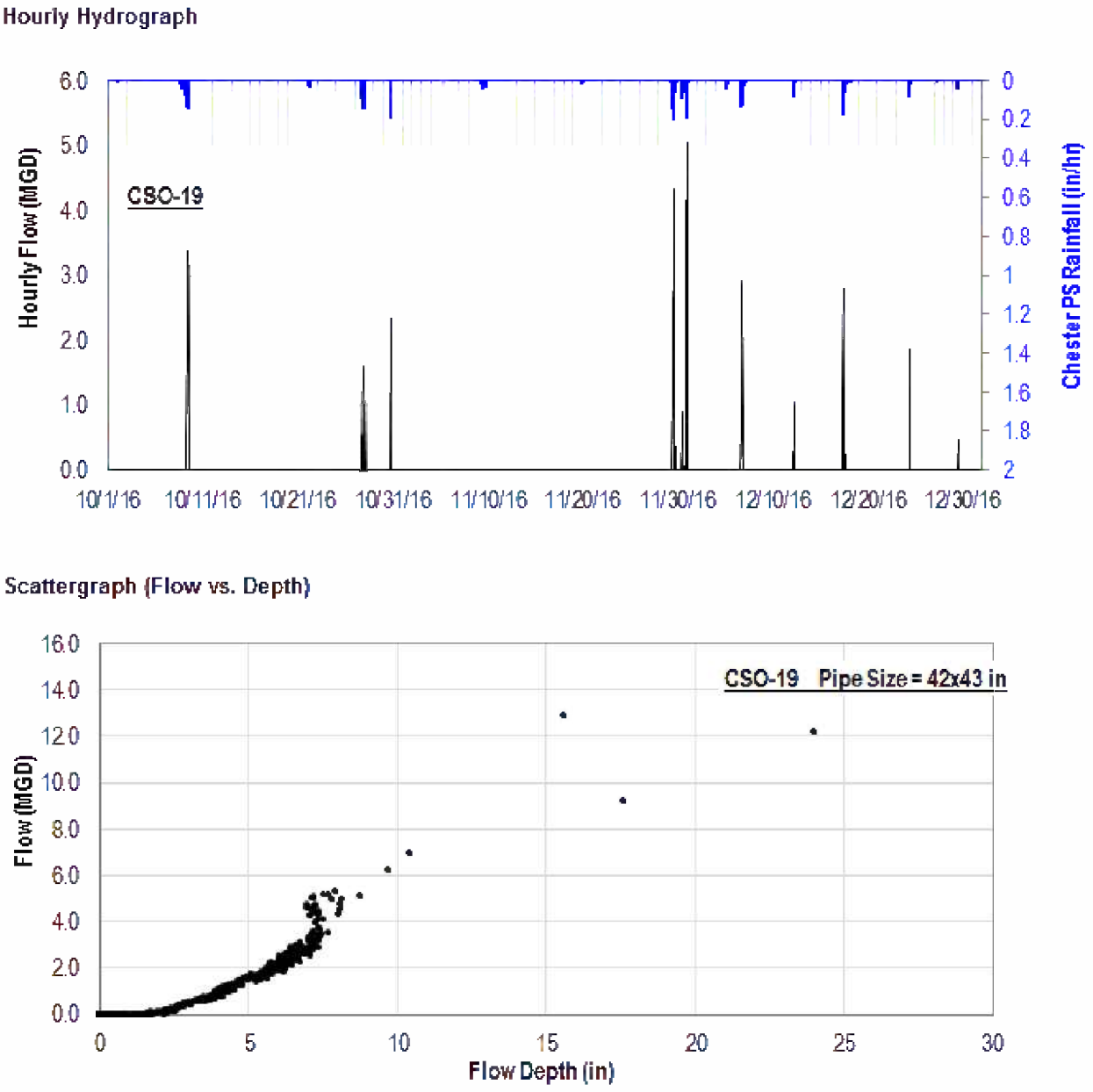


Figure 38: Flow Monitoring Data, In-25

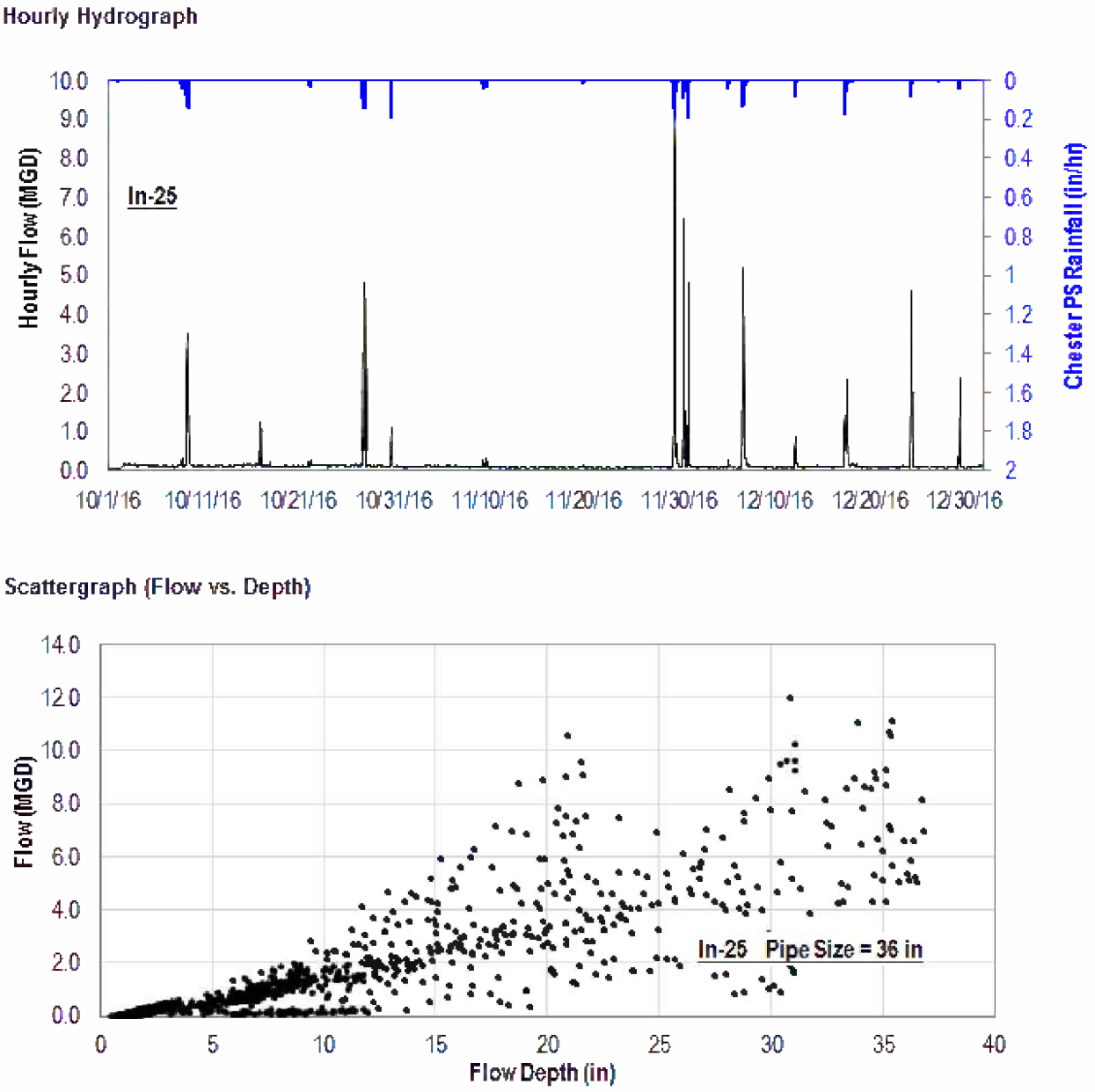


Figure 39: Flow Monitoring Data, In-26

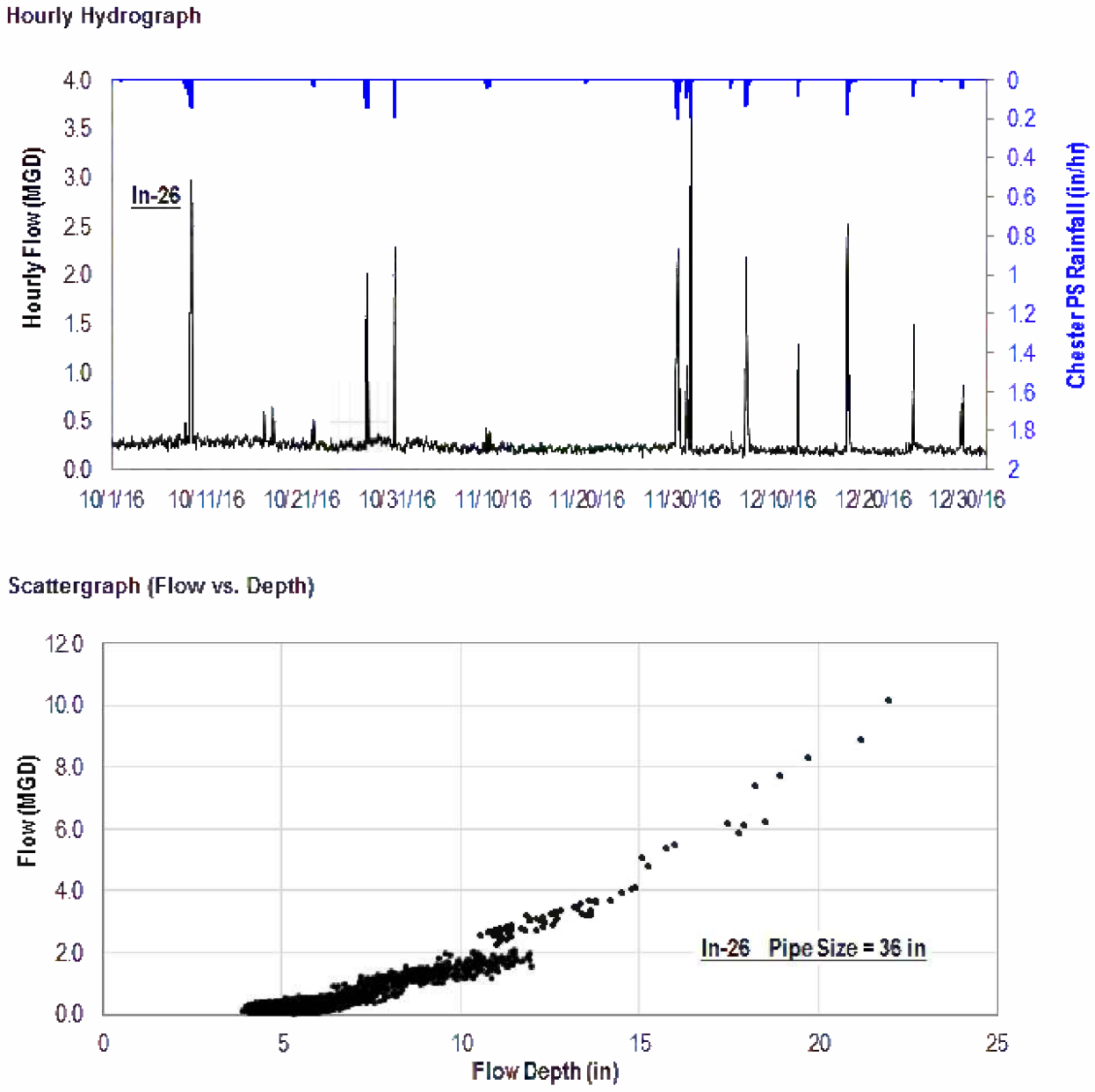


Figure 40: Flow Monitoring Data, INT-2nd St

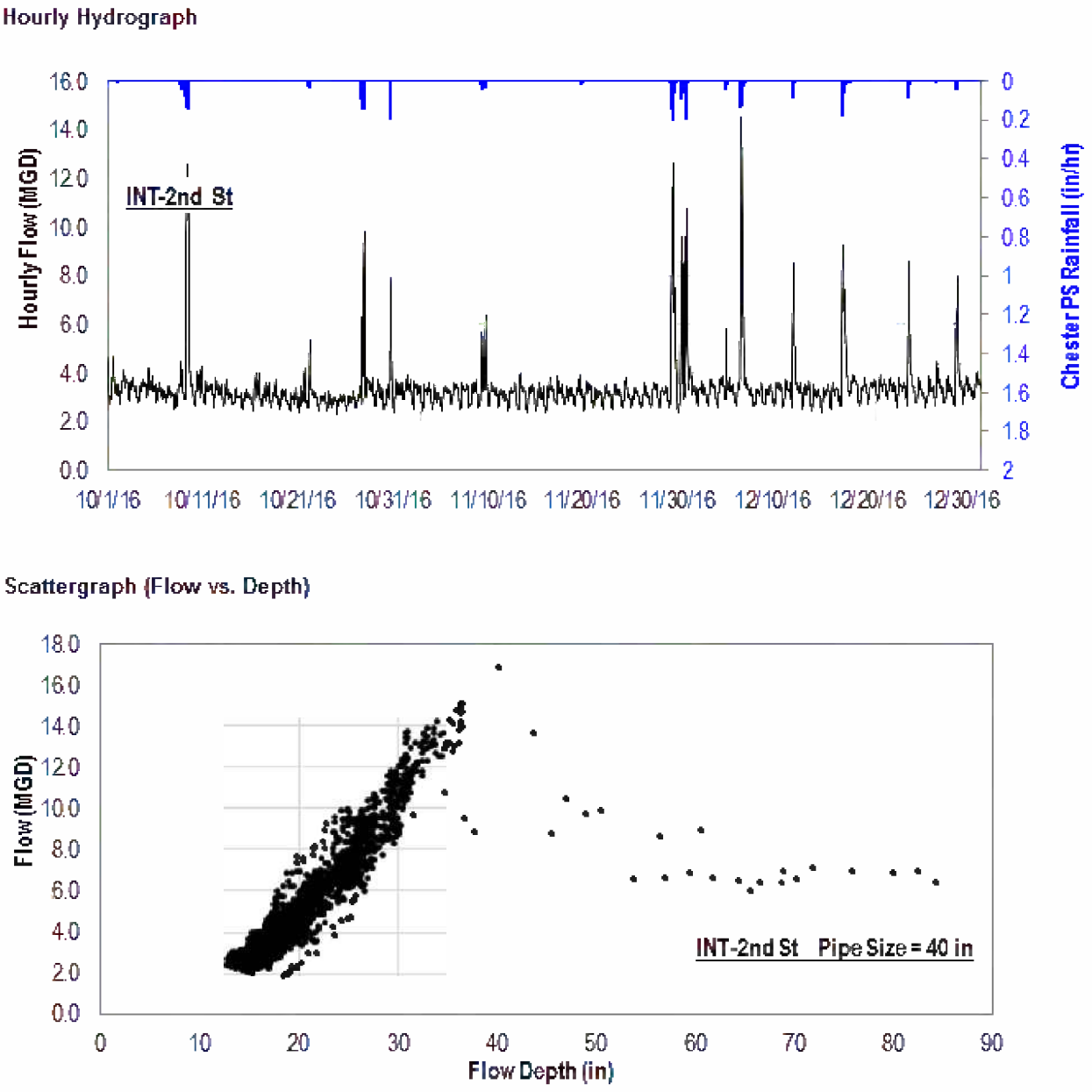


Figure 41: Flow Monitoring Data, INT-DRI

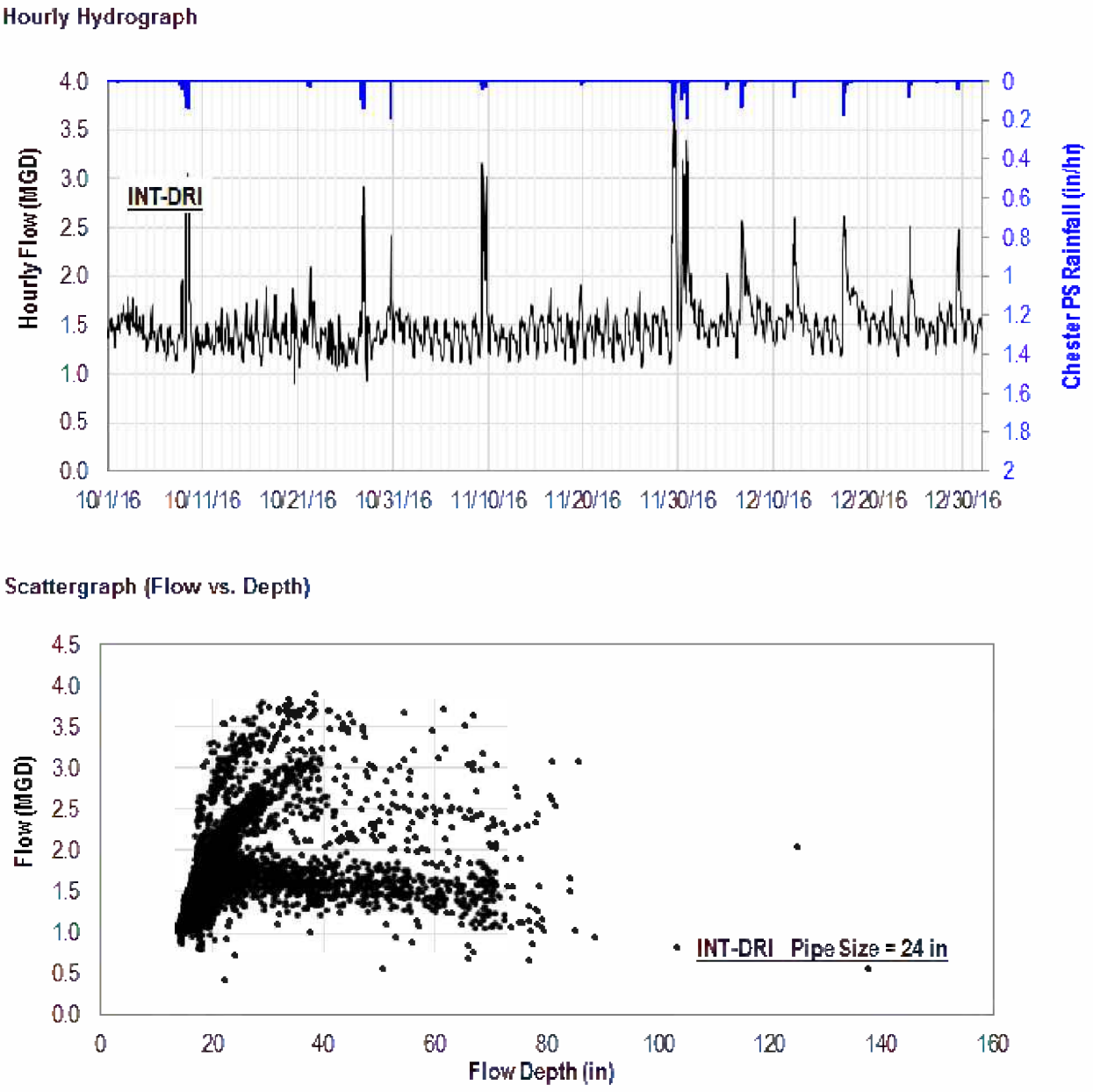


Figure 42: Flow Monitoring Data, INT-Ridley 2

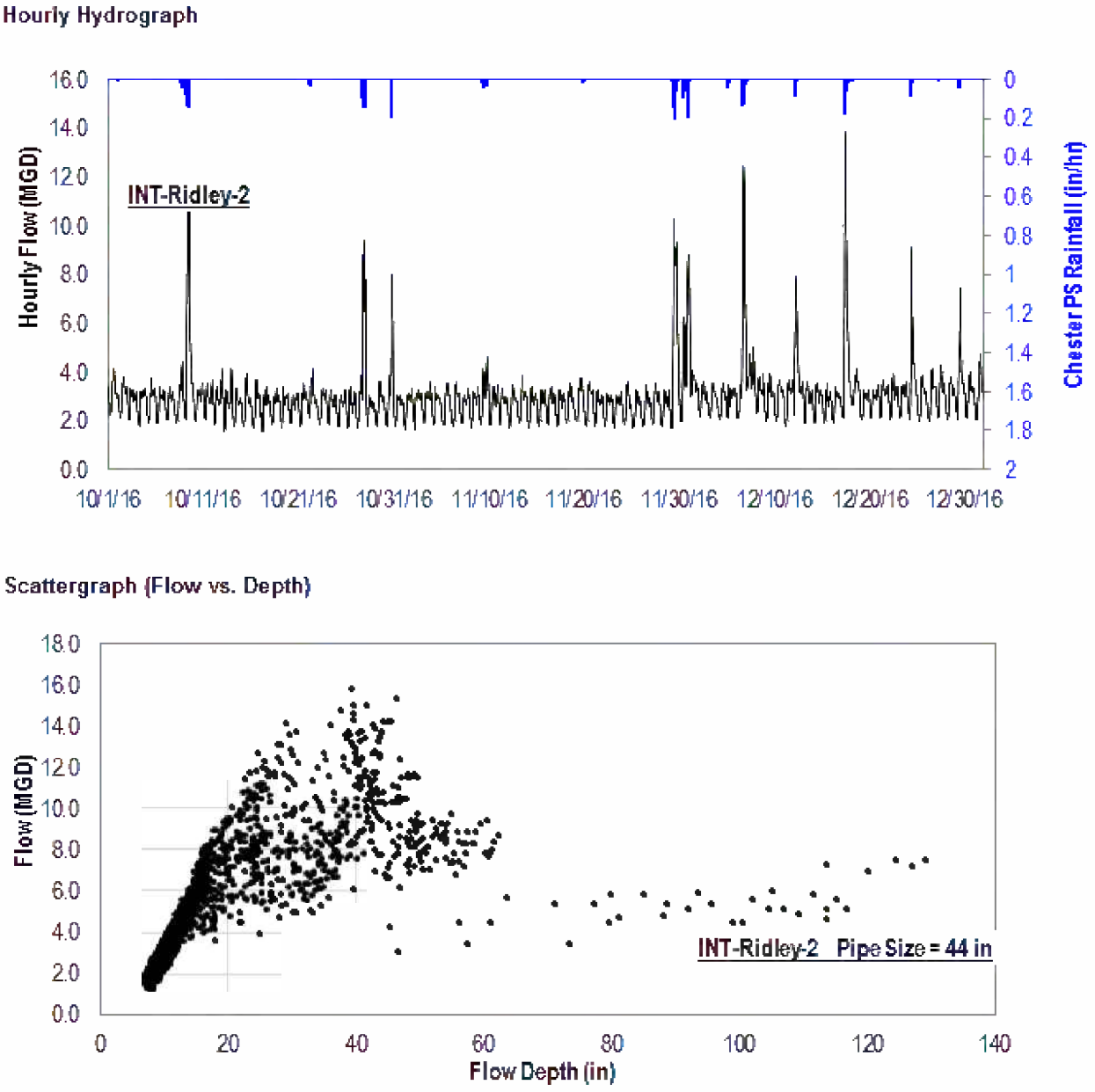


Figure 43: Flow Monitoring Data, INT-Ridley 3

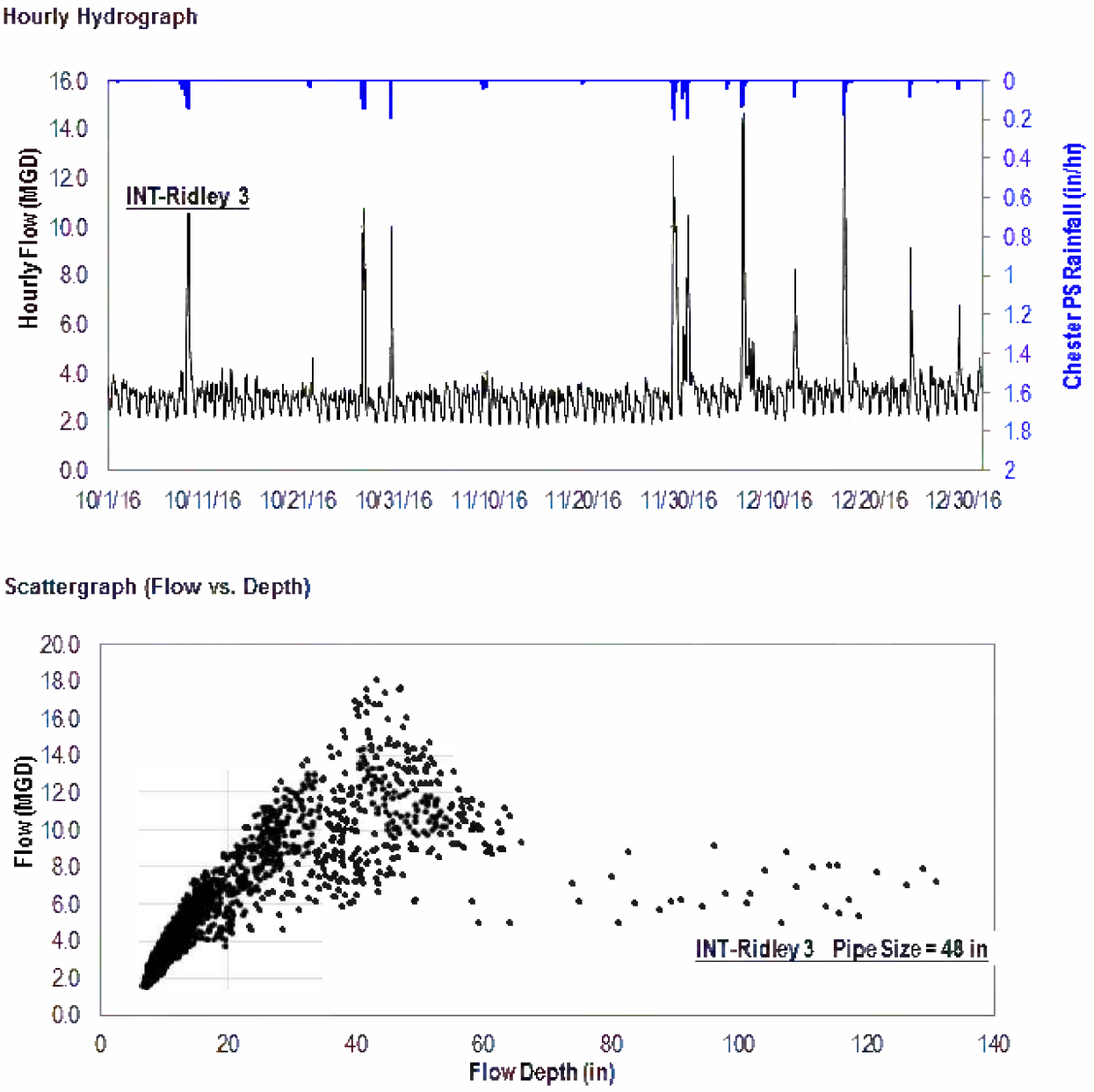


Figure 44: Flow Monitoring Data, INT-WEI

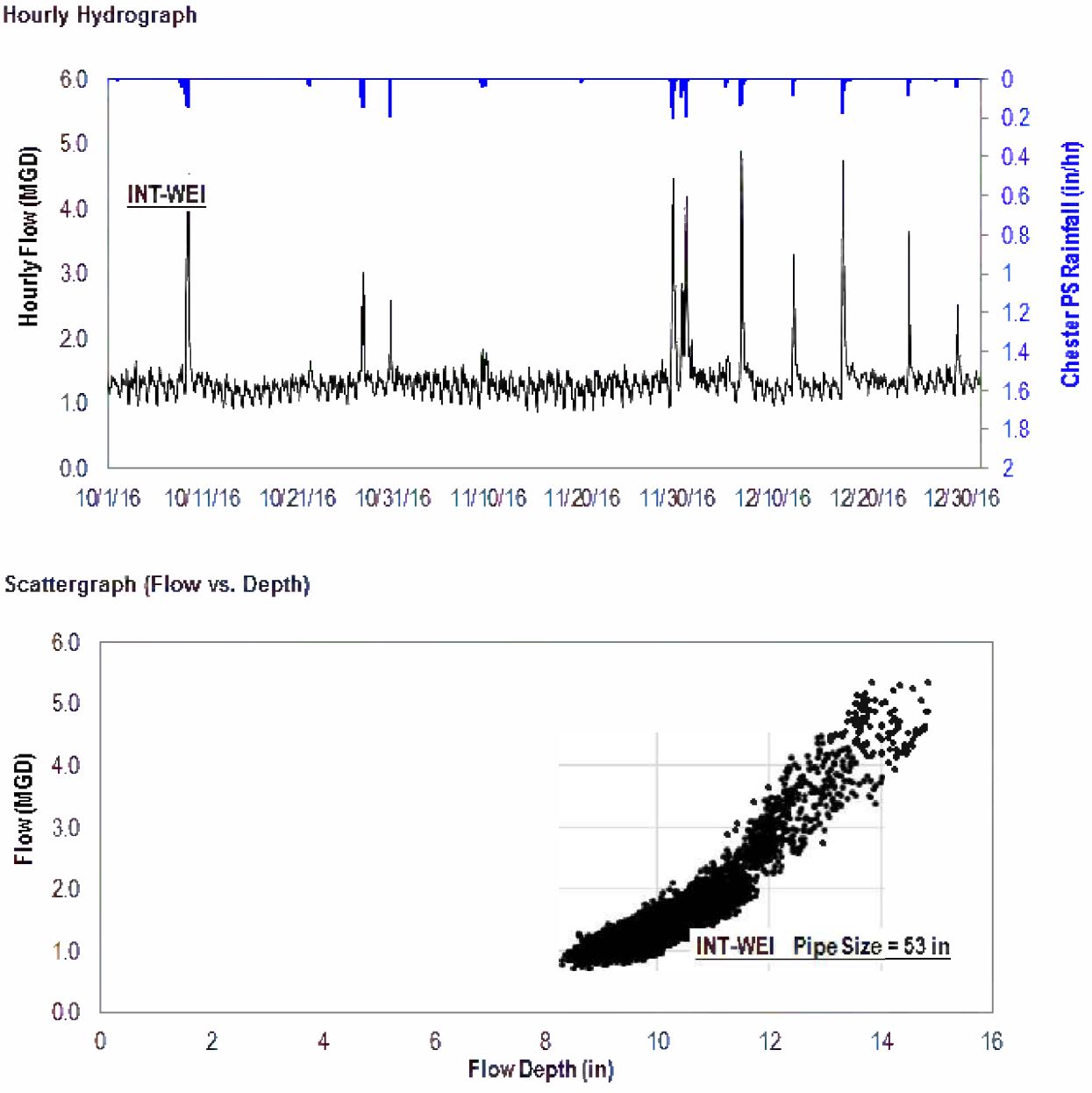


Figure 45: Flow Monitoring Data, Sep-1

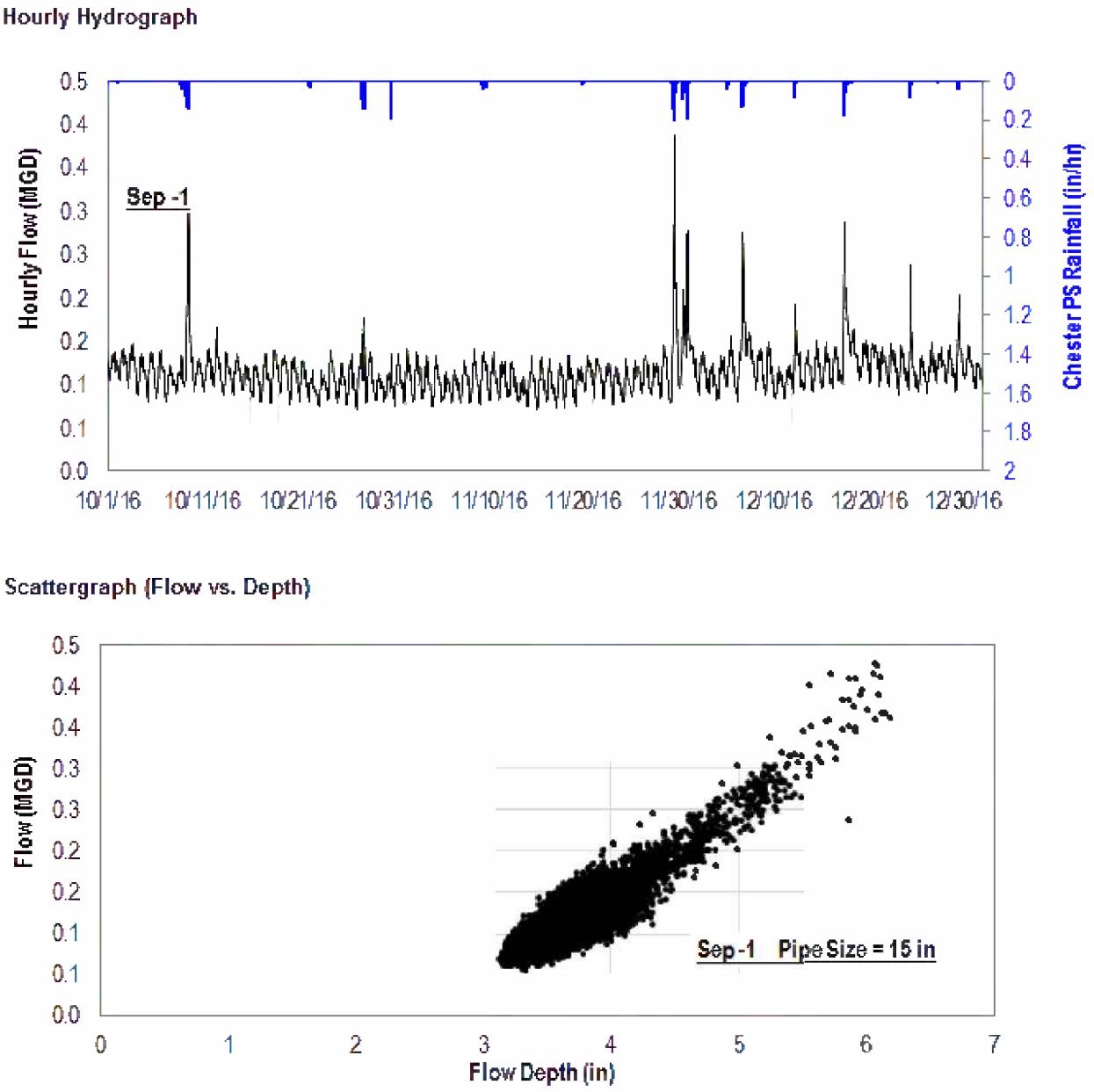


Figure 46: Flow Monitoring Data, Sep-2

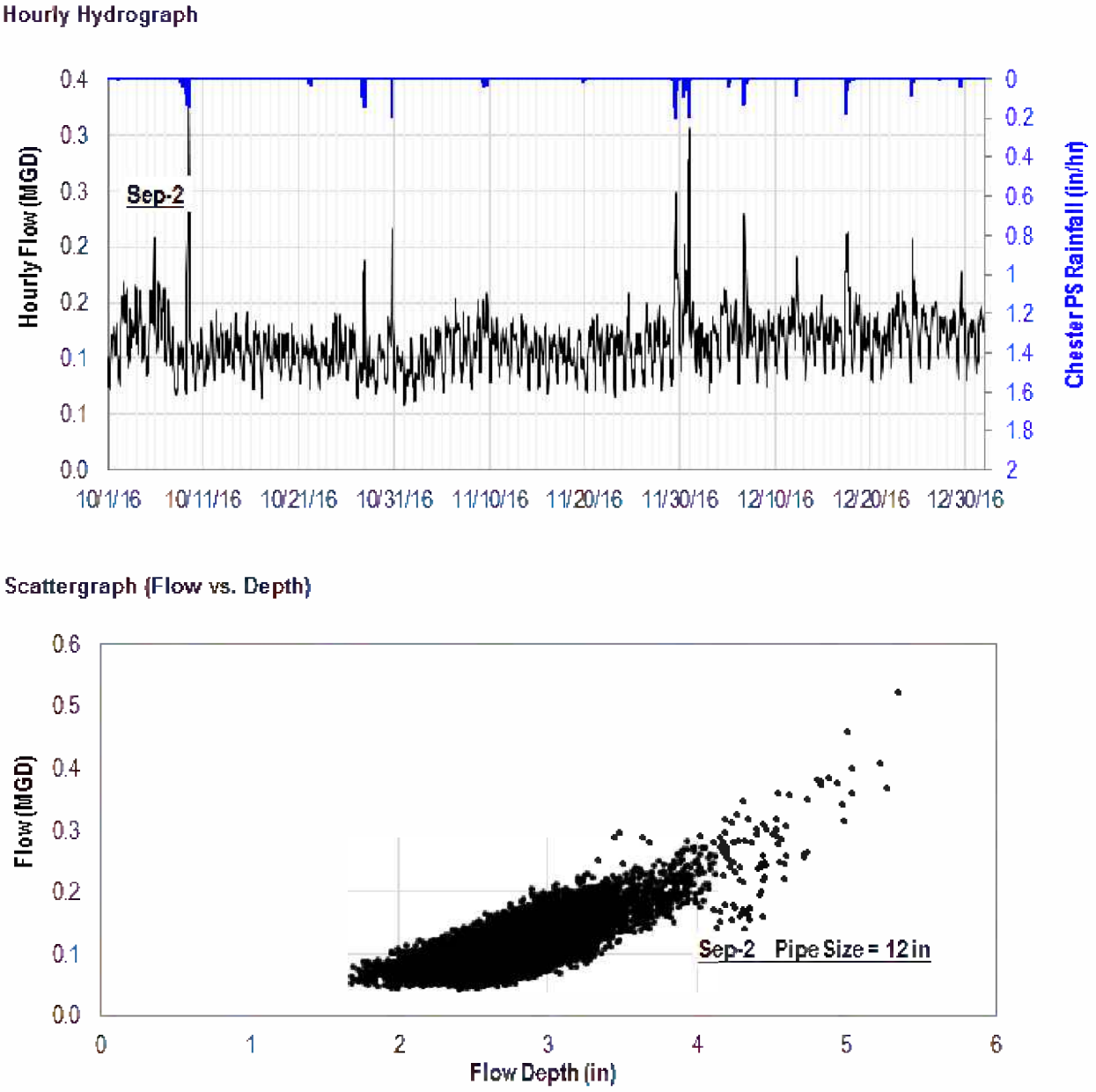


Figure 47: Flow Monitoring Data, Sep-3

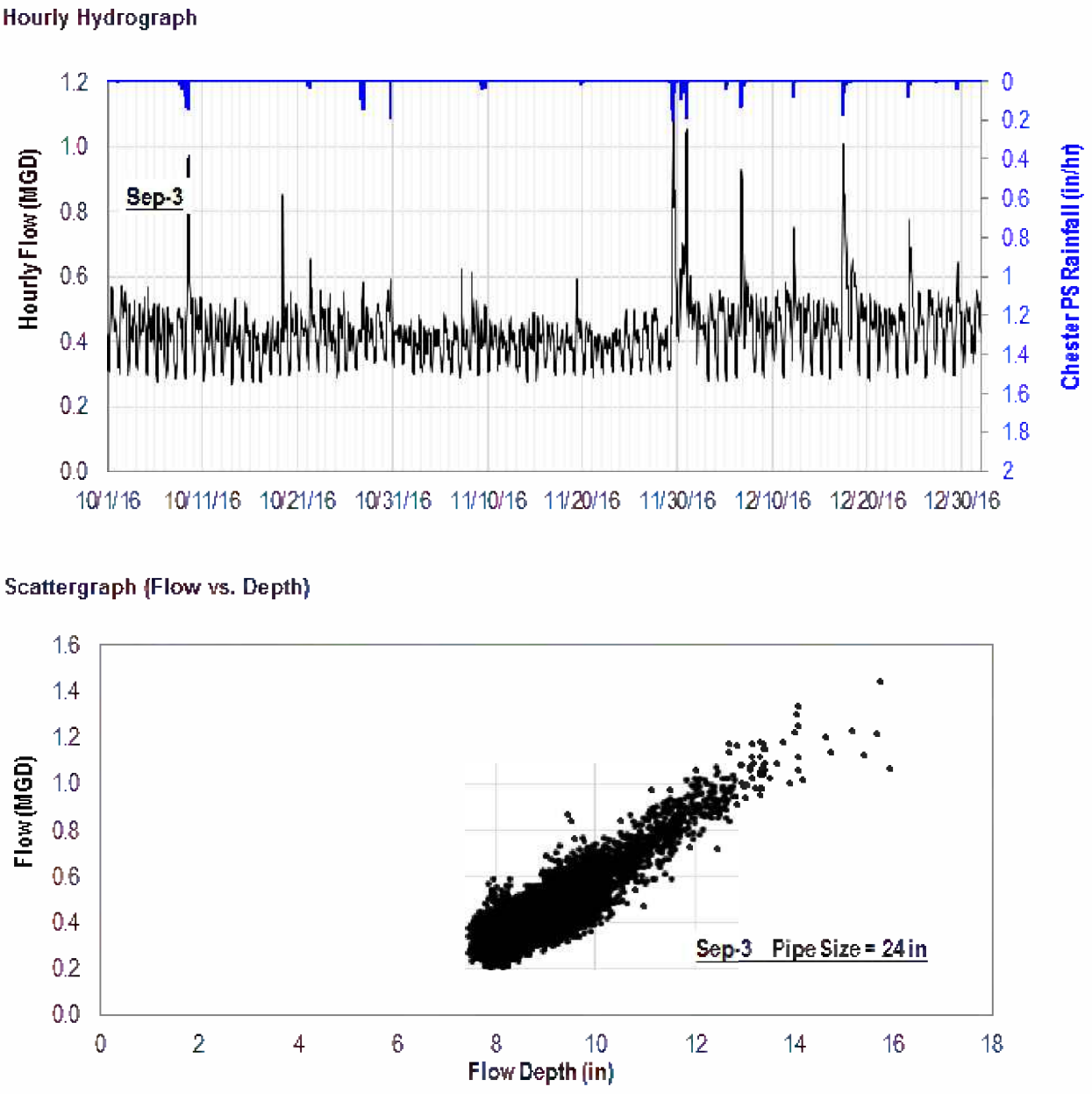
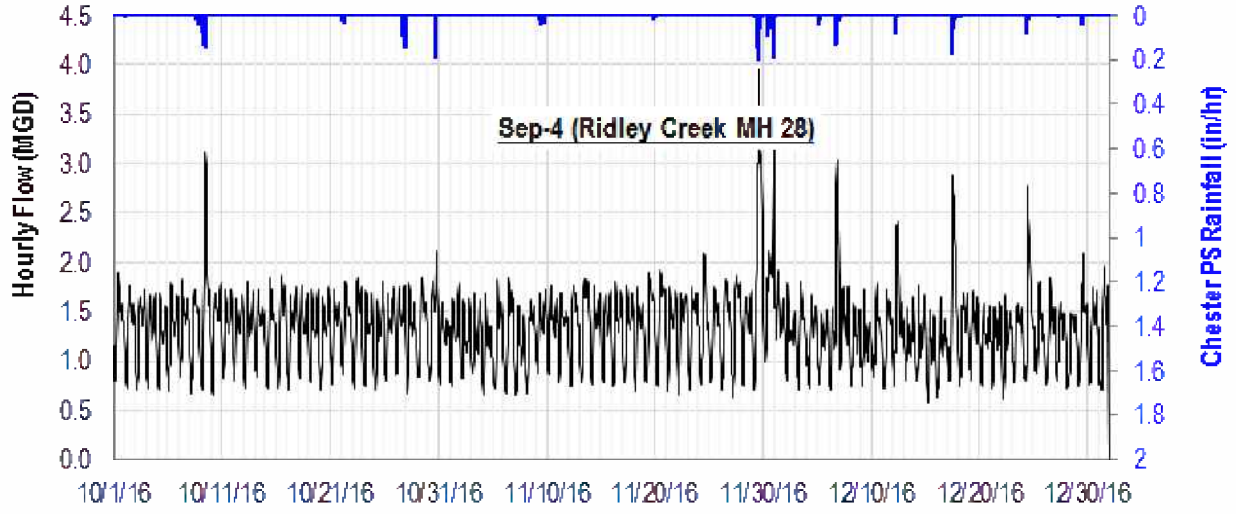


Figure 48: Flow Monitoring Data, Sep-4

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

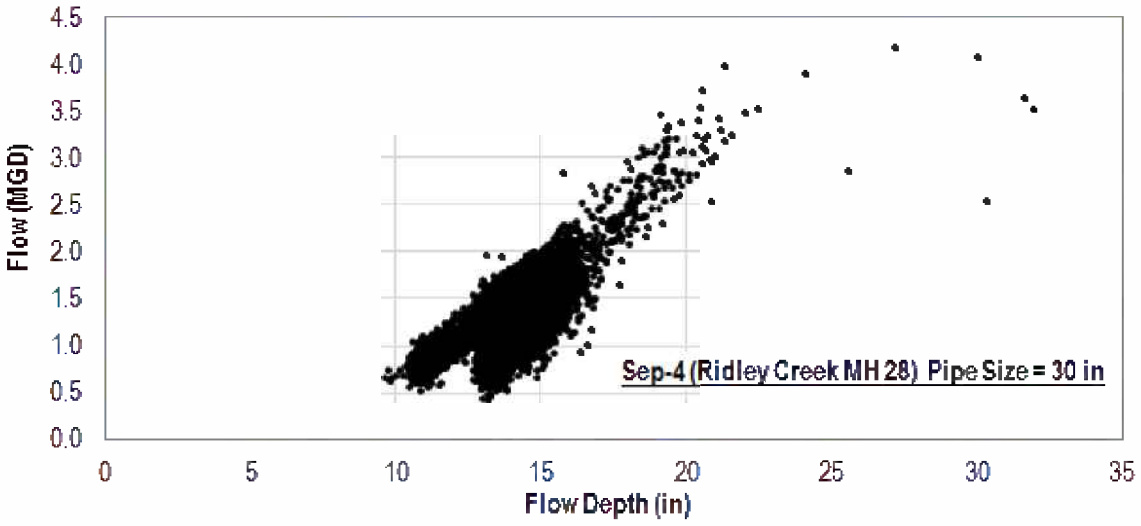


Figure 49: Flow Monitoring Data, Side-1

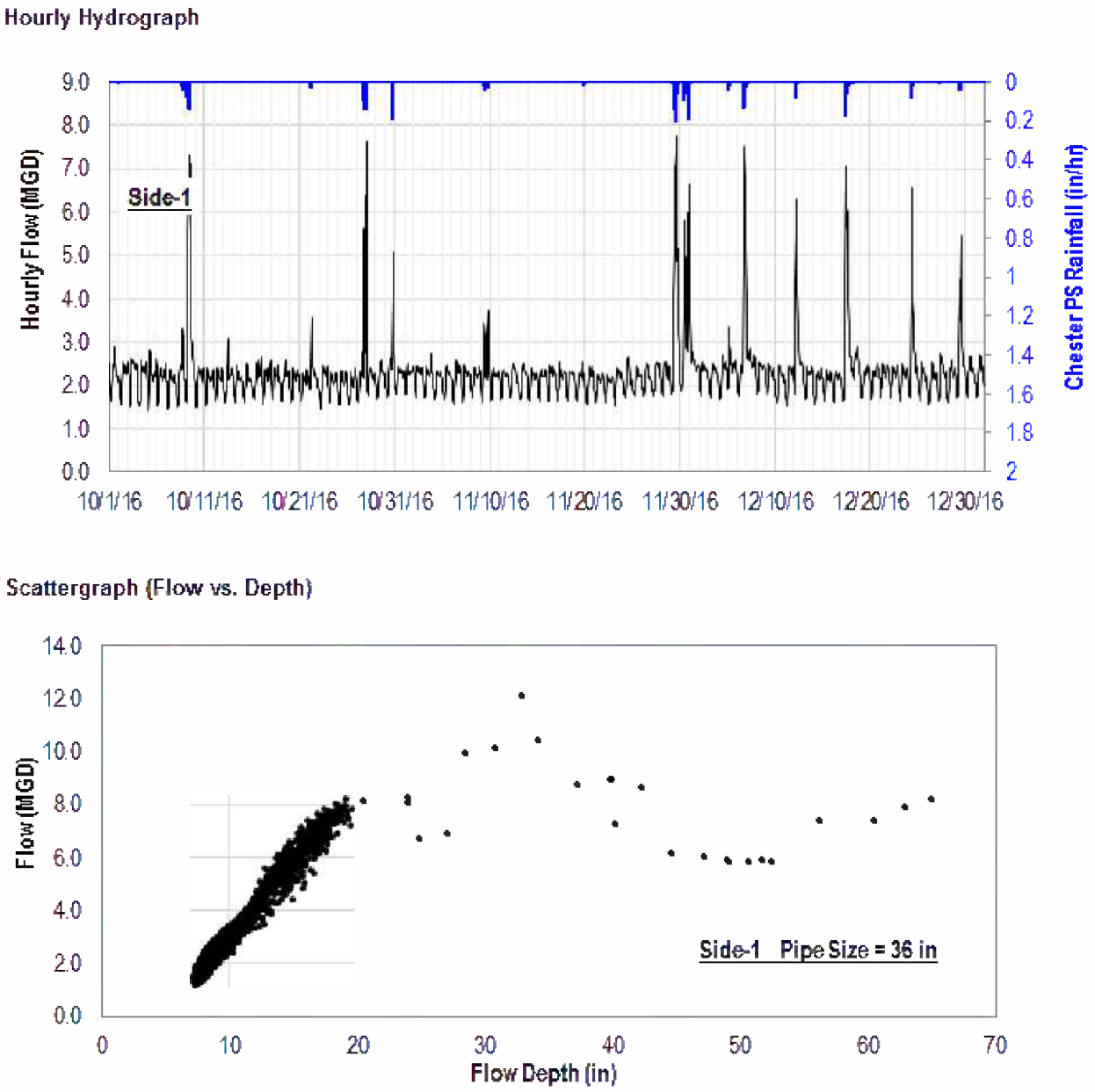
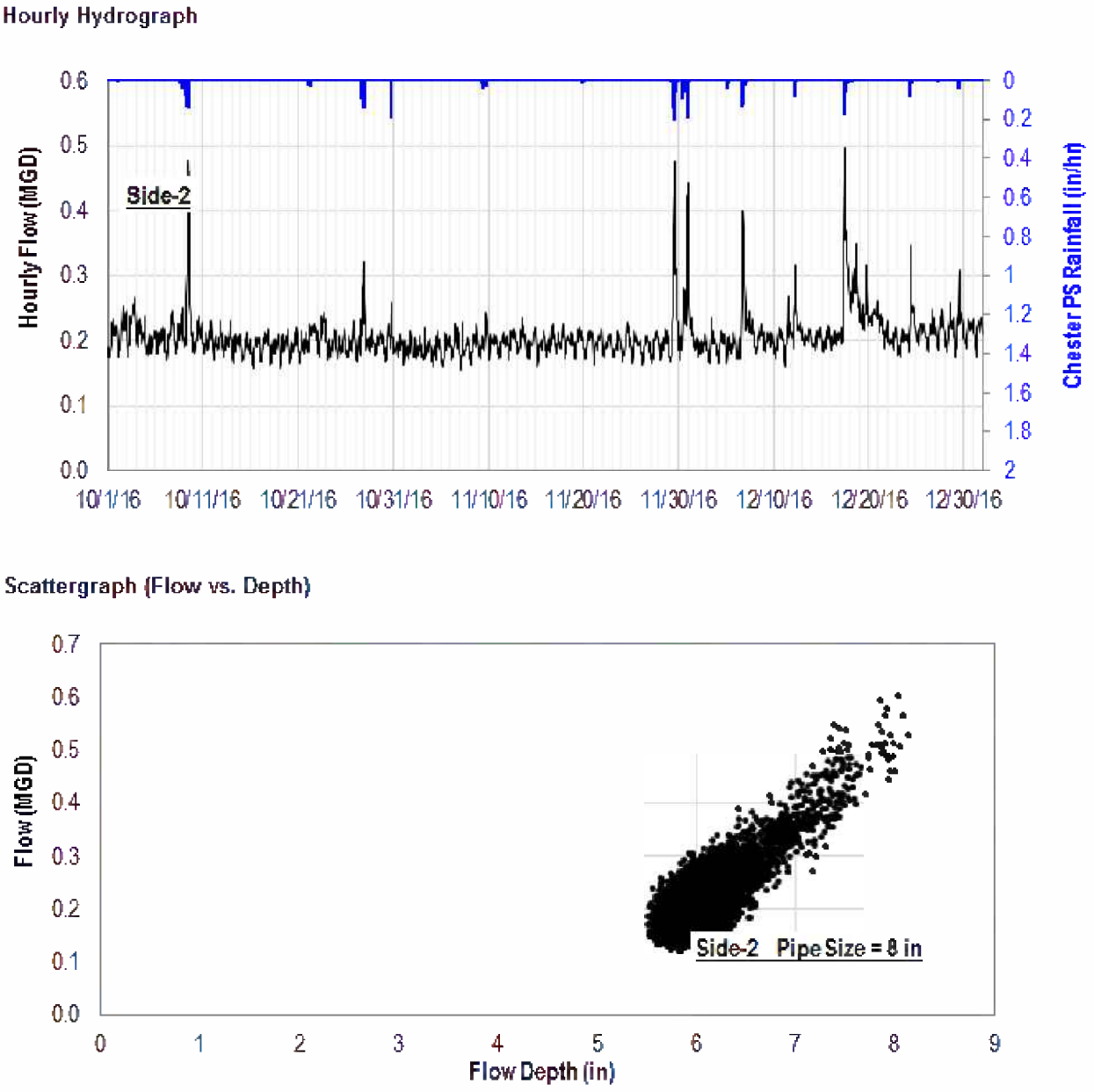


Figure 50: Flow Monitoring Data, Side-2



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Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Rainfall and Flow Monitoring Quarterly Report No. 4

(January 1, 2017 to April 1, 2017)

Final

April 2017

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Rainfall and Flow Monitoring Quarterly Report No. 4.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	4/25/17 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	4/25/17 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	4/26/17 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) entered into a Consent Decree (CD) with the United States Government in August 2015. The purpose of the Consent Decree is to establish a schedule for implementation of Long Term Control Plan Update (LTCPU) to achieve full compliance with the Clean Water Act and the regulations and Clean Streams Law and regulations. The lodging of this Consent Decree was entered by the court on August 17, 2015, it was signed and filed on November 10, 2015 by the United States District Court for the Eastern District of Pennsylvania.

According to the Consent Decree, DELCORA's Hydrologic and Hydraulic Model (H&H Model) must be updated to meet the requirements in Section V.A.14 of the Consent Decree. A detailed plan to update, calibrate and validate the H&H model has been submitted and approved by the USEPA on March 1, 2016. Additional rainfall and flow monitoring is required to calibrate and validate the H&H model. Requirements of rainfall and flow monitoring are detailed in the Consent Decree Section V.A.14.d and e, which is included in the following:

> "*d.* *Rainfall and flow monitoring shall be carried out in accordance with current good industry practice for a period of at least twelve* ***(12) months****, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows from the entire Model Area, and the response of each CSO to wet weather flows.*
>
> *e.* *For all rainfall and flow monitoring carried out in support of efforts to update and calibrate the H&H Model, DELCORA shall prepare and submit to Plaintiffs for review and comment in accordance with the requirements of Section VI (Review and Approval of Submittals) quarterly technical memoranda documenting the results and quality of the rainfall and flow monitoring data."*

In summary, rainfall and flow monitoring shall be conducted for at least 12 months, and quarterly technical memoranda shall be submitted to Plaintiffs for review.

To satisfy the above mentioned rainfall and flow monitoring requirements, and in accordance with the submitted DELCORA H&H Model Update and Calibration Plan, DELCORA has installed 5 new rain gauges and 39 new flow meters in its sewer collection system. Starting from March 18, 2016, most of the newly installed rain gauges and flow meters were in service and began generating data.

This report is a summary of the Rainfall and Flow Monitoring during January 1, 2017 to April 1, 2017.

Section 2 Rainfall Monitoring

2.1 Rainfall Monitoring Locations

The site locations of the four existing and five newly installed rain gauges are shown in **Figure 1**. These rain gauges provide an effective spatial coverage of the entire WRTP's service area.

The four (4) existing rainfall gauges are in Delaware County that record precipitation in 15-minute increments. The gauges are located at the following DELCORA owned facilities:

- Western Regional Treatment Plant (WRTP, will be used for model calibration)
- Central Delaware County Pump Station (CDPS, will be used for model calibration)
- Muckinipates Pump Station (MPS, will be used for model calibration)
- Darby Creek Pump Station (DCPS, will NOT be used for model calibration)

The five (5) newly installed rain gauges are listed in **Table 1** with detail information of rain gauge location, service starting date, and data recording interval.

Table 1: Newly Installed Rain Gauges

	Rain Gauge ID	Location	Service Start Date	Data Interval
1	RG_Rose Valley	18 N. Longpoint Lane, Media, PA	3/05/16	5-minute
2	RG_Chester-PS	55 East 2nd Street, Chester, PA	3/05/16	5-minute
3	RG_NCPS	1628 Naamans Creek Rd., Marcus Hook, PA	3/05/16	5-minute
4	RG_Springfield	217 Saxer Avenue, Springfield, PA	4/03/16	5-minute
5	RG_UCT	1671 N. Upper Providence Road, Media, PA	4/16/16	5-minute

2.2 Rain Gauge Calibration/Verification Procedure

Rain Gauge calibrations were performed during the rain gauge installation. Additional calibrations will be performed to the manufacturer's specifications on a bi-annual basis or as needed if irregular data is observed. Rain gauges are routinely checked for debris, and cleared after snow/ice storms.

Each "tip" of the rain gauge bucket should correspond with 0.01" of rain. To ensure the modem is reading the tipping bucket pulse accurately, the tech will tip the bucket 10 times in rapid succession. The tech should see that 0.1" of rain is recorded.

2.3 Rainfall Event Summary

Rainfall events were analyzed for each individual rain gauge based on the inter-event time of 12 hours. In total there were 33 rainfall events during reporting period. **Table 2** lists all 18 rainfall events with total precipitation greater than 0.1 inch.

Figure 1: Rain Gauge Locations

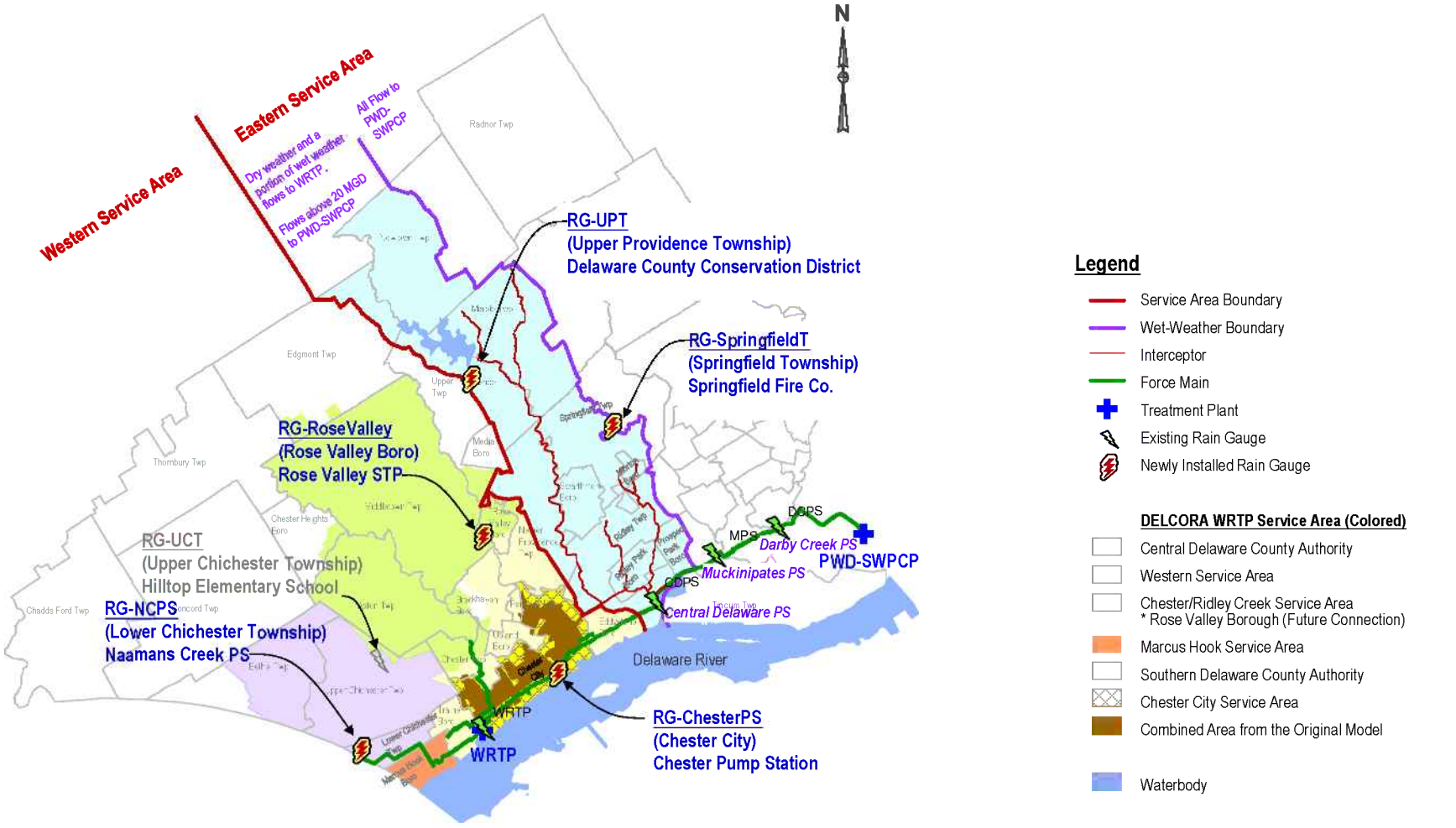


Figure 2 shows rainfall amounts at each rain gauge in each month for January, February and March. It is obvious that rainfall in the area has significant spatial and temporal variance. As an example, during this reporting period, the rain gauge at the Chester Pump Station (Chester PS) recorded a total rainfall of 7.63 inches while the gauge at the Upper Providence Township (UPT) recorded 9.23 inches. **Figure 3** shows the 1-hour rainfall profile for all of the 5 rain gauges.

Table 2: Rainfall Event Summary, 1/1/17 - 4/1/17

	Rain Event Starting Time	Rose Valley	Chester-PS	NCPS	Springfield	UPT
1	1/2/2017 4:25	0.9	0.78	0.95	0.84	0.93
2	1/10/2017 12:20	0.4	0.25	0.42	0.23	0.39
3	1/11/2017 20:05	0.21	0.22	0.33	0.18	0.28
4	1/17/2017 10:15	0.51	0.29	0.41	0.66	0.57
5	1/20/2017 11:35	0.28	0.19	0.26	0.19	0.11
6	1/21/2017 23:15	0.89	0.82	0.95	1.02	1.01
7	2/7/2017 9:45	0.06	0.03	0.07	0.1	0.08
8	2/9/2017 1:35	0.5	0.53	0.65	0.37	0.45
9	2/11/2017 10:30	0.06	0	0	0.12	0.31
10	2/12/2017 9:50	0.23	0.21	0.27	0.31	0.4
11	2/25/2017 16:30	0.6	0.59	0.25	0.69	0.66
12	2/28/2017 11:55	0.4	0.19	0.25	0.22	0.33
13	3/10/2017 7:00	0.37	0.31	0.38	0.36	0.29
14	3/14/2017 4:30	0.35	0.67	0.67	0.1	0.01
15	3/16/2017 9:20	0.24	0.17	0.54	0.41	0.34
16	3/26/2017 22:00	0.16	0.14	0.16	0.15	0.28
17	3/28/2017 7:05	0.45	0.41	0.49	0.66	0.52
18	3/30/2017 20:50	2.18	1.83	2.51	1.83	2.27
	Subtotal (1/1/17-4/1/17)	8.79	7.63	9.56	8.44	9.23

Figure 2: Rainfall Event Summary, 1/1/17 - 4/1/17

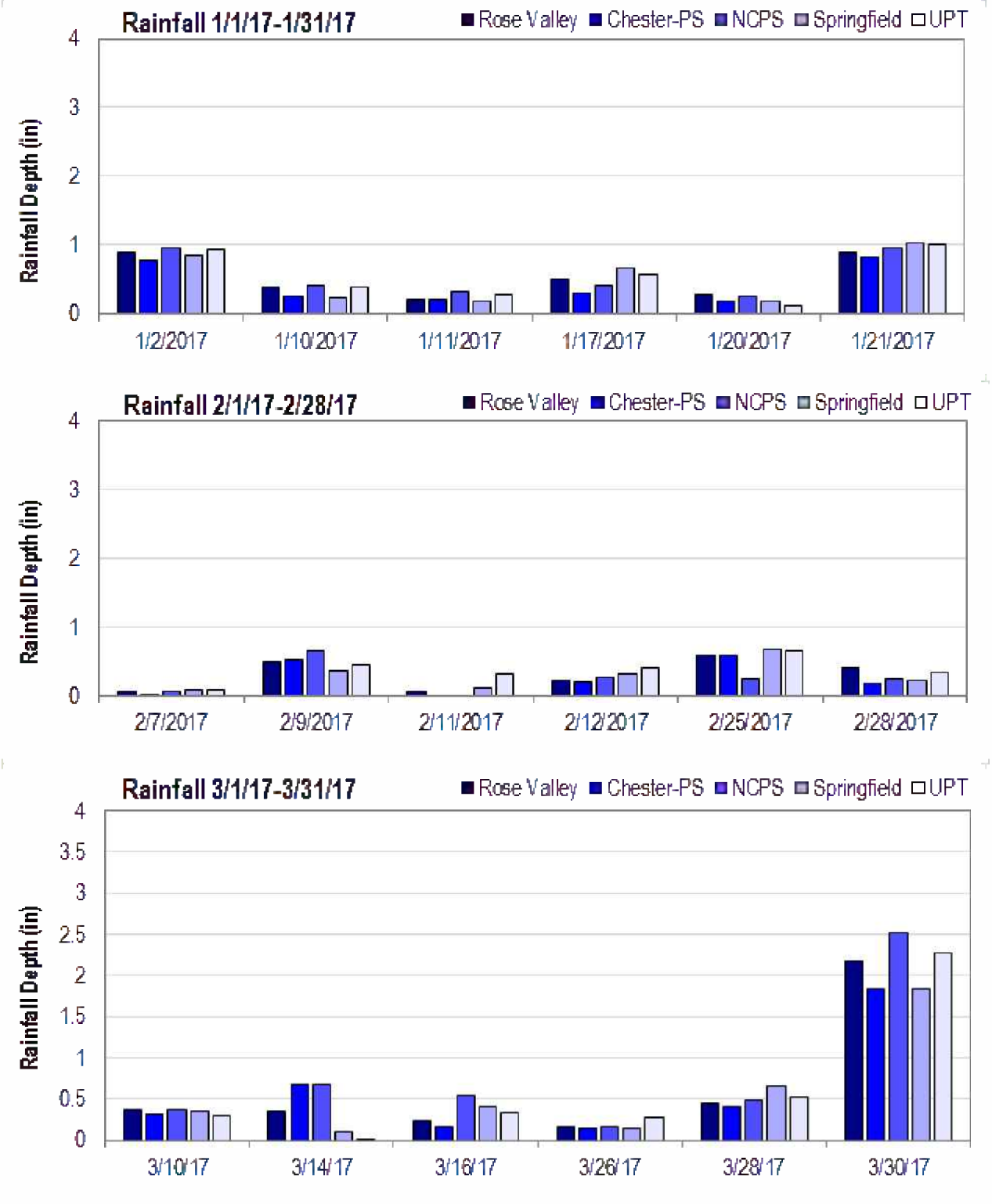
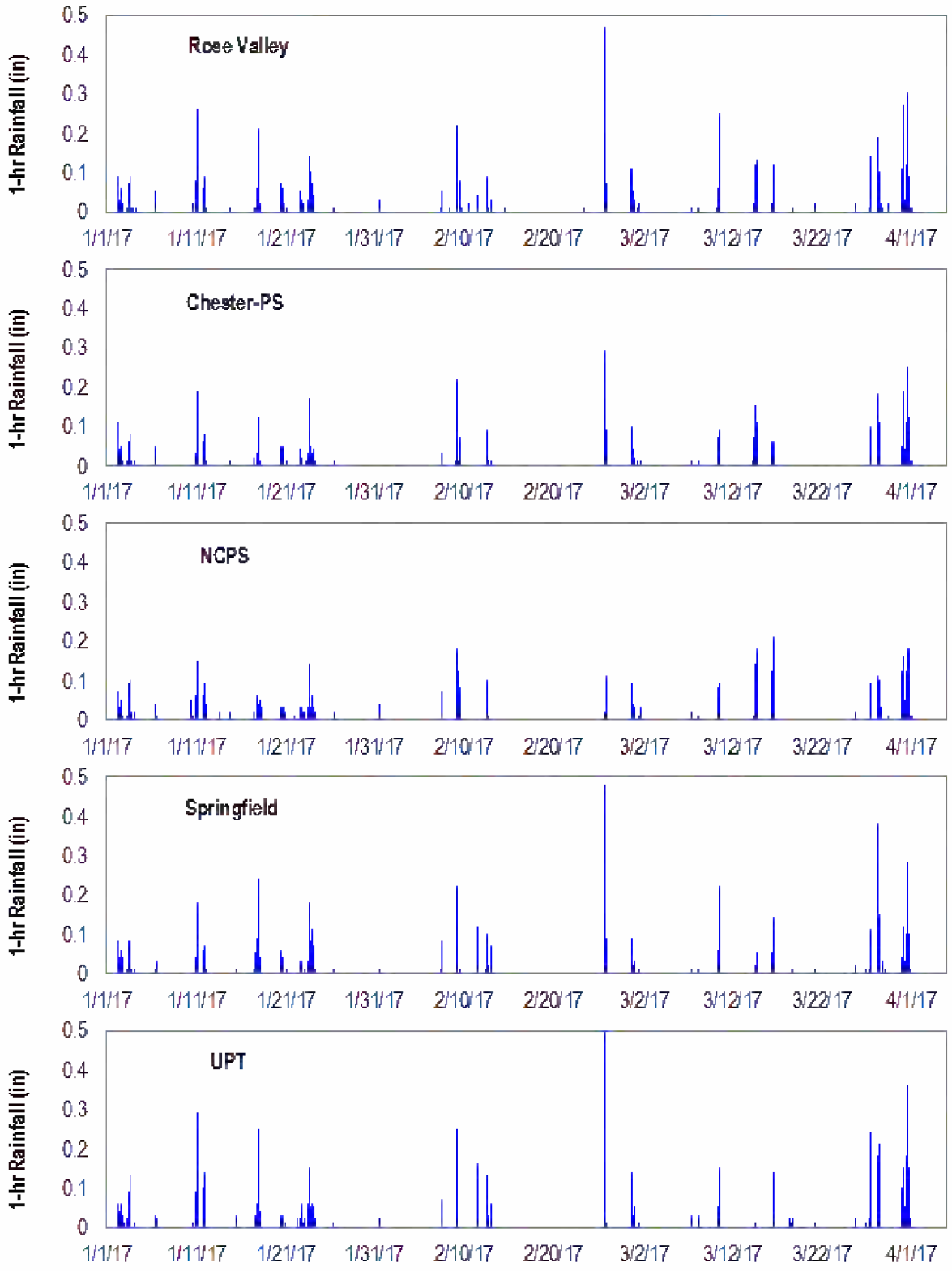


Figure 3: Hourly Rainfall Profile



2.3.1 Rainfall Return Frequency

Rainfall return frequency was analyzed for rain gauges RG_NCPS and RG_UPT because they usually record greater rainfall amounts than the others. The frequency analysis was also performed for RG_ChesterPS because it is located in the combined area.

Figure 4 shows Duration-Depth-Frequency (DDF) plot for RG_NCPS. One storm was recorded with total precipitation volumes greater than 1 inch. The event (3/30/17) is less than a 1-year event.

Figure 4: Duration-Depth-Frequency (DDF) Plot, RG_NCPS

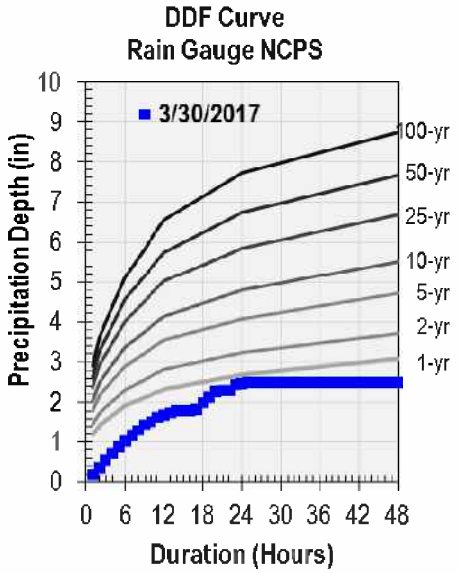


Figure 5 shows two Duration-Depth-Frequency (DDF) plots for RG_UPT. Two storms were recorded with total precipitation volumes greater than 1 inch. Both events (1/22/17 and 3/31/17) are less than 1-year events.

Figure 5: Duration-Depth-Frequency (DDF) Plot, RG_UPT

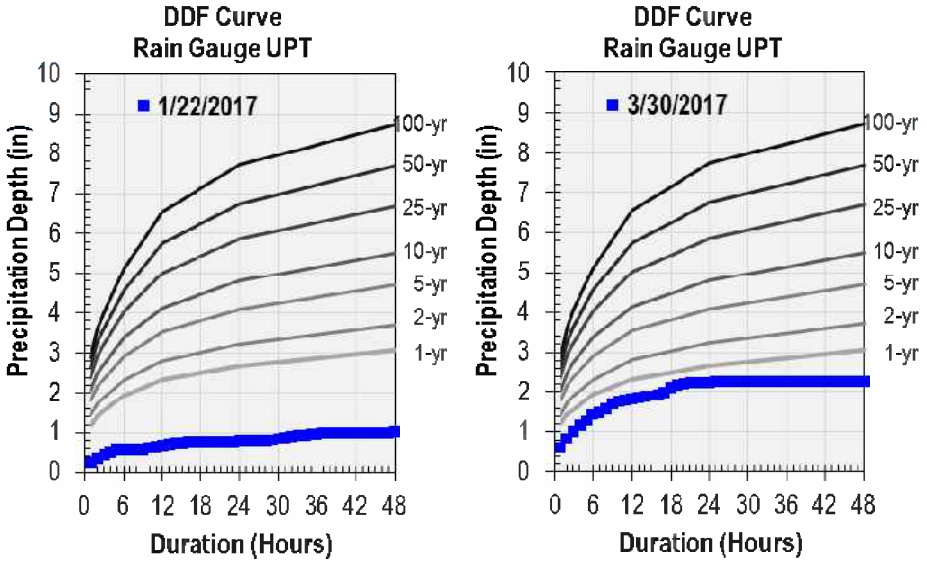


Figure 6 shows Duration-Depth-Frequency (DDF) plot for RG_ChesterPS. Only one storm (11/29/17) was recorded with a total precipitation volume greater than 1 inch. It is less than a 1-year event.

Figure 6: Duration-Depth-Frequency (DDF) Plot, RG_Chester PS

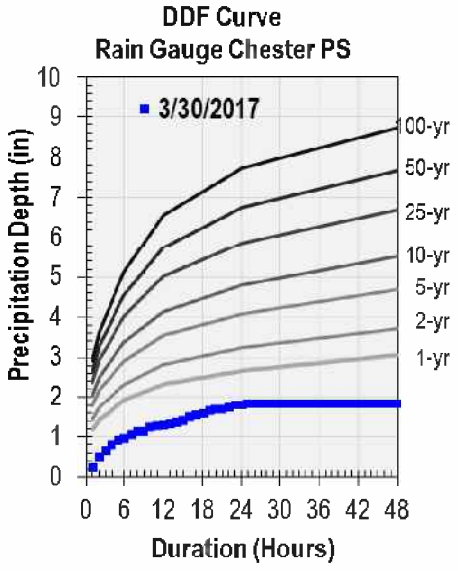
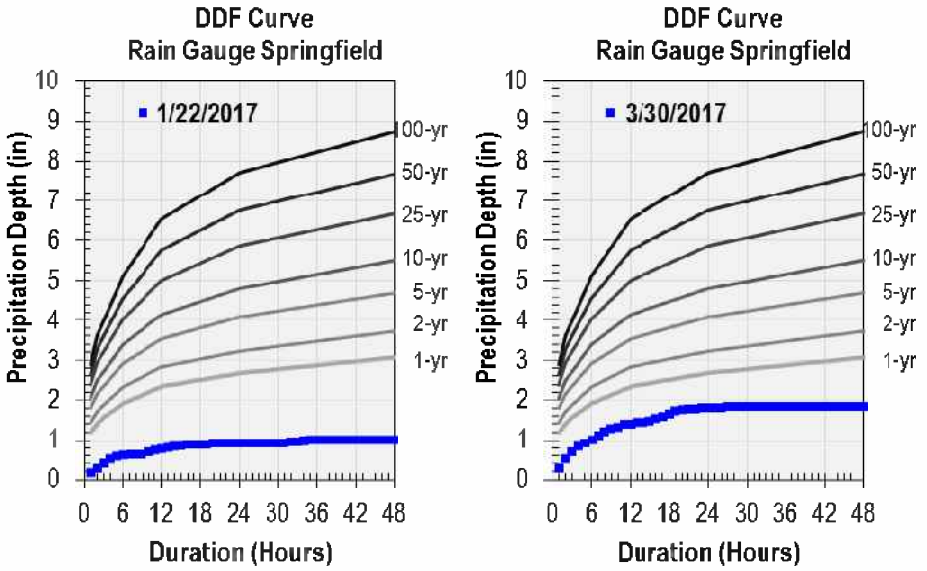


Figure 7 shows two Duration-Depth-Frequency (DDF) plots for RG_Springfield. Two storms (1/22/17 and 3/30/17) were recorded with a total precipitation volume greater than 1 inch. They are both less than a 1-year event.

Figure 7: Duration-Depth-Frequency (DDF) Plot, RG_Springfield



Section 3 Flow Meter Monitoring

3.1 Flow Monitoring Program

The site locations of the existing and newly installed flow meters are shown in **Figure 8**. **Figure 9** shows the newly installed flow meters on a larger scale, mostly in the combined area. These new meters were installed to investigate surface runoff from the combined area and CSO discharges, rainfall-derived inflow and infiltration (RDII) from the separated area, and system response to the wet weather conditions. The schematic of the newly installed flow meters is included in **Figure 10**.

The newly installed flow meter locations are categorized into the following four types:

- Category 1: Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
- Category 2: Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
- Category 3: Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.
- Category 4: Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
- Category 5: Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

One meter was proposed at manhole MH3029 to measure flow from the separated area upstream of the combined area (CSO#018). The site was severely surcharged during field investigation. Meanwhile it was found that at manhole MH3002 (four manholes upstream of MH3029, approximately 800 feet upstream) another CSL flow meter (Ridley Creek MH-28) was already installed for DELCORA. It was determined that instead of installing a new flow meter around the site, the team will use the existing meter Ridley Creek MH-28 for this flow monitoring program.

In total, 39 flow meters are included in this monitoring program. Details of the installed flow meters are included in **Table 3**.

3.2 Flow Meters Field Calibration/Verification Procedures

As part of the operation of flow meters, verifications of meter accuracy are performed on a regular basis. Calibrations are performed at a minimum every eight weeks, or more as needed.

The procedure used for performing meter calibrations is outlined below. This procedure only defines the required result. Any specific equipment function issues should be referred to the equipment manual or the manufacturer's technical support department.

Table 3: Details of the Newly Installed Flow Meters

Meter ID	GIS ID	Location	Pipe Size (in)	Material	Evidence of Surcharge	Category
CSO 02	3462	DS	36	Brick	Yes	2
CSO 03	2726	DS	38	Brick	Yes	2
CSO 05	2634	DS	48	Concrete	Yes	2
CSO 08	3463	DS	60	Concrete	Yes	2
CSO 14	3481	DS	45"x53"	Brick	Yes	2
CSO 19	690	DS	42"x43"	Concrete	Yes	2
Eff-02	3460	US	8	Clay	Yes	2
Eff-03	3454	DS	14.25	Concrete	Yes	2
Eff-05	2635	DS	12	Concrete	Yes	2
Eff-08	2246	DS	18.2	PVC	Yes	2
Eff-14	3482	DS	18	Concrete	Yes	2
Eff-19	***	DS	36	Concrete	Yes	2
In-03	2721	US	36	Brick	Yes	1
In-05	2634	US	28	Brick	Yes	1
In-08	3463	US	60	Concrete	Yes	1
In-09	1987	US	48	Cast Iron	Yes	1
In-10	1670	US	36	Brick	Yes	1
In-11	1770	US	49	Cast Iron	Yes	1
In-13	3479	US	48	Concrete	Yes	1
In-14	3481	DS	43"x47"	Brick	Yes	1
In-16	752	US	60	Concrete	No	1
In-17	691	US	36	Brick	Yes	1
In-18	3033	US	66"x43"	Concrete	Yes	1
In-19-1	625	DS	49"x47.5"	Clay	No	1
In-19-2	688	US	42"	Concrete	Yes	1
In-2	2751	DS	36	Corrugated PVC	No	1
In-25	3502	US	36	Concrete	Yes	1
In-26	1192	US	36	Brick	No	1
INT- 2nd St	1548	DS	40	Concrete	No	5
INT-DRI	2743	US	24	Clay	Yes	5
INT-Ridley 2	1487	US	44	Concrete	Yes	5
INT-Ridley 3	1509	US	48	Concrete	Yes	5
INT-WestEnd	2755	US	53	Concrete	No	5
Sep-1	2135	US	15	Clay	Yes	4
Sep-2	2134	DS	12	Clay	No	4
Sep-3	798	US	24	Clay	No	4
Sep-4 (Existing, Ridley Creek MH-28)			30	Concrete	No	4
Side-1	1571	US	36	Concrete	No	3
Side-2	2135	US	8	Clay	Yes	3

Figure 8: Existing and Newly Installed Flow Meter Locations

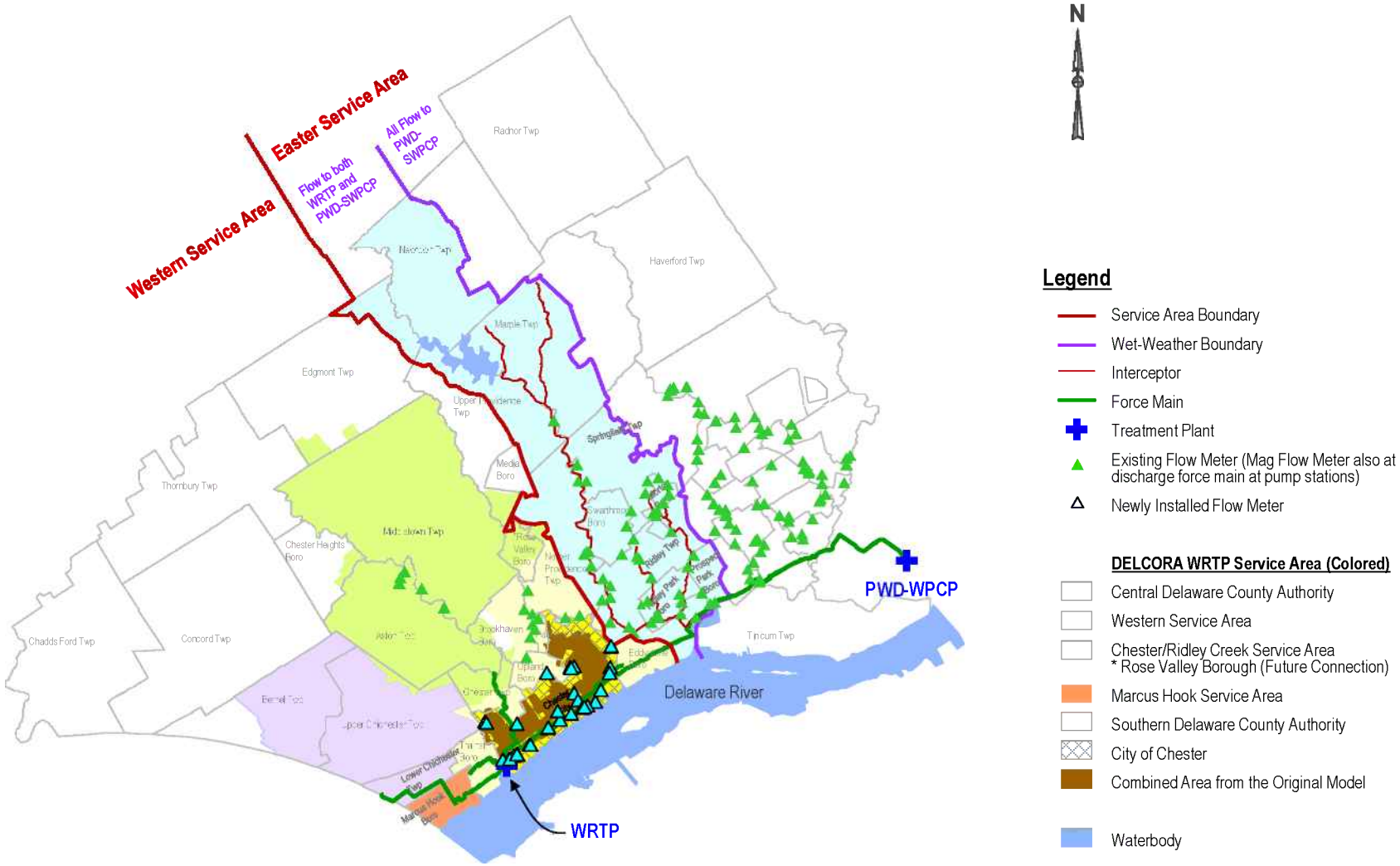


Figure 9: Newly Installed Flow Meter Locations

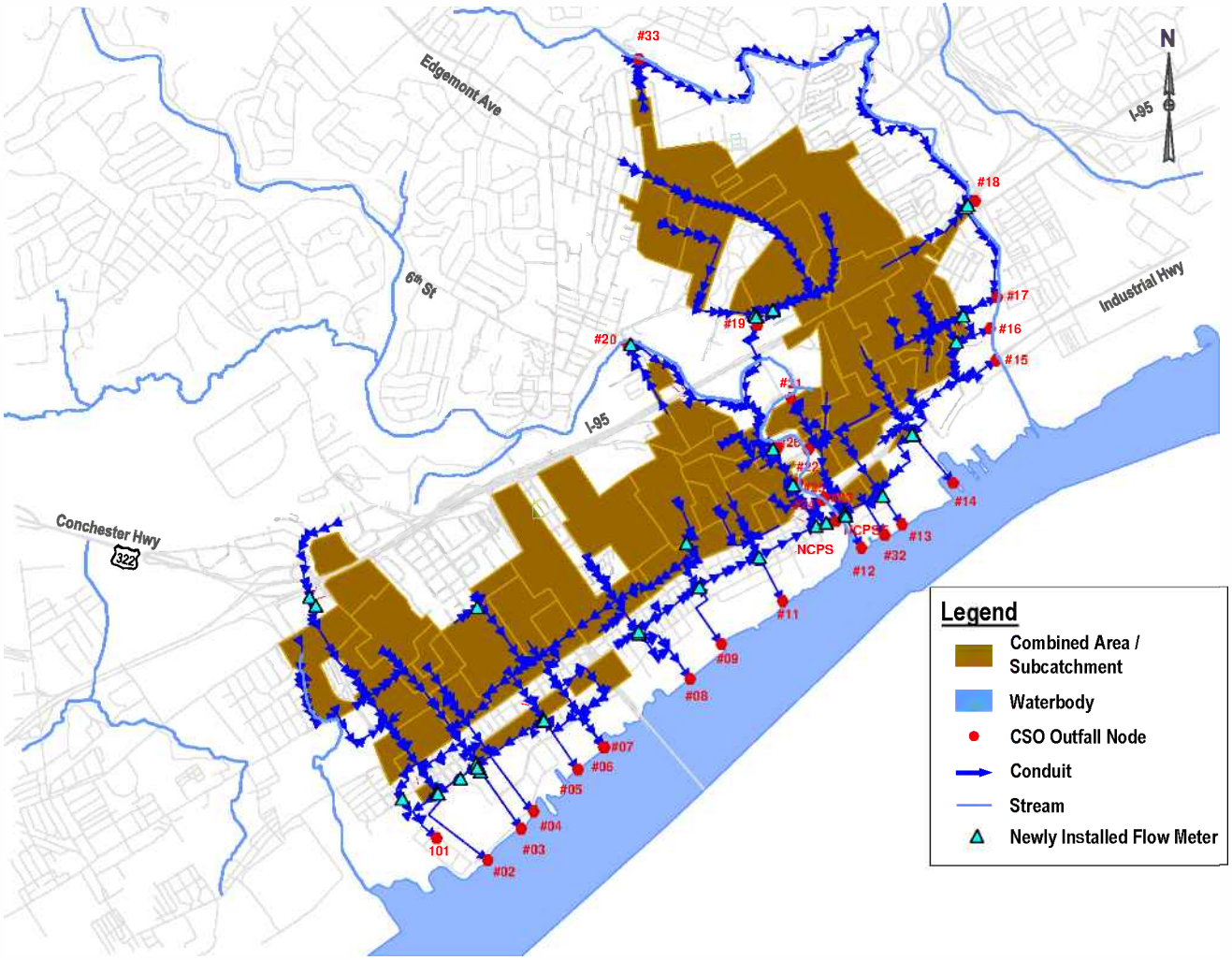
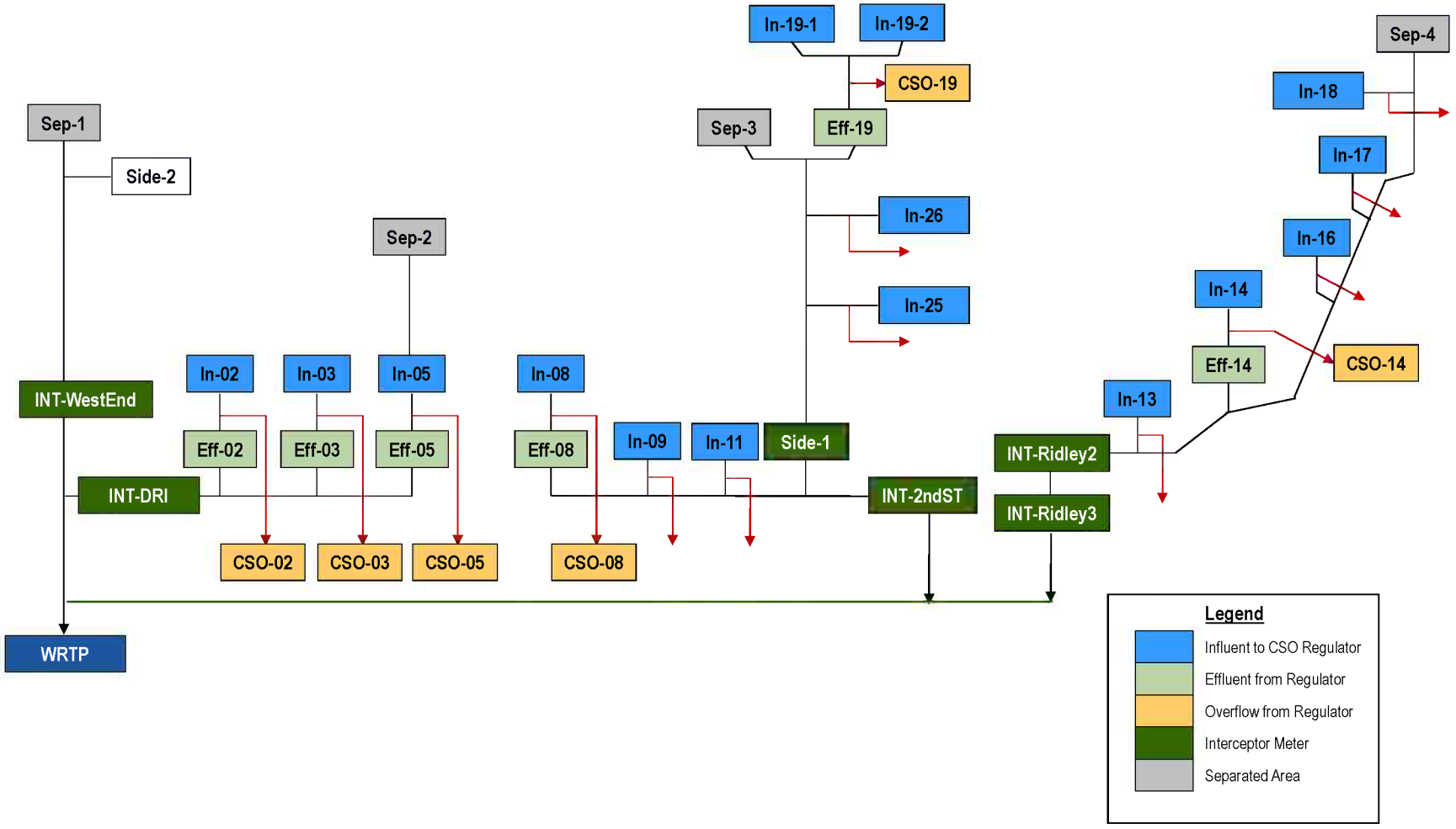


Figure 10: Flow Monitoring Schematic



Manually Downloaded Meters
This method is used for any meter that cannot be interrogated remotely by the data analyst. Field technicians use the *Daily Field Download Sheet* for recording the calibration results.

- Record the date.
- Record the field time, which is the local time.
- Record the meter time.
- Record the instantaneous depth reading from the meter.
- Measure the peak velocity.
- Record the instantaneous average or peak, whichever is applicable.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Remote Connection Meters
This method is used for any meter that can be interrogated remotely. The data analyst uses the *Daily Field Download Sheet* for single depth and velocity meters and the *Multi- Sensor Calibration Sheet* for meter types that record multiple depth and/or velocity readings.

- Fill all site visit information fields on form.
- Have the field tech measure the depth of flow and record with time.
- Record the time and instantaneous depth reading from the meter or the depth sensor, whichever is applicable. All available depth sensors should be activated and compared to the field measurement.
- Have the field tech measure the peak the velocity or have them perform a velocity profile if the depth is sufficient then record with time.
- Record the time and instantaneous velocity reading from the meter or the velocity sensor, whichever is applicable. All available velocity sensors should be activated and compared to the field measurement.
- Note any service performed at the site, included sensor scrubbing.

The resulting meter readings should be within 0.25" for depth and within 10% for peak-to-peak or average-to-average for velocity. Should readings be outside these guidelines, troubleshooting is conducted per the manufacturer guidelines. If this does not resolve the discrepancy, the data manager is notified.

Special Cases

- Blind Verifications: A blind verification occurs when a field technician's only role is to measure the depth and velocity of the flow and report the values to the data analyst. In these cases, the crew is "blind" to what the meter is reading. The data analyst will then compare the readings to current/recent data or live readings. Should the blind verification be out of tolerance, the analyst can direct the crew to perform additional blind verifications or perform a conventional verification and/or troubleshoot as necessary.

- Installations/Removals: When installing or removing meters, the above calibration method should be used for three consecutive verifications, performed at 5 minute intervals.
- Third Party Audit: When performing a calibration at a meter that is not maintained by CSL and where CSL is to verify the meter function, the CSL Audit report should be used.

3.3 Flow Monitoring Data Summary

Flow, level and velocity data are received for each flow monitoring site at 5-minute intervals (Sep-4 has 15-min interval data). Metering data is analyzed for dry weather flows (DWF), hourly peak flows, and hourly peaking factors for each monitoring site. A "dry weather" condition was defined as a period with no precipitation that begins three days after the last wet weather event and lasts until the beginning of the next precipitation event.

Table 4 shows dry weather flow (DWF), hourly peak flow, hourly peaking factor and flow condition observations.

The dry weather flows are also shown in the schematic in **Figure 11**. Generally the downstream dry weather flow is greater than the upstream locations for all of the meters. For meters immediately upstream and downstream of CSO regulators, the upstream and downstream dry weather flows should be similar. **Figure 12** shows the influent and effluent from CSO#08 as an example to indicate that the dry weather of the two are similar.

The hourly peaking factor in the combined area is in the range of 7 to 99 and average at 27. The hourly peaking factor for the interceptor is between 2.8 and 5.2 with an average of 3.9. The hourly peaking factor is between 2.7 and 3.6 for the separated area, with an average of 3.1.

A detailed hydrograph and scattergraph for each flow monitoring site is shown in **Figure 13** to **Figure 51**, each includes:

- The flow hydrographs show hourly flow and rainfall profile. Hourly Rainfall data is included for the convenience of reviewing flow response to the wet weather conditions. Hourly flow and rainfall were calculated from the 5-min interval.
- The scattergraphs (based on 5-min data, excepting 15-min data for Sep-4) are essentially a plotting of flow rate versus depth. This plotting helps to understand the flow patterns and conditions on the individual monitored sewer pipes.
- For CSOs 02, 03, 05, 08, 14, & 19, flows including influent, effluent and overflows were plotted in the same plot.

Table 4: Flow Monitoring Summary

Meter ID	Hourly Peak (MGD)DWF	DWF (MGD)	Hourly Peaking Factor	Comments
In-02	6.66	0.28	23.66	Free flow most of the time
Eff-02	0.68	0.28	2.43	Surcharged under common conditions
CSO-02	4.86	0.01		Free flow most of the time
In-03	4.94	0.23	21.49	Free flow most of the time
Eff-03	0.67	0.22	3.02	Surcharged under large storms
CSO-03	3.76	0.00		Free flow most of the time
In-05	12.00	0.77	15.65	Backwater observed
Eff-05	2.55	0.70	3.66	Severely surcharged under common conditions
CSO-05	10.83	0.01		Free flow most of the time, backwater observed
In-08	17.92	1.00	17.98	Free flow most of the time
Eff-08	6.55	0.90	7.25	Free flow most of the time
CSO-08	10.22	0.02		Free flow most of the time
In-09	5.54	0.14	40.05	Free flow most of the time
In-10	4.18	0.17	24.72	Free flow most of the time
In-11	6.09	0.19	32.57	Free flow most of the time
In-13	29.03	0.25	115.46	Free flow most of the time, backwater during large storms
In-14	7.50	0.42	17.66	Backwater observed
Eff-14	4.97	0.42	11.86	Free flow mostly, backwater and surcharge during large storms
CSO-14	3.04	0.00		Free flow most of the time
In-16	3.36	0.30	11.33	Free flow most of the time, backwater during large storms
In-17	4.81	0.16	29.36	Backwater observed
In-18	9.67	0.11	91.49	Free flow most of the time
In-19-1	6.49	0.68	9.53	Free flow most of the time
In-19-2	6.31	0.50	12.71	Free flow most of the time
Eff-19	3.66	1.25	2.92	Free flow most of the time
CSO-19	11.53	0.01		Free flow most of the time
In-25	5.94	0.11	55.13	Free flow mostly, backwater observed
In-26	4.47	0.22	20.41	Free flow mostly
INT-2nd St	12.85	3.58	3.59	Free flow mostly, surcharge and backwater during large storms
INT-DRI	3.47	1.57	2.21	Severe surcharge and backwater observed
INT-Ridley 2	15.86	3.28	4.84	Free flow mostly, surcharge and backwater observed
INT-Ridley 3	17.64	3.60	4.90	Free flow mostly, surcharge and backwater observed
INT-WEI	7.16	1.40	5.10	Free flow mostly
Sep-1	0.78	0.13	5.83	Free flow mostly
Sep-2	0.61	0.13	4.66	Free flow mostly
Sep-3	2.40	0.46	5.21	Free flow mostly
Sep-4	5.64	1.52	3.70	Free flow mostly
Side-1	7.36	2.19	3.37	Free flow mostly, surcharge and backwater observed
Side-2	1.08	0.22	4.82	Free flow mostly

Figure 11: Dry Weather Flow Balance Schematic

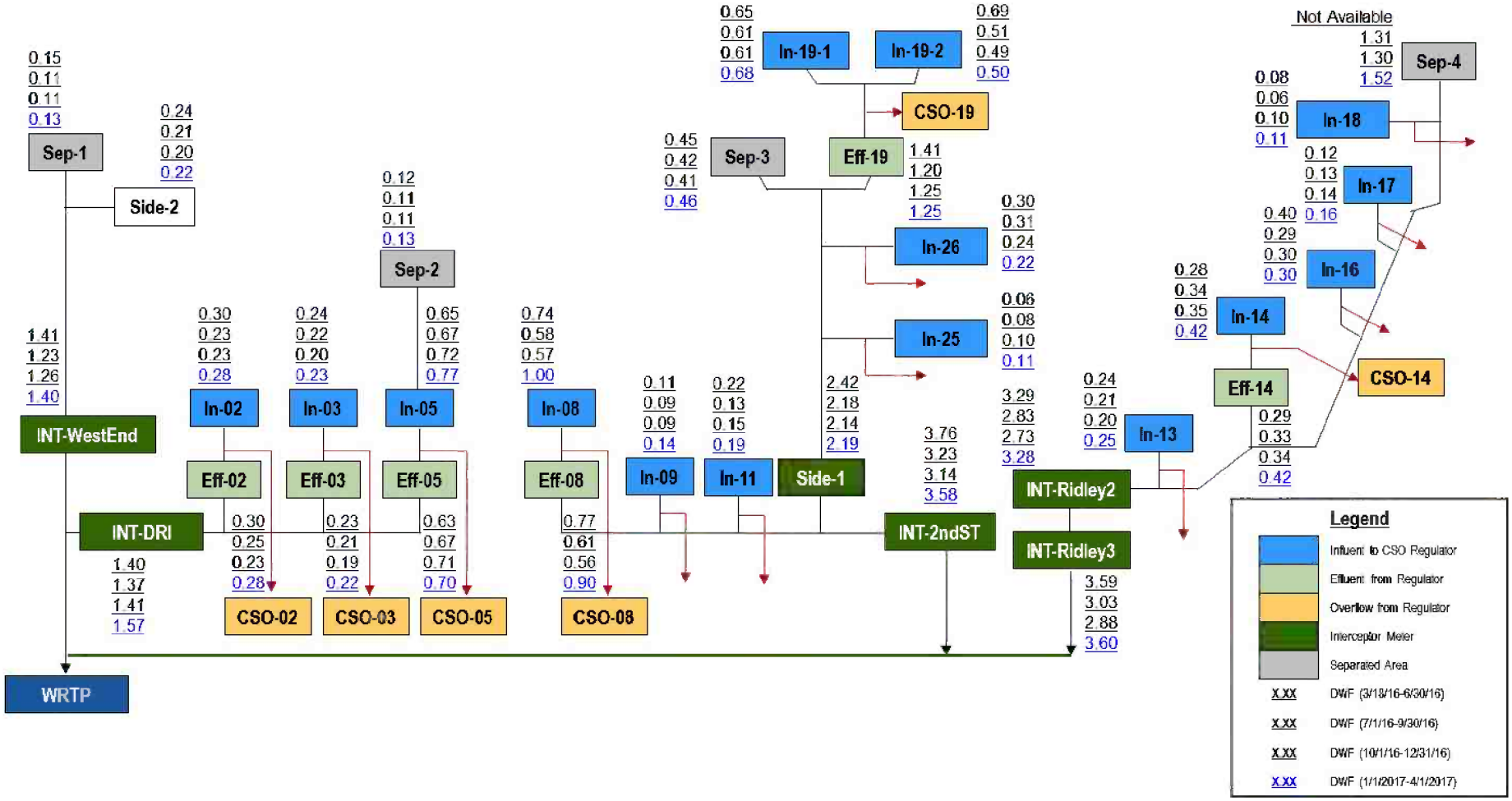


Figure 12: Flow Hydrograph In-08 and Eff-08

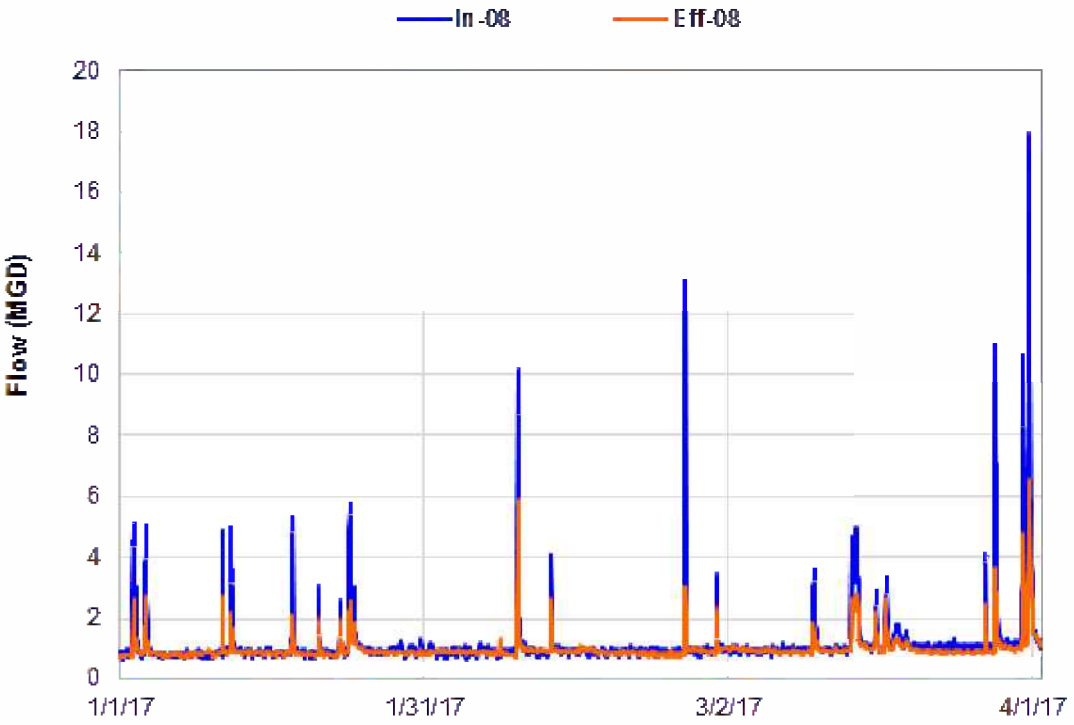
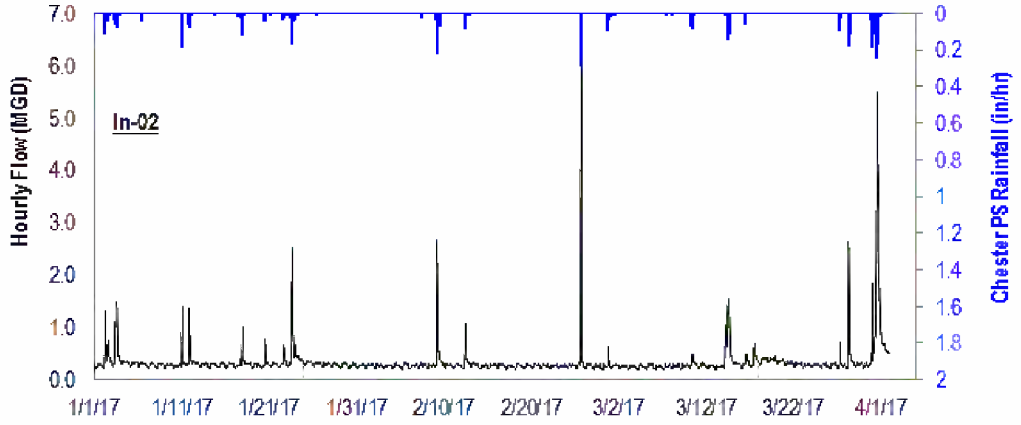
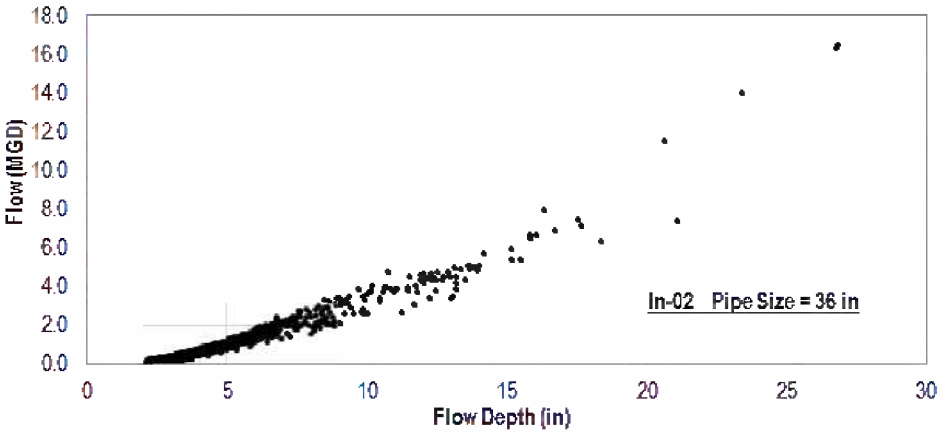


Figure 13: Flow Monitoring Data, In-02

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#02 Influent , Effluent and Overflow

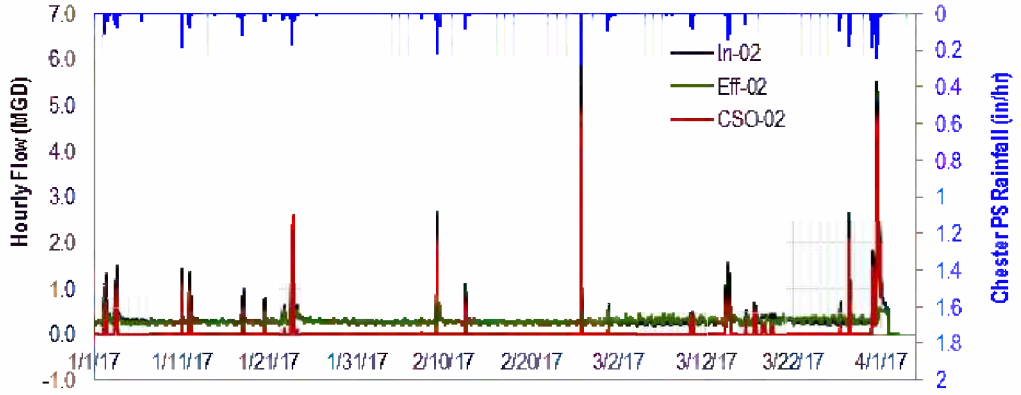


Figure 14: Flow Monitoring Data, EFF-02

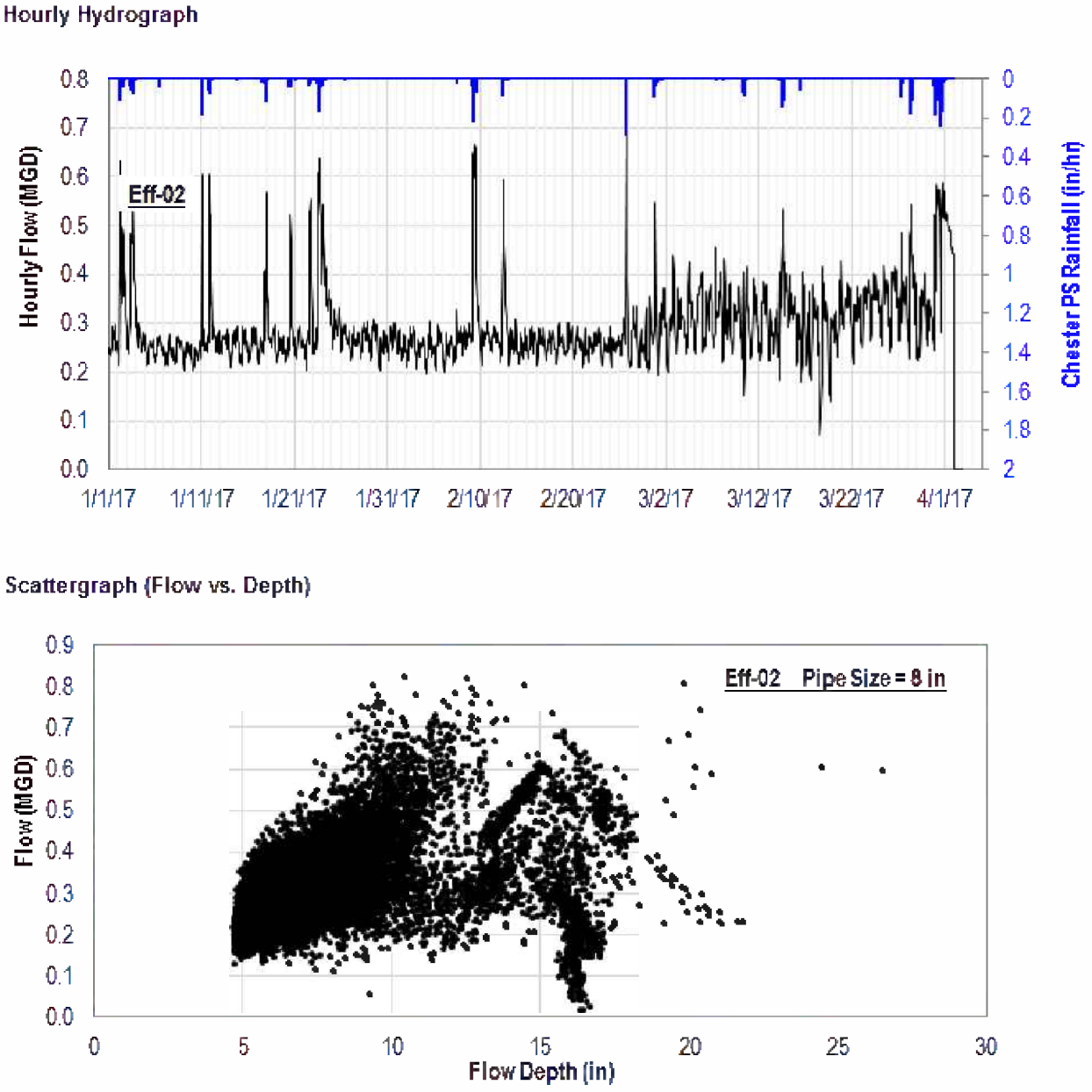


Figure 15: Flow Monitoring Data, CSO-02

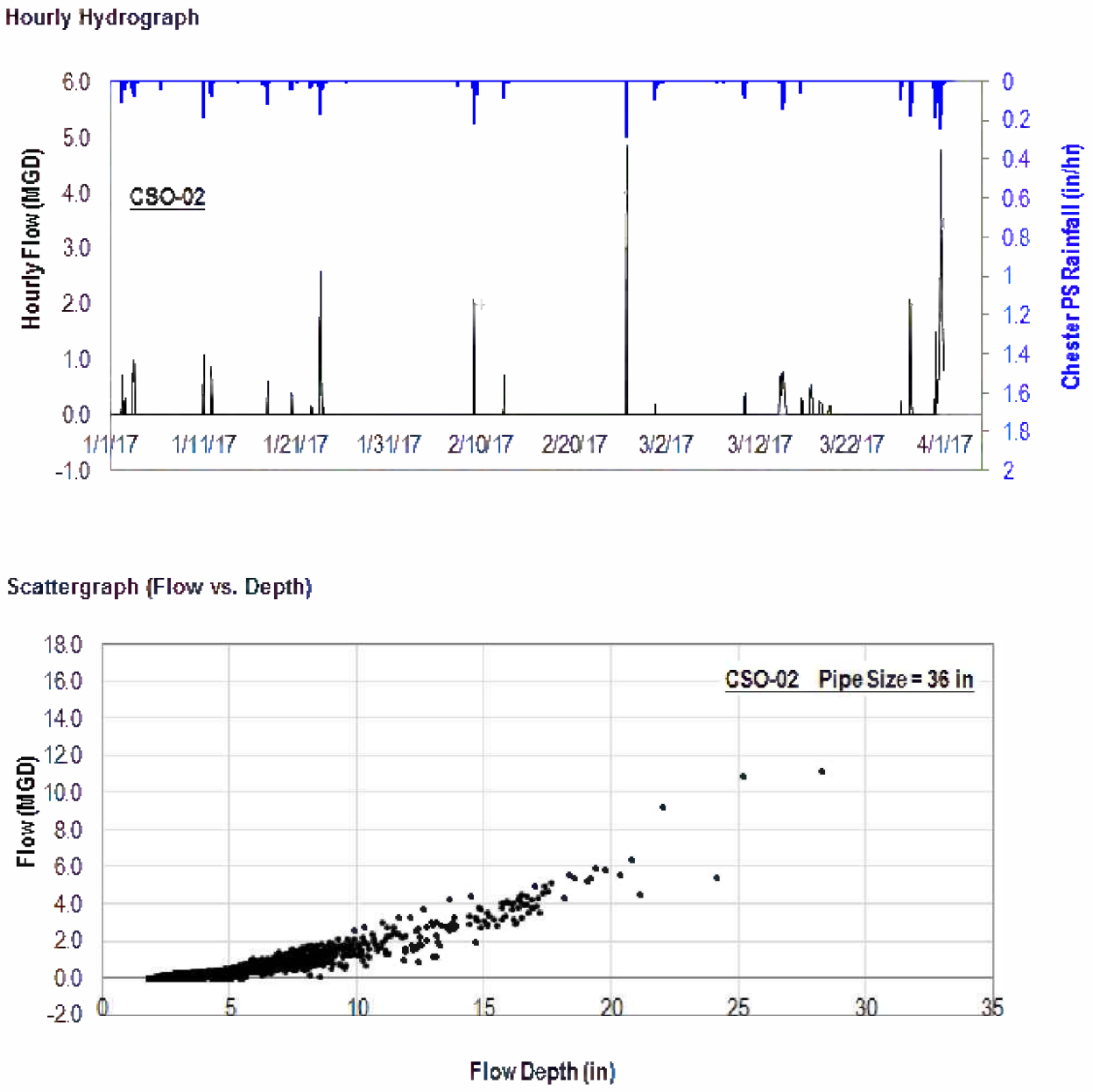
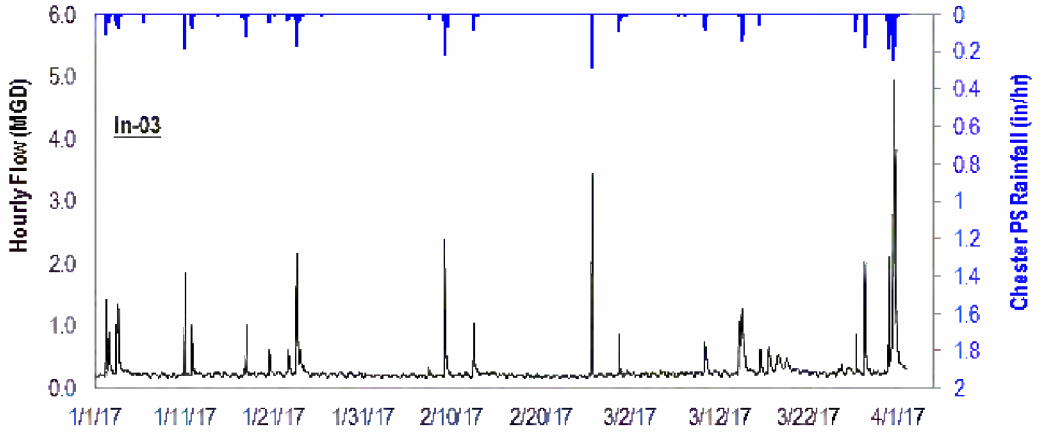
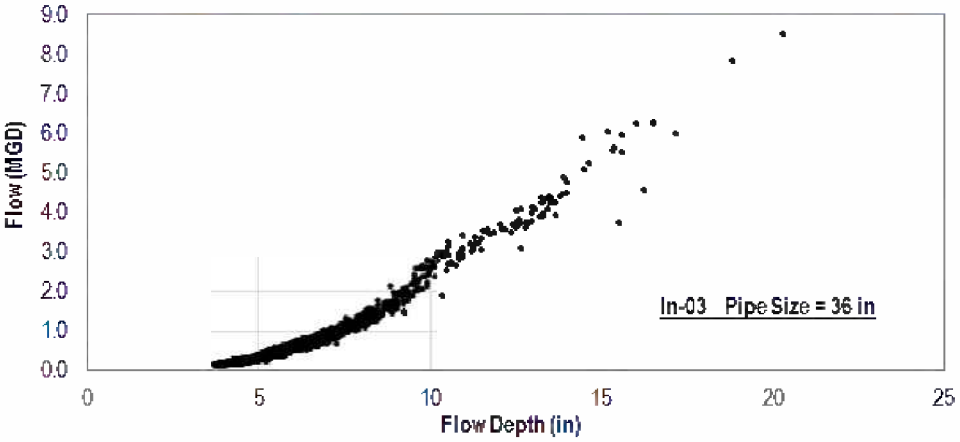


Figure 16: Flow Monitoring Data, IN-03

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#03 Influent , Effluent and Overflow

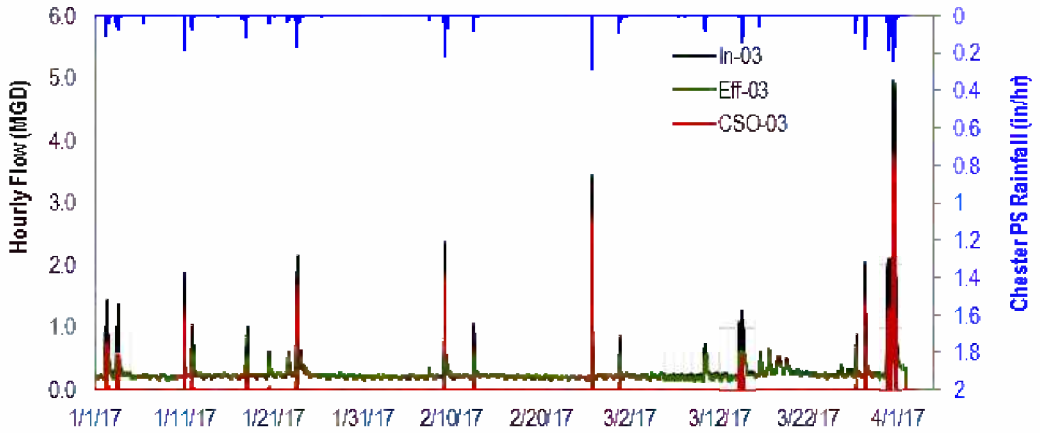


Figure 17: Flow Monitoring Data, Eff-03

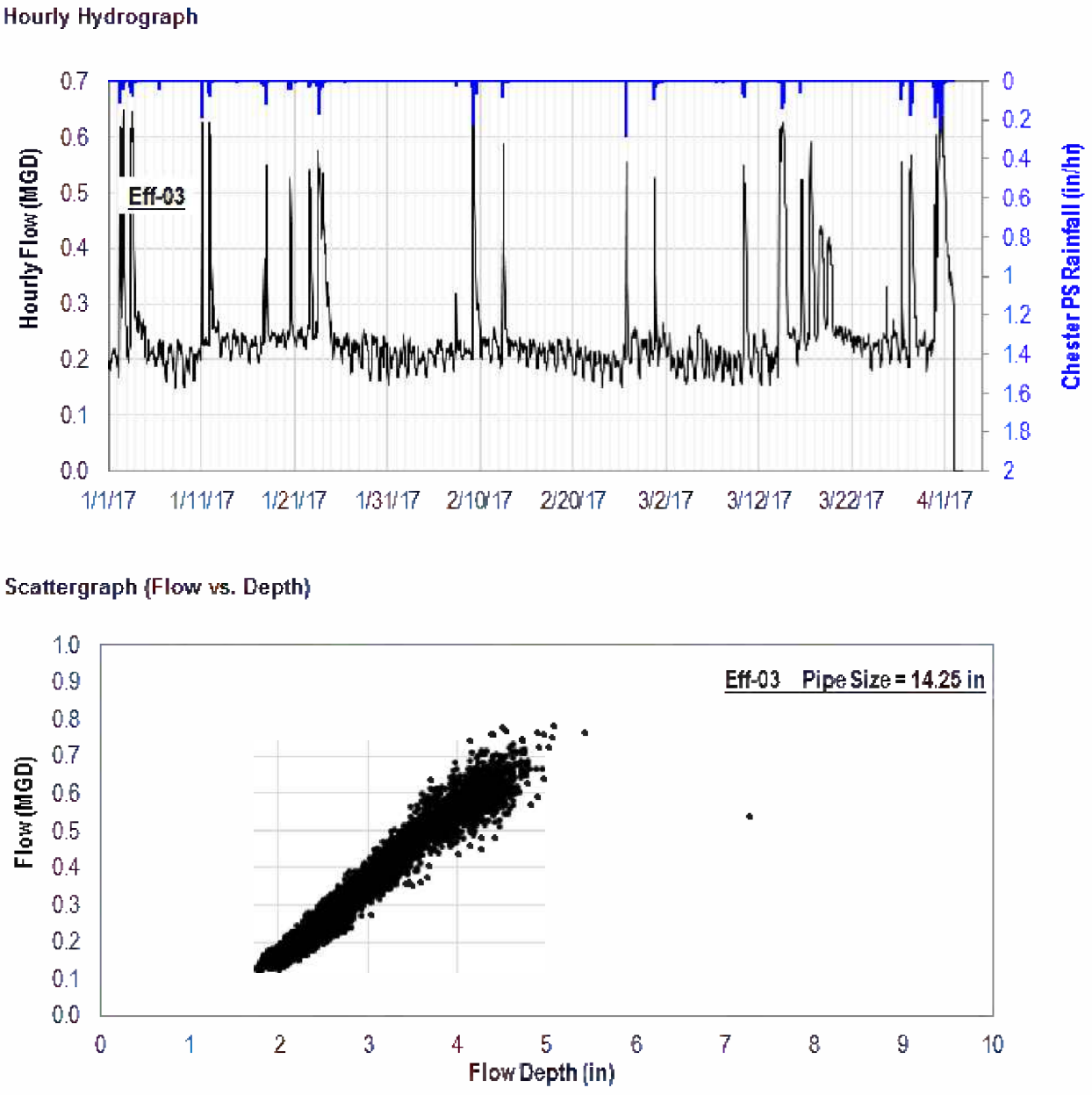


Figure 18: Flow Monitoring Data, CSO-03

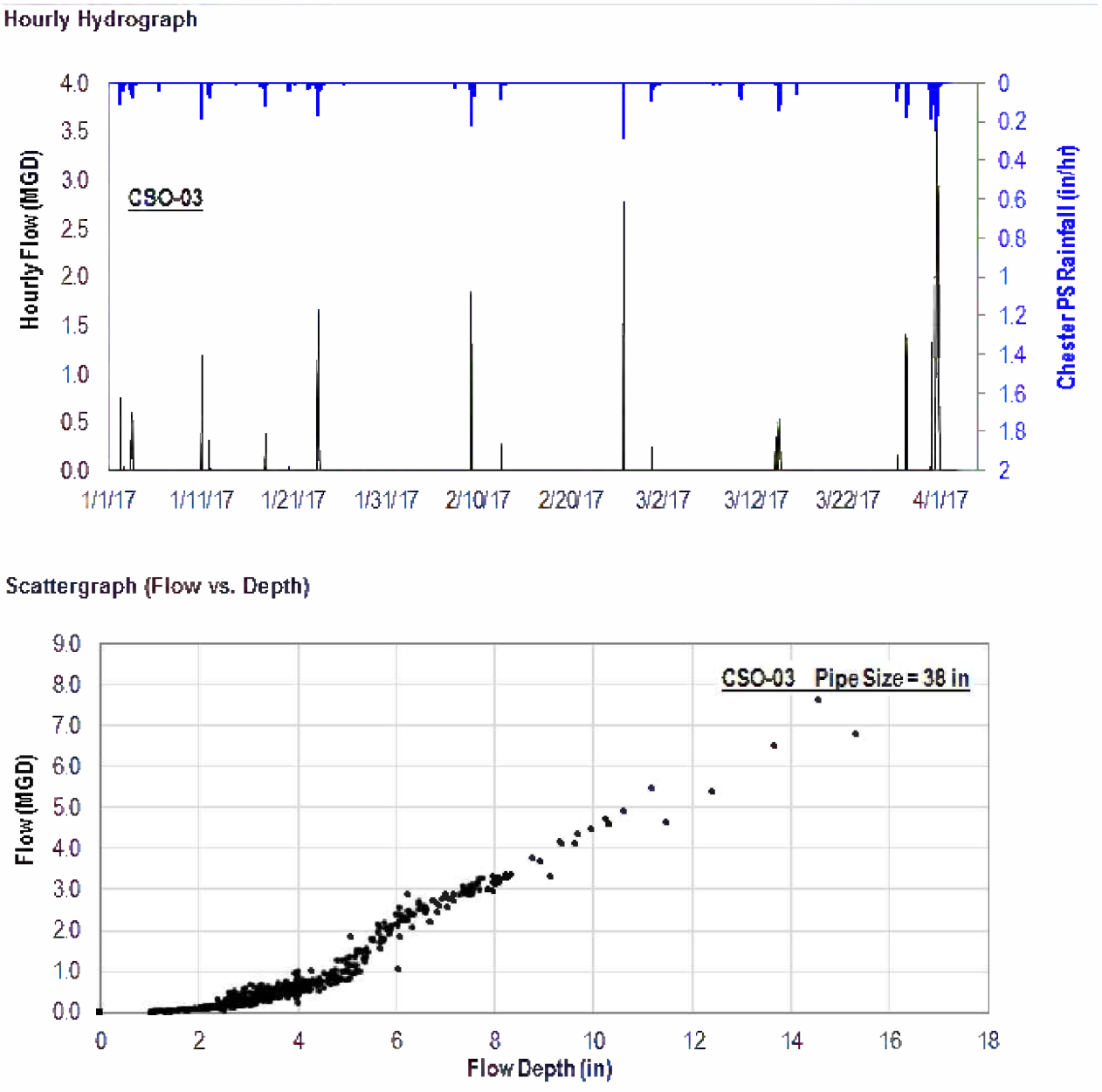
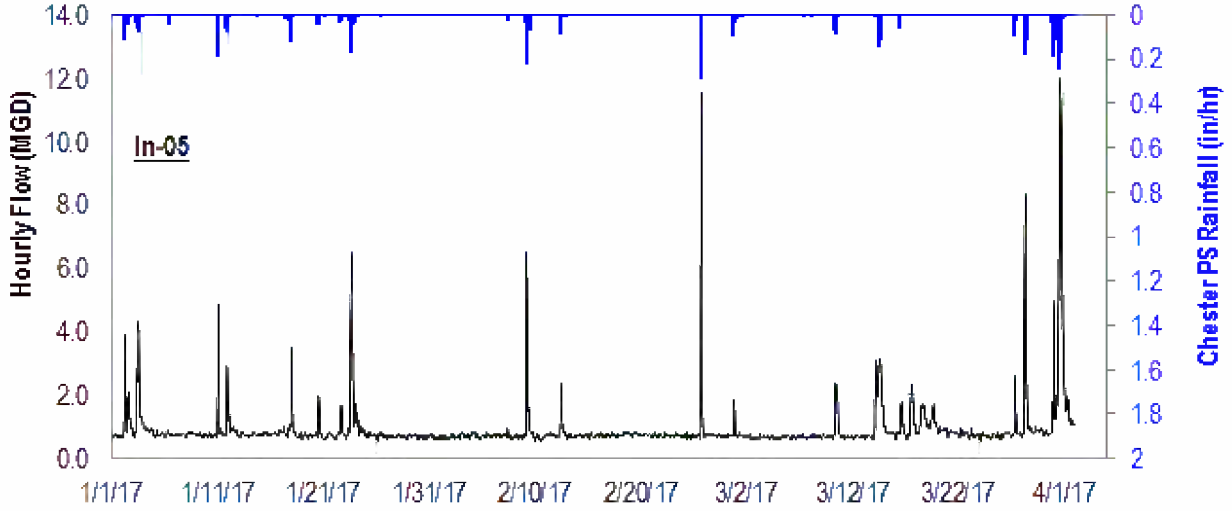


Figure 19: Flow Monitoring Data, IN-05

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

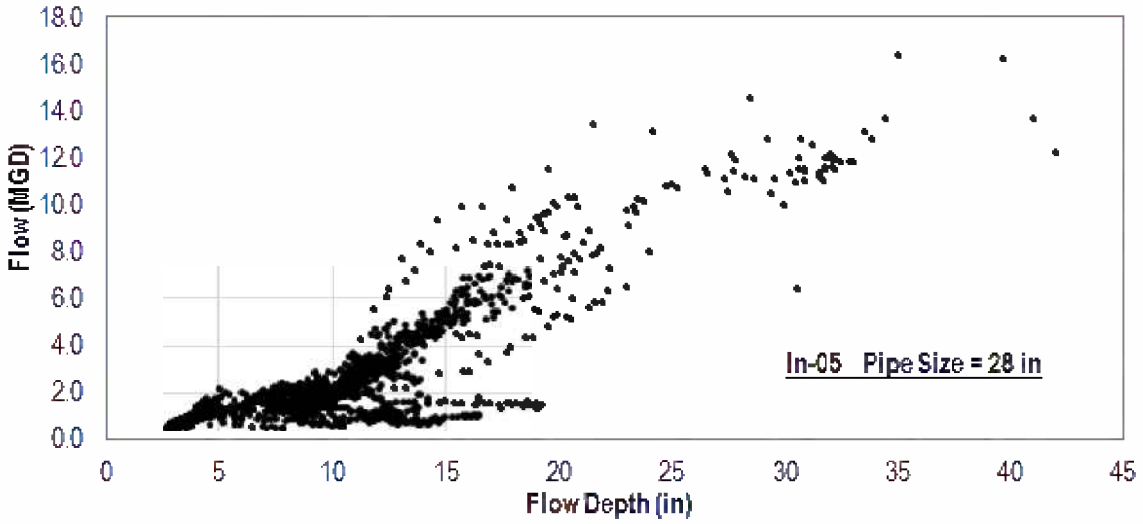
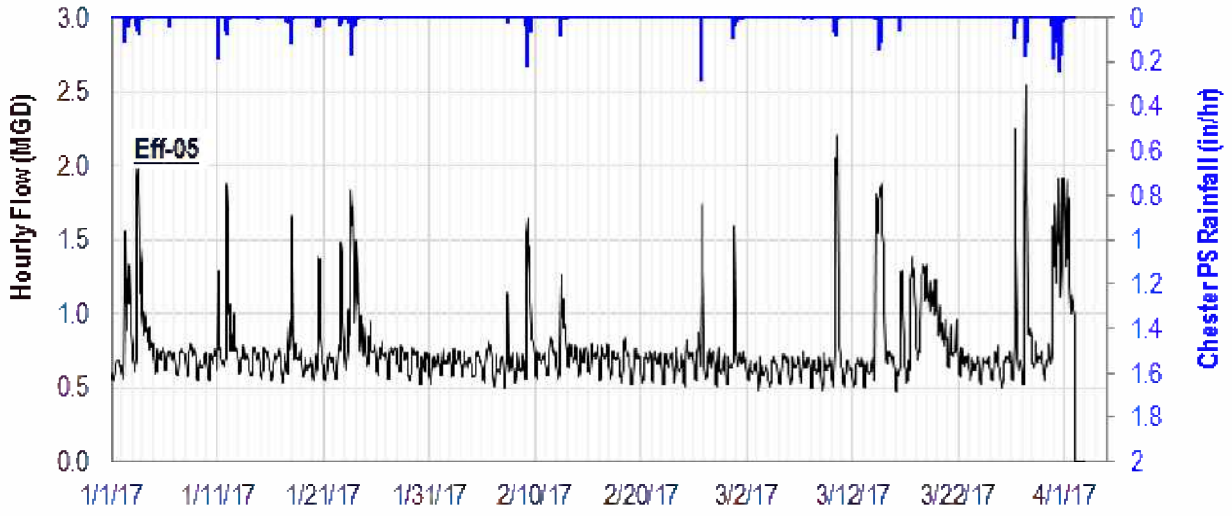


Figure 20: Flow Monitoring Data, Eff-05

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

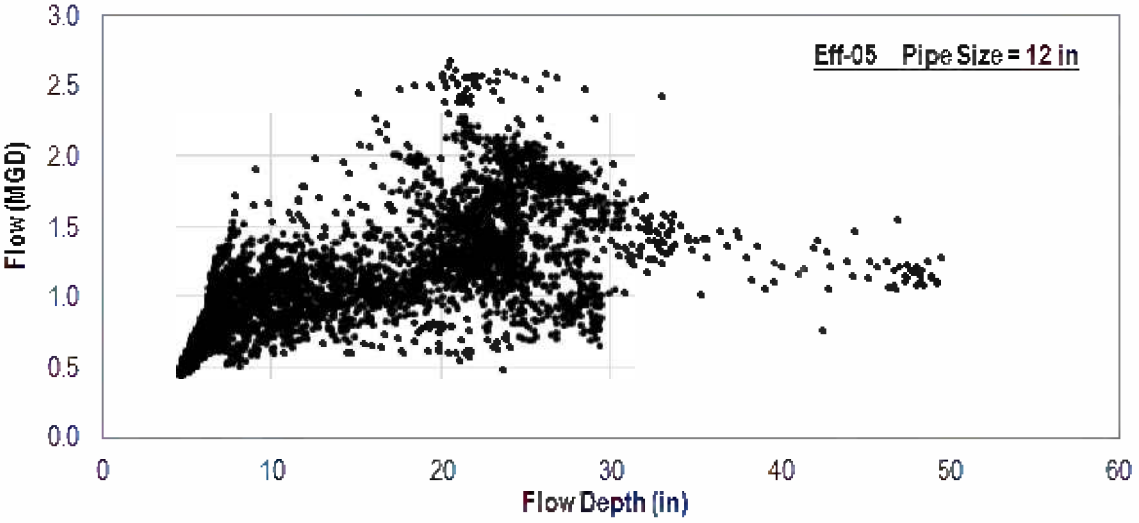


Figure 21: Flow Monitoring Data, CSO-05

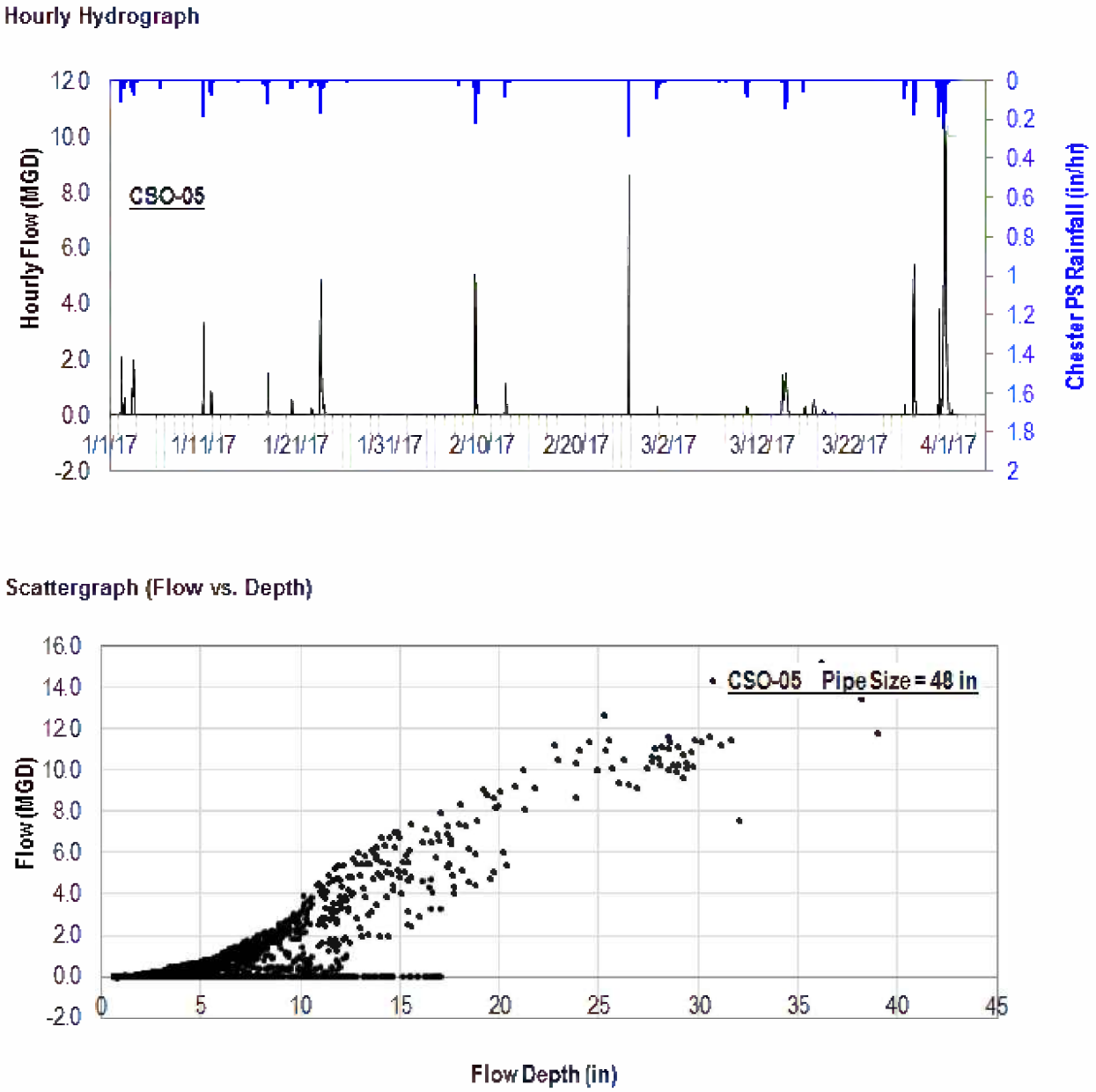
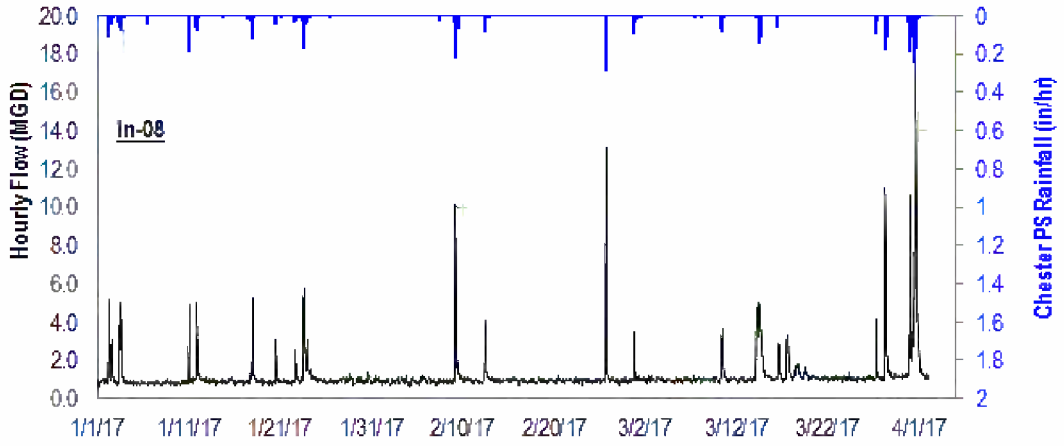
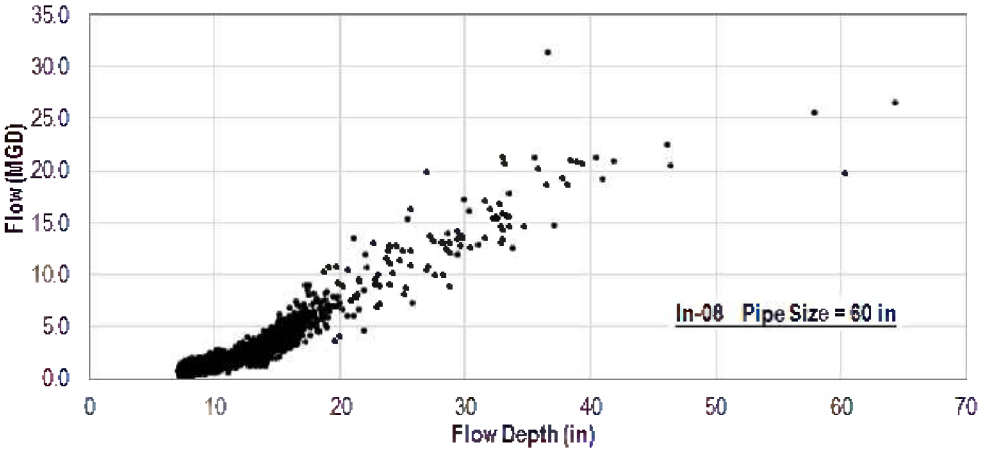


Figure 22: Flow Monitoring Data, IN-08

Hourly Hydrograph



Scattergraph (Flow vs. Depth)



CSO#08 Influent , Effluent and Overflow

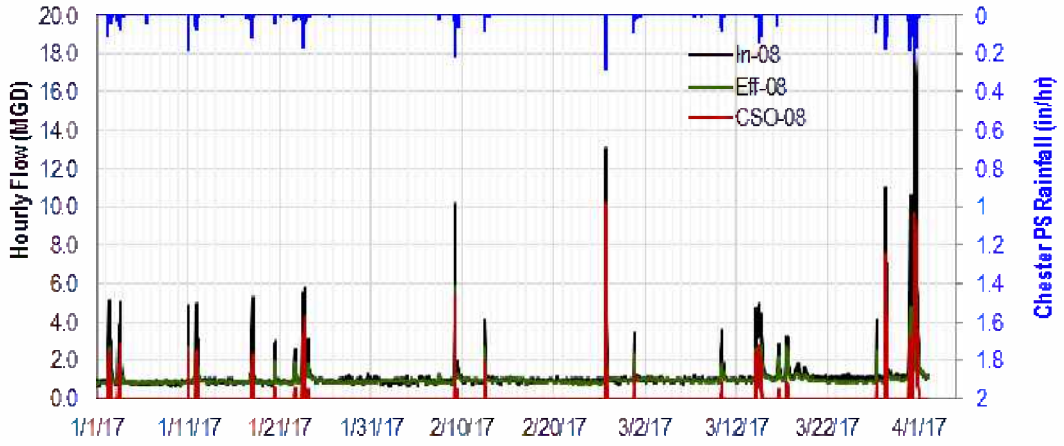


Figure 23: Flow Monitoring Data, Eff-08

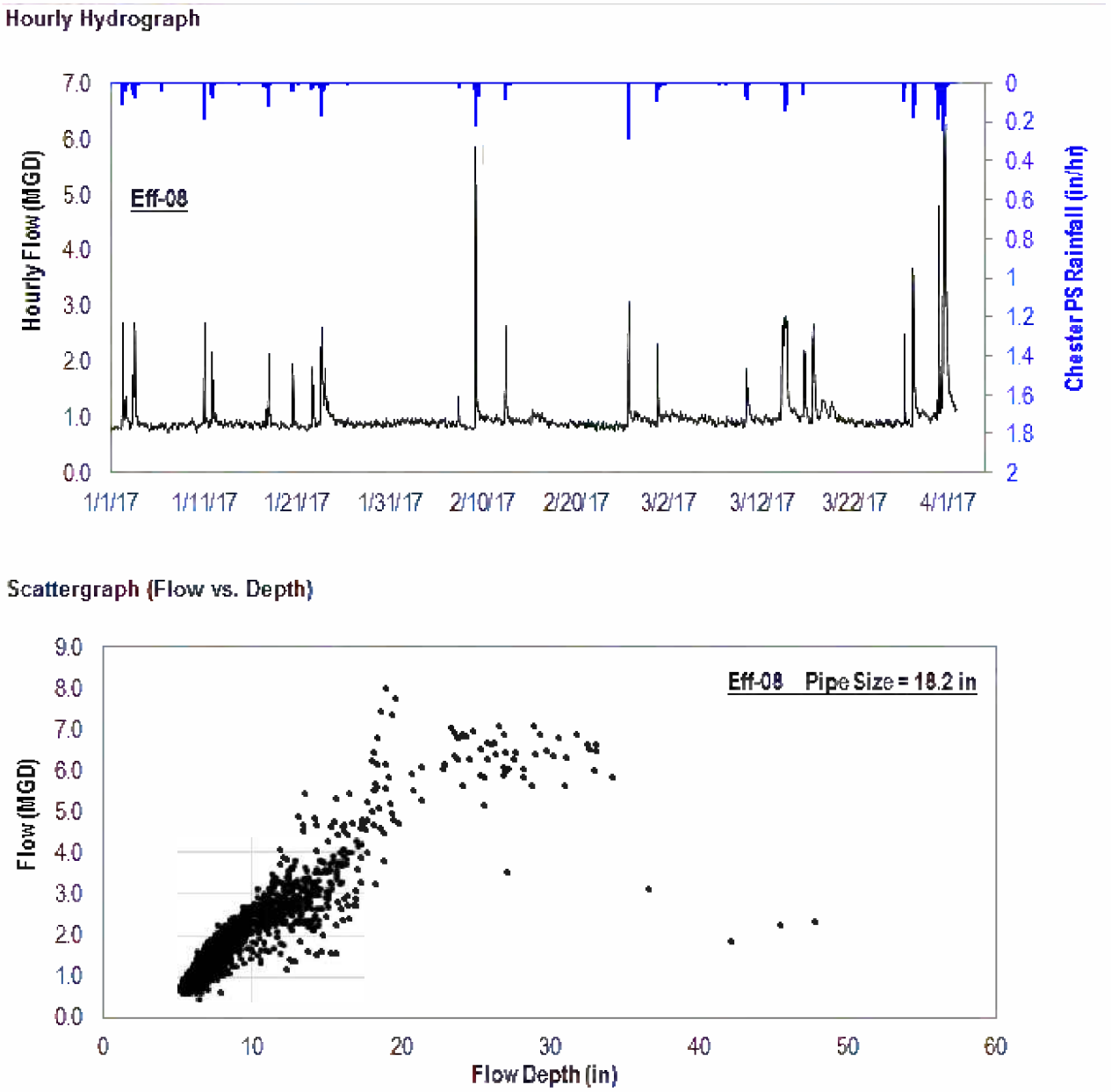


Figure 24: Flow Monitoring Data, CSO-08

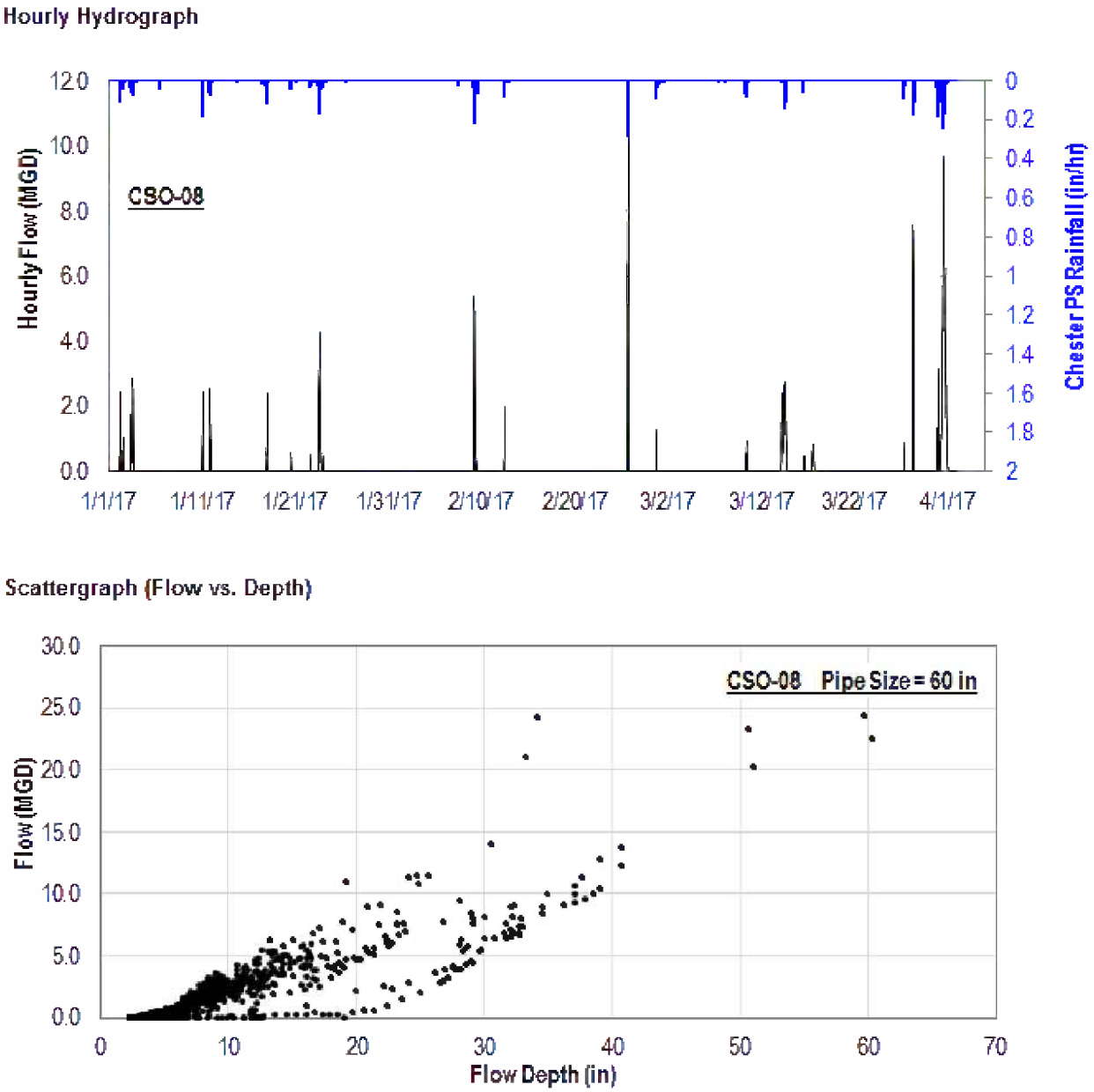


Figure 25: Flow Monitoring Data, In-09

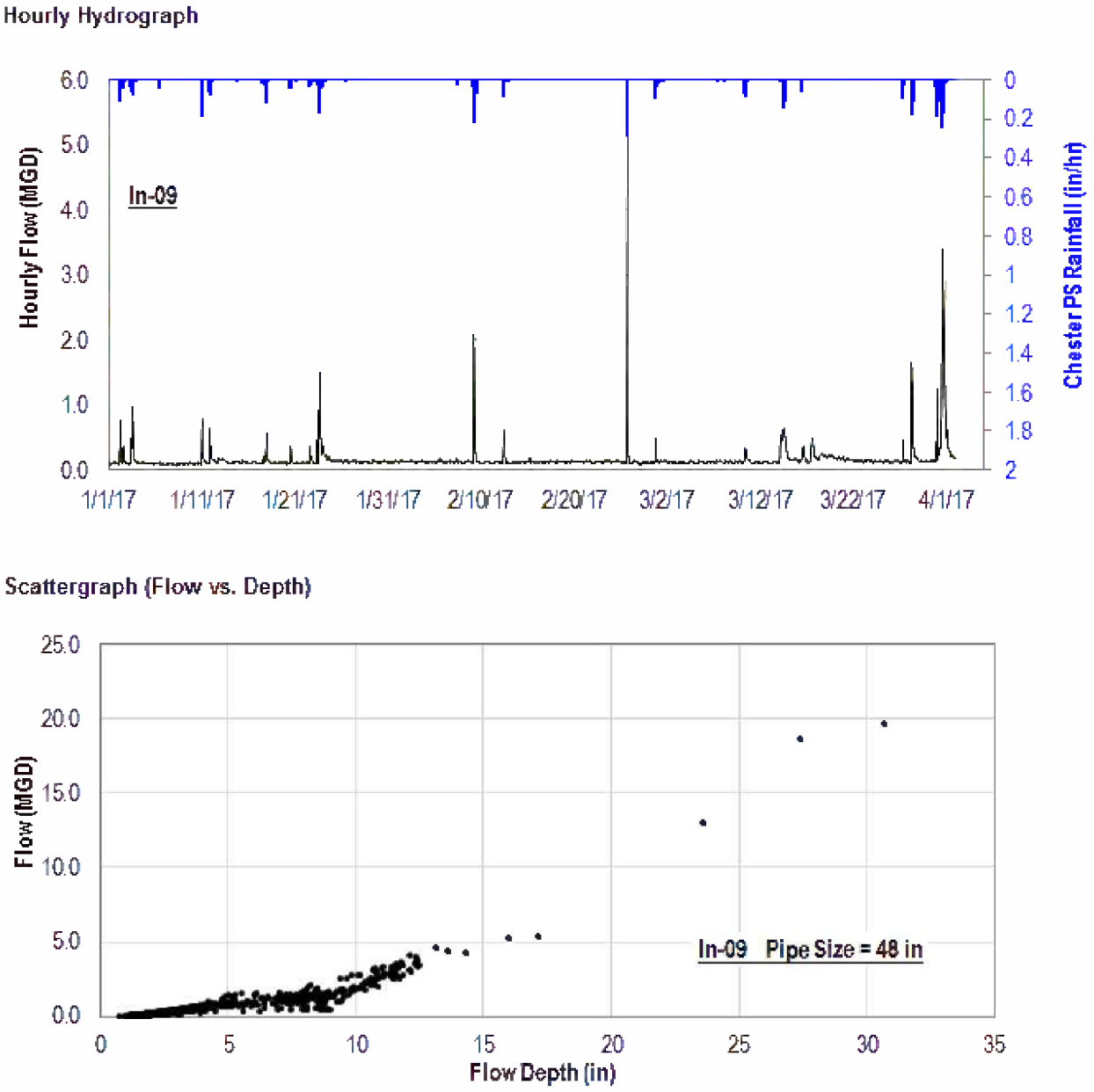


Figure 26: Flow Monitoring Data, In-10

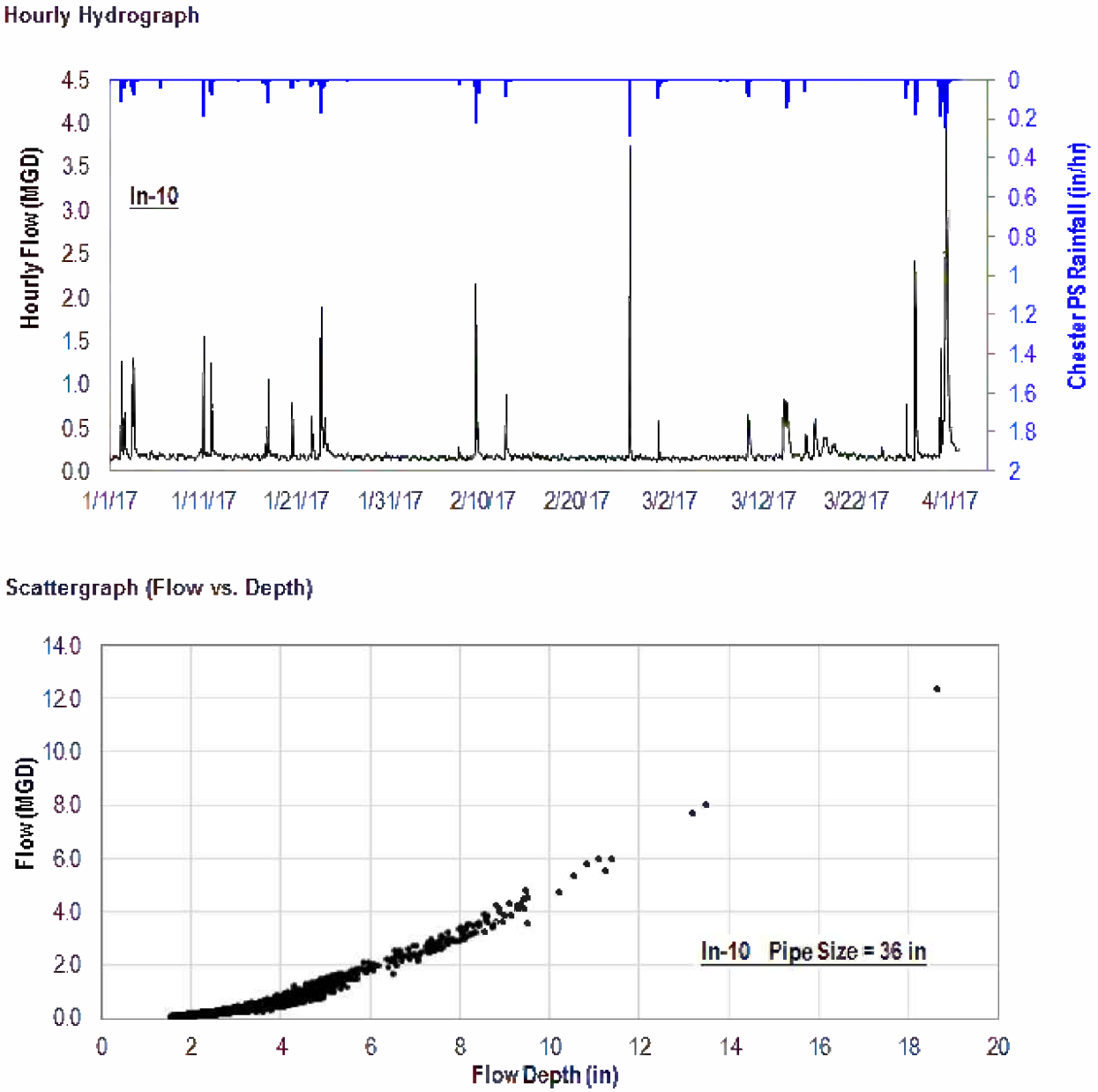
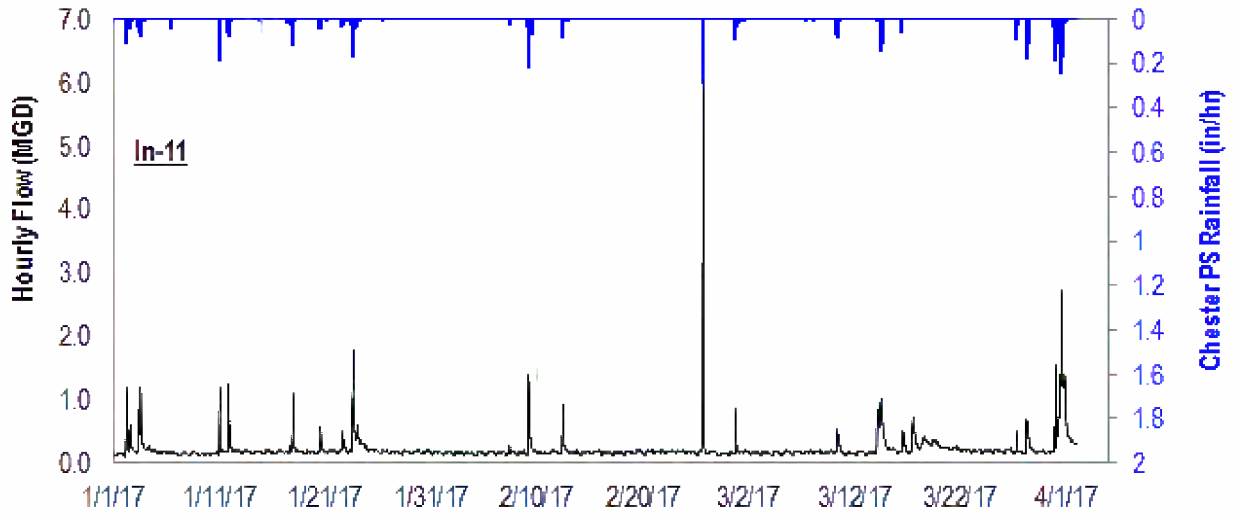


Figure 27: Flow Monitoring Data, In-11

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

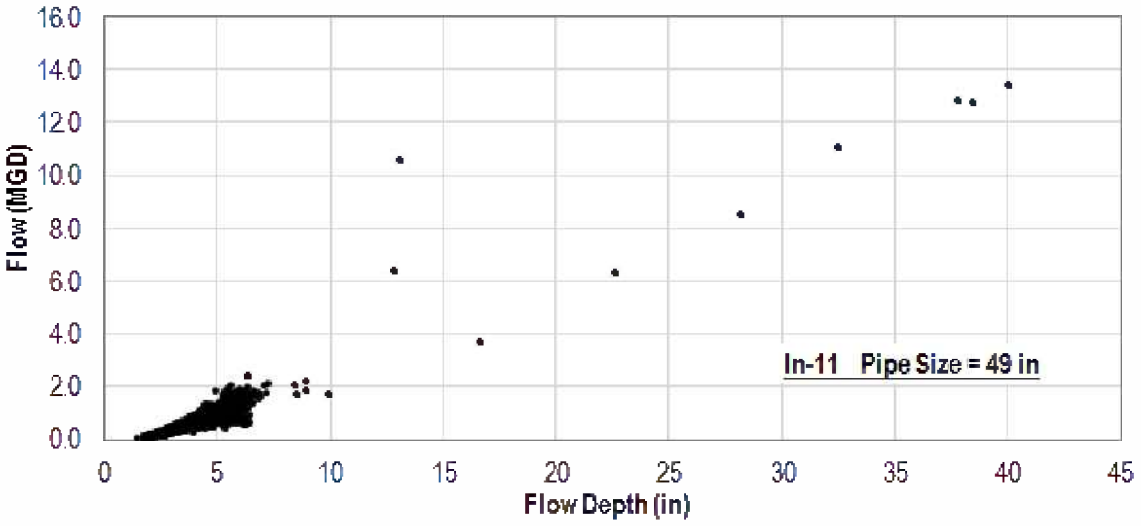


Figure 28: Flow Monitoring Data, In-13

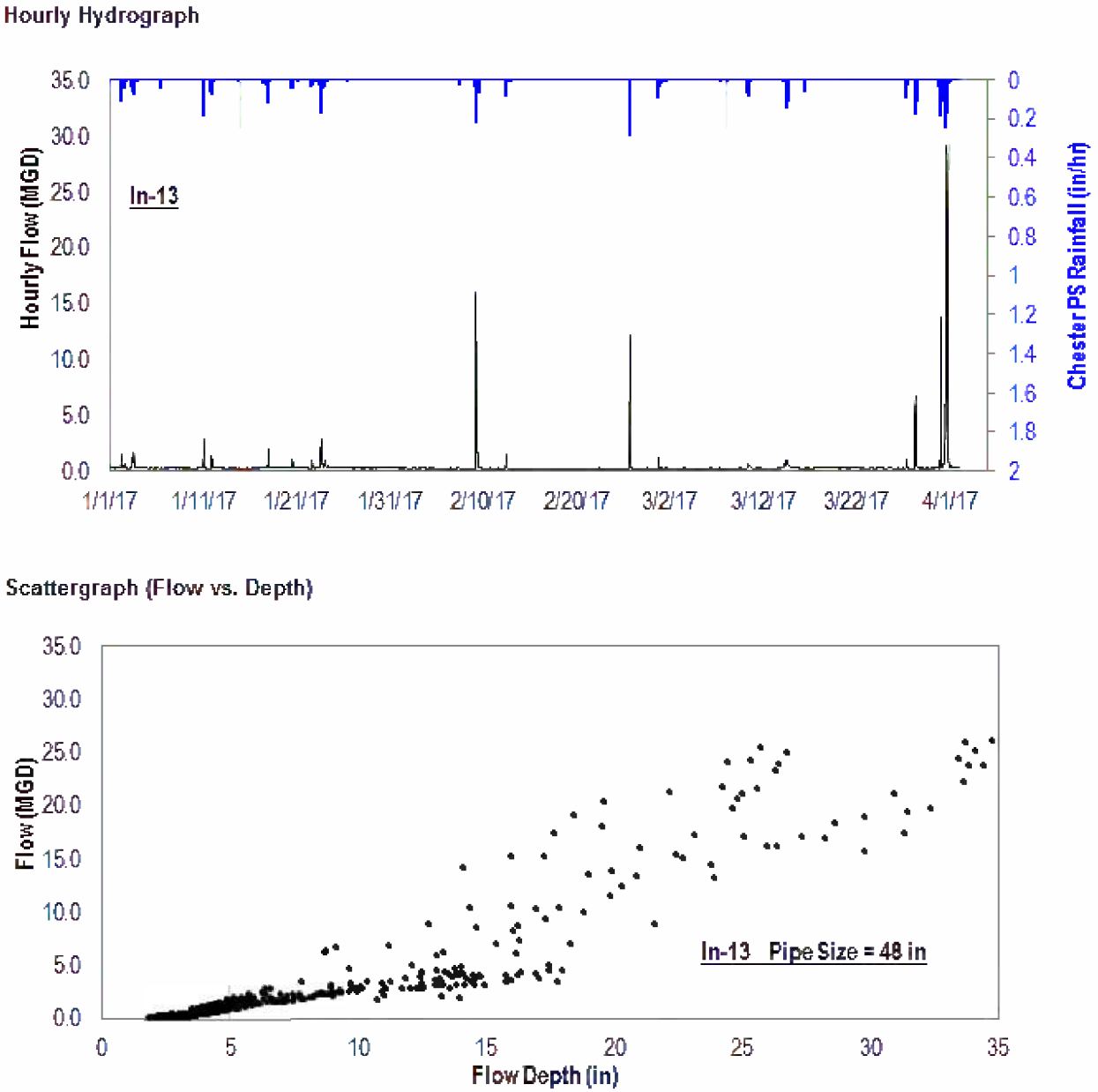


Figure 29: Flow Monitoring Data, In-14

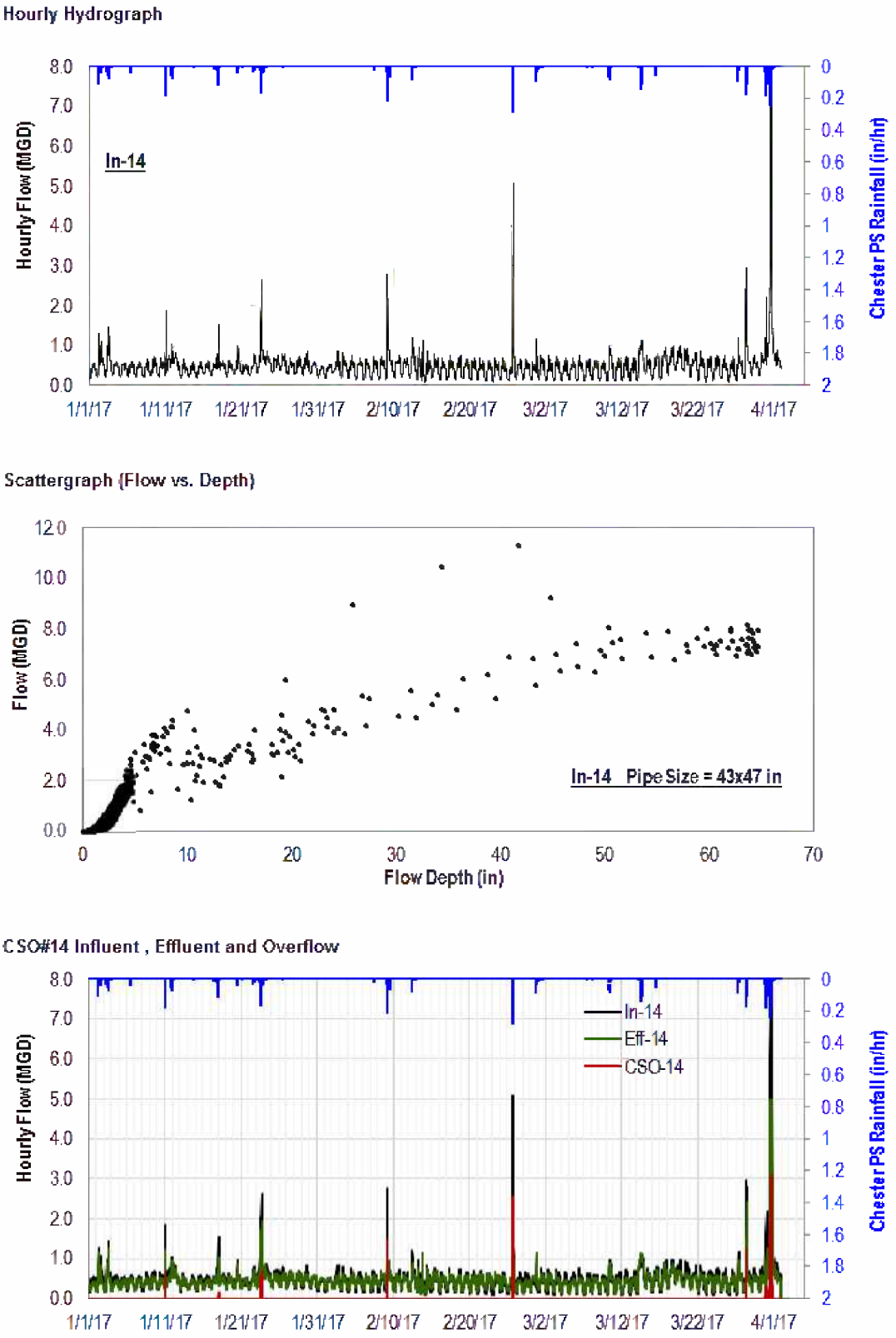
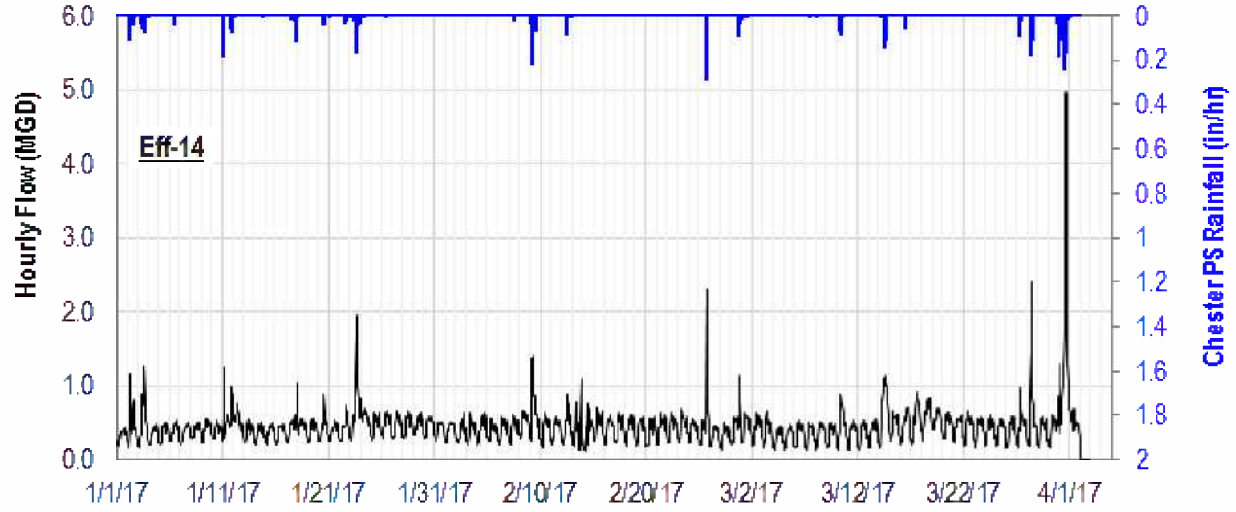


Figure 30: Flow Monitoring Data, Eff-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

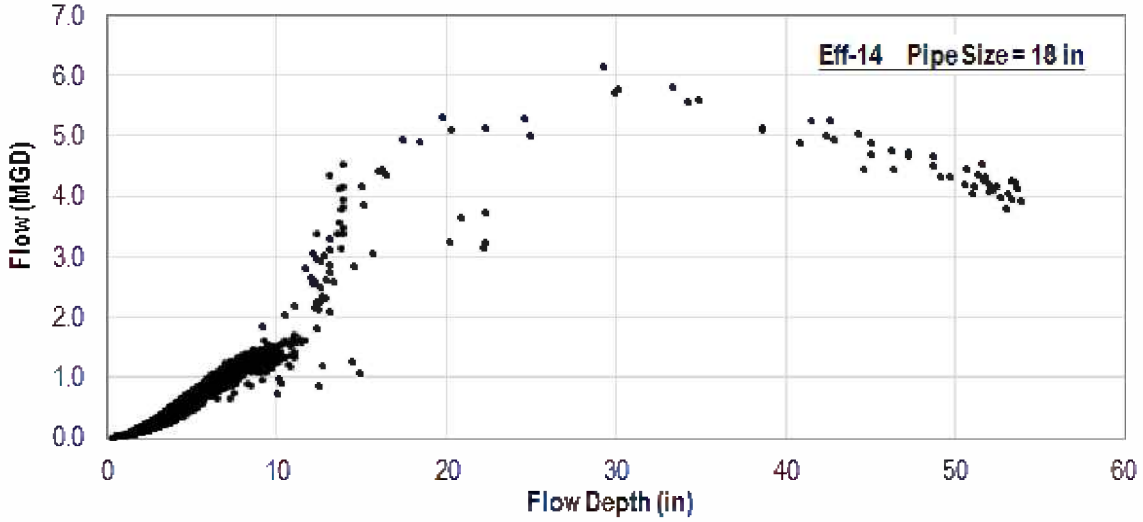
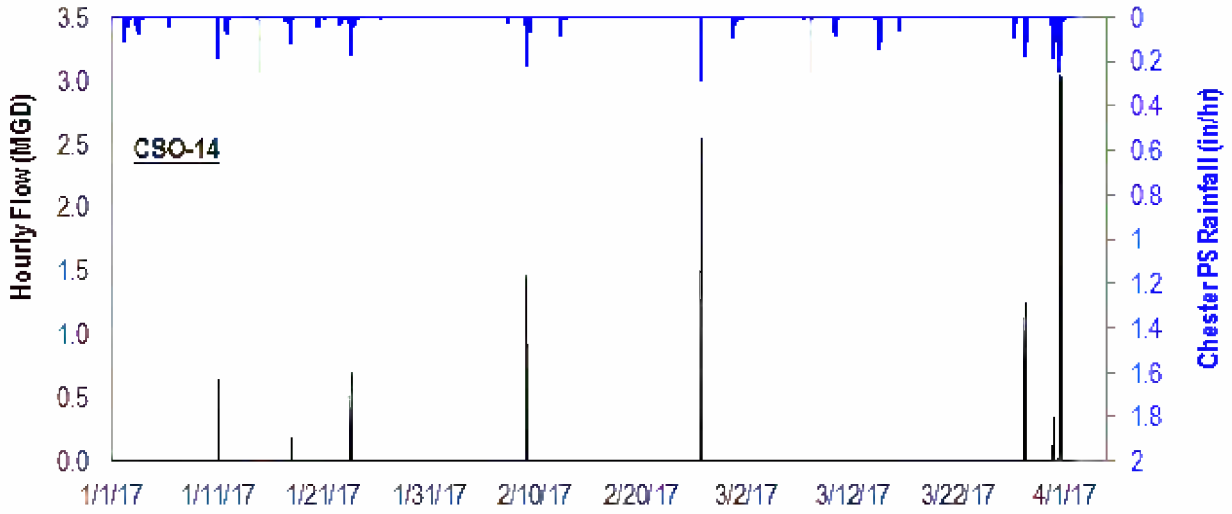


Figure 31: Flow Monitoring Data, CSO-14

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

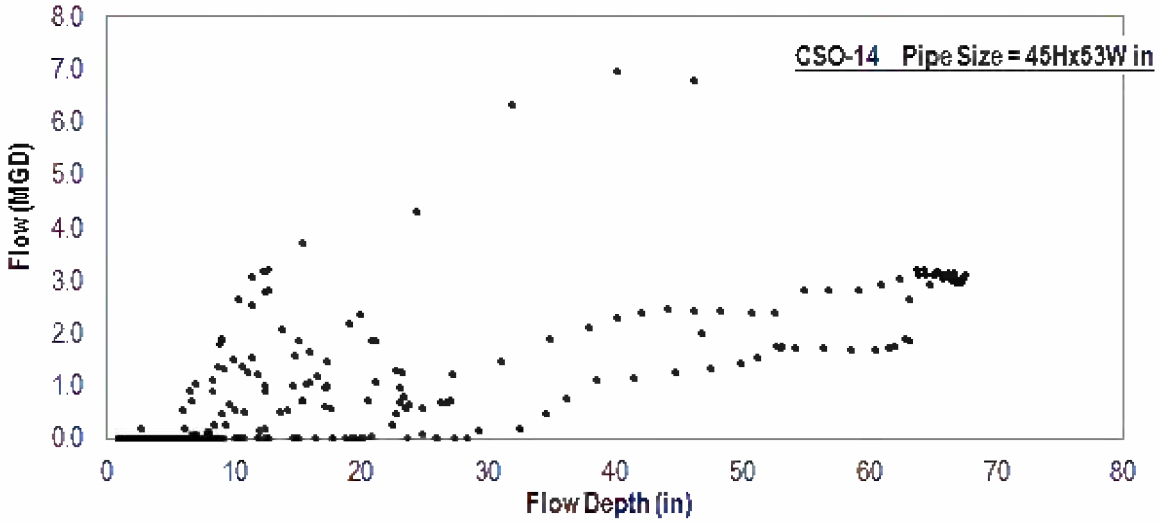


Figure 32: Flow Monitoring Data, In-16

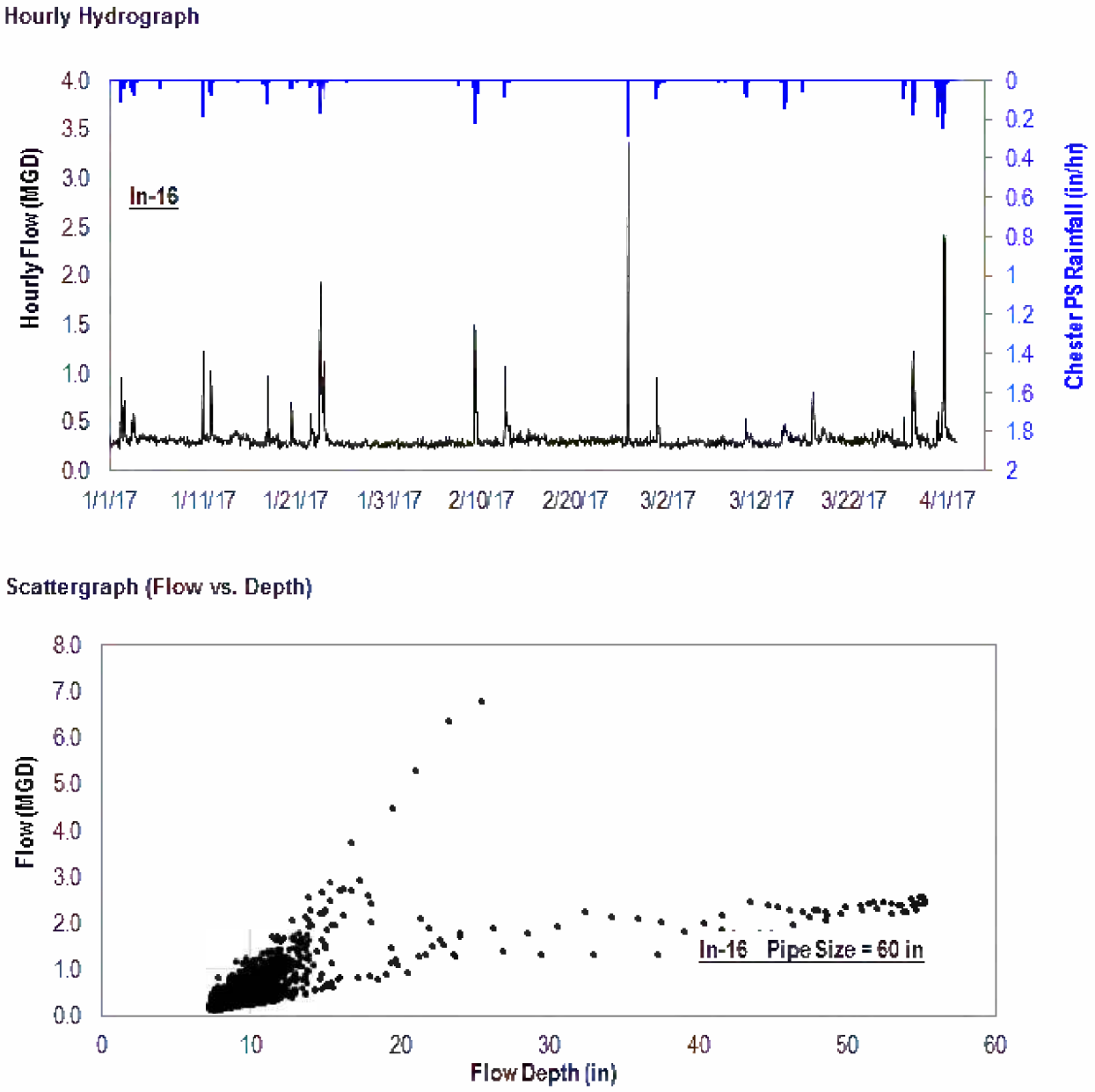


Figure 33: Flow Monitoring Data, In-17

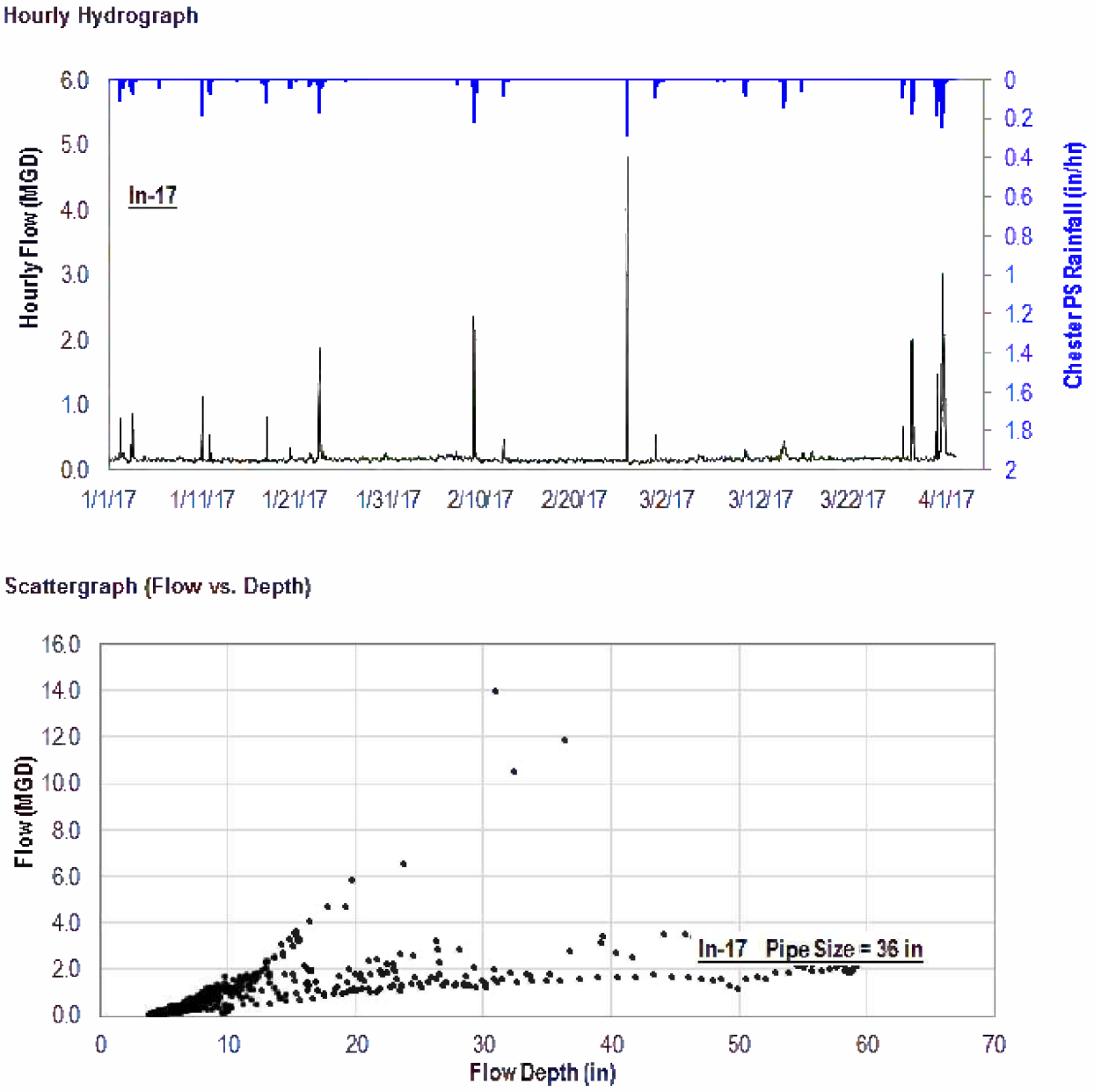


Figure 34: Flow Monitoring Data, In-18

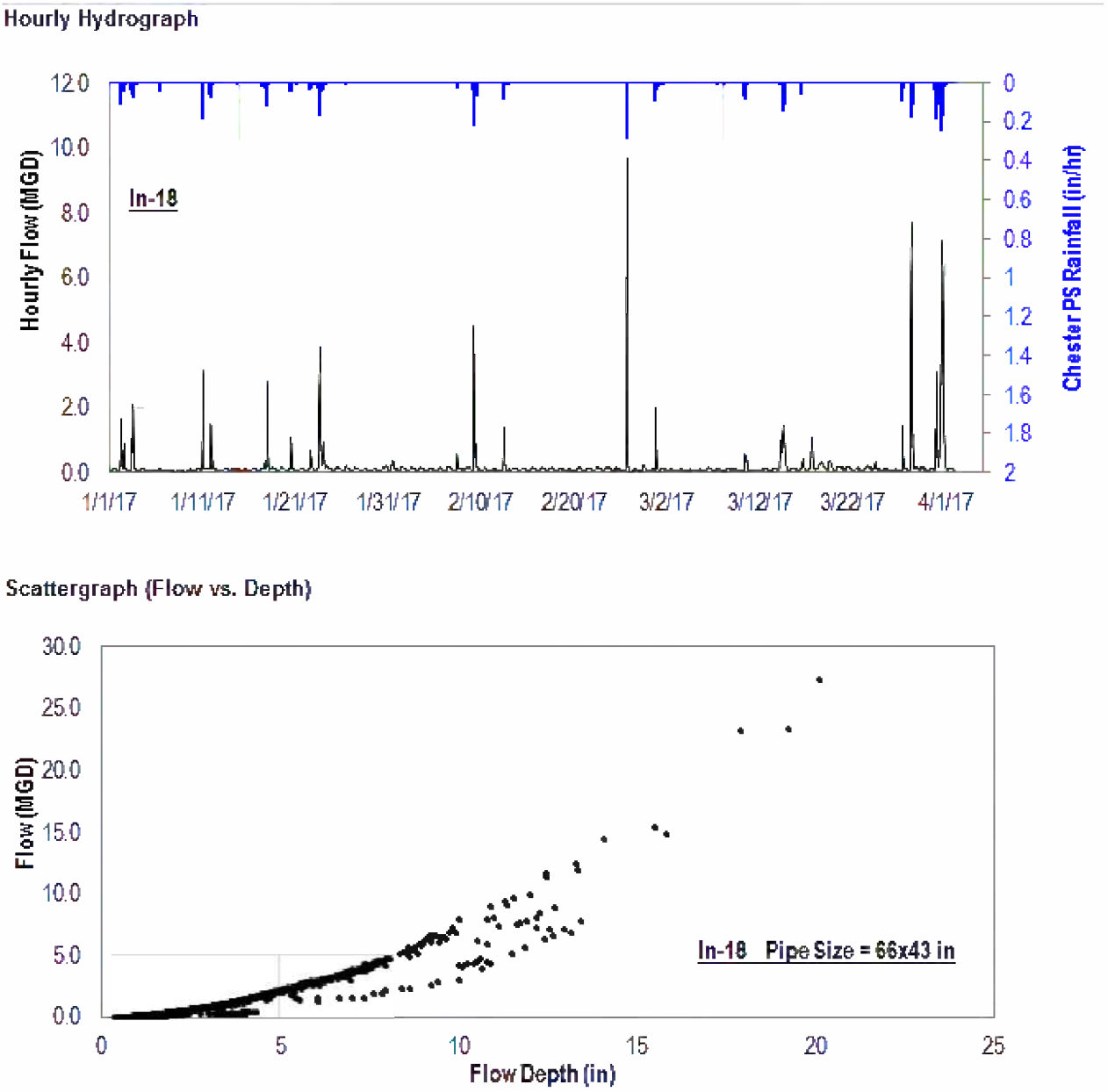


Figure 35: Flow Monitoring Data, In-19-1

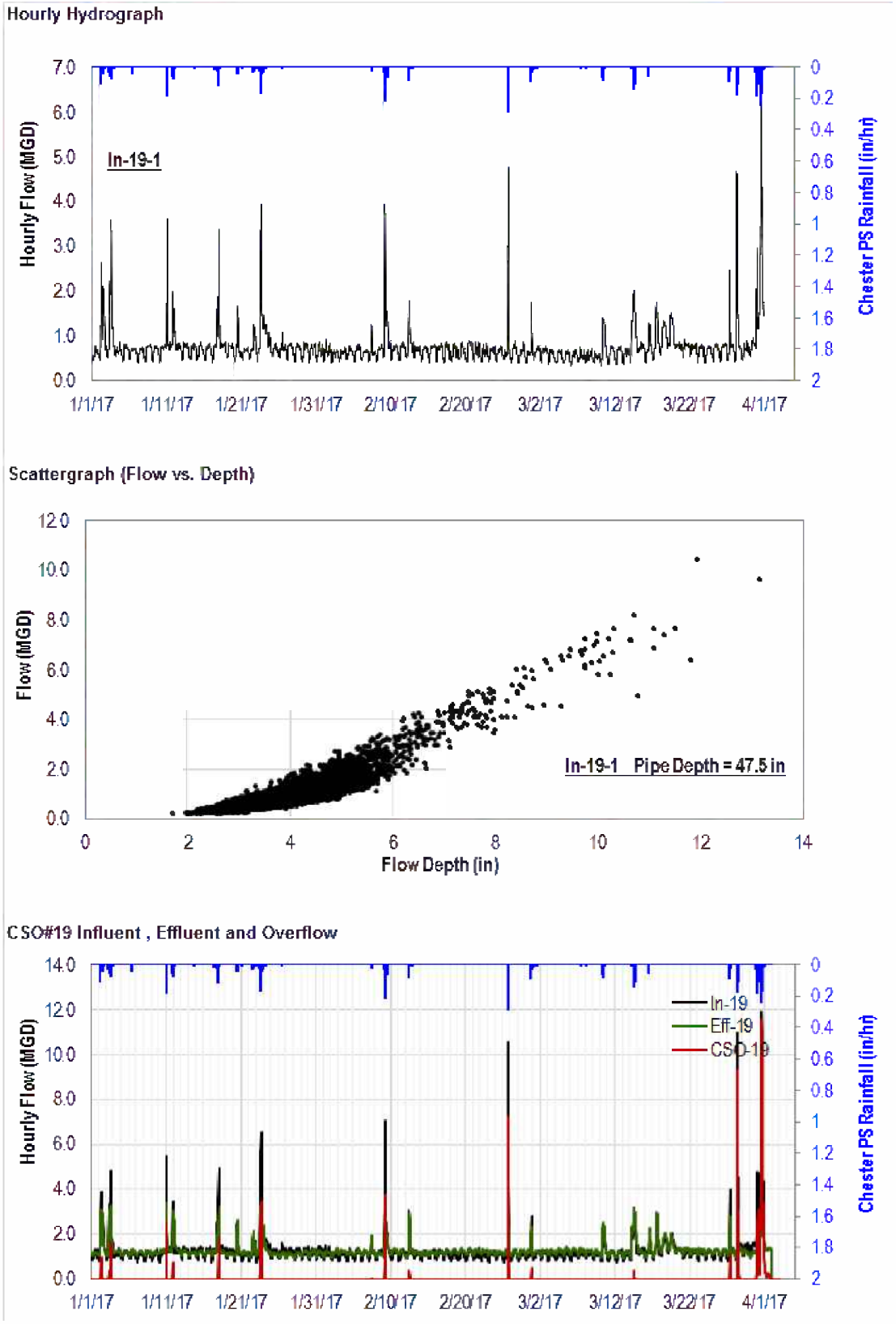


Figure 36: Flow Monitoring Data, In-19-2

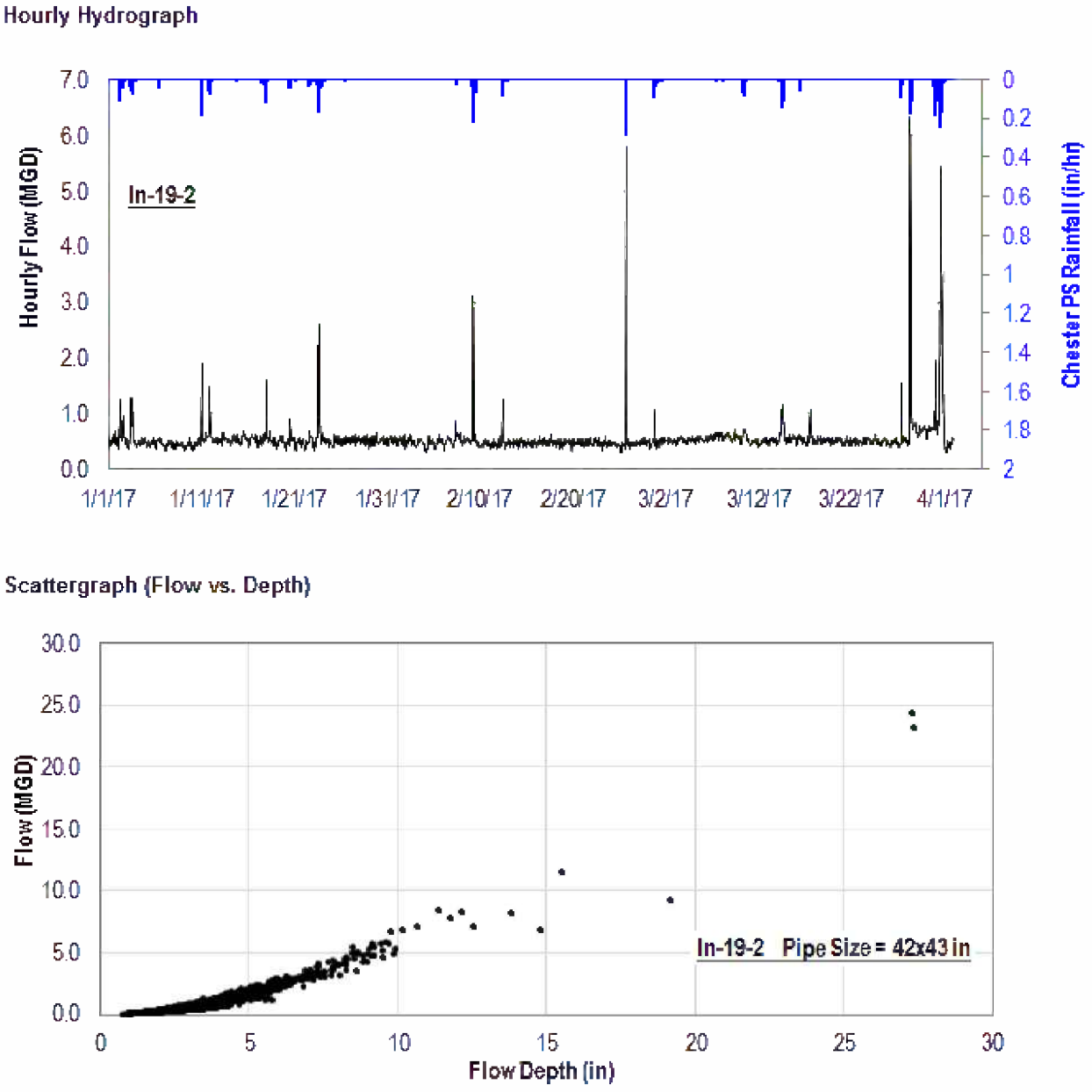


Figure 37: Flow Monitoring Data, Eff-19

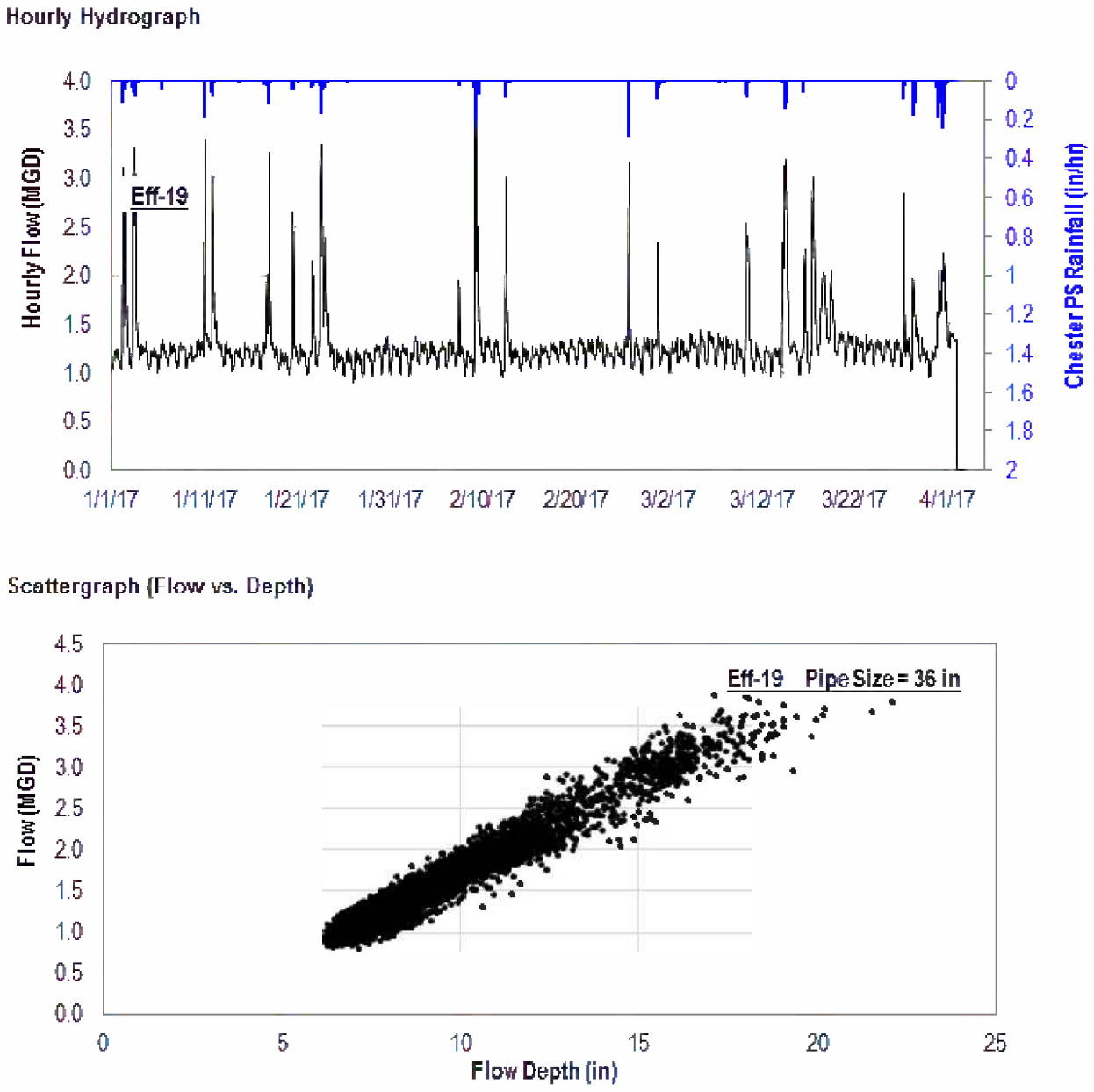
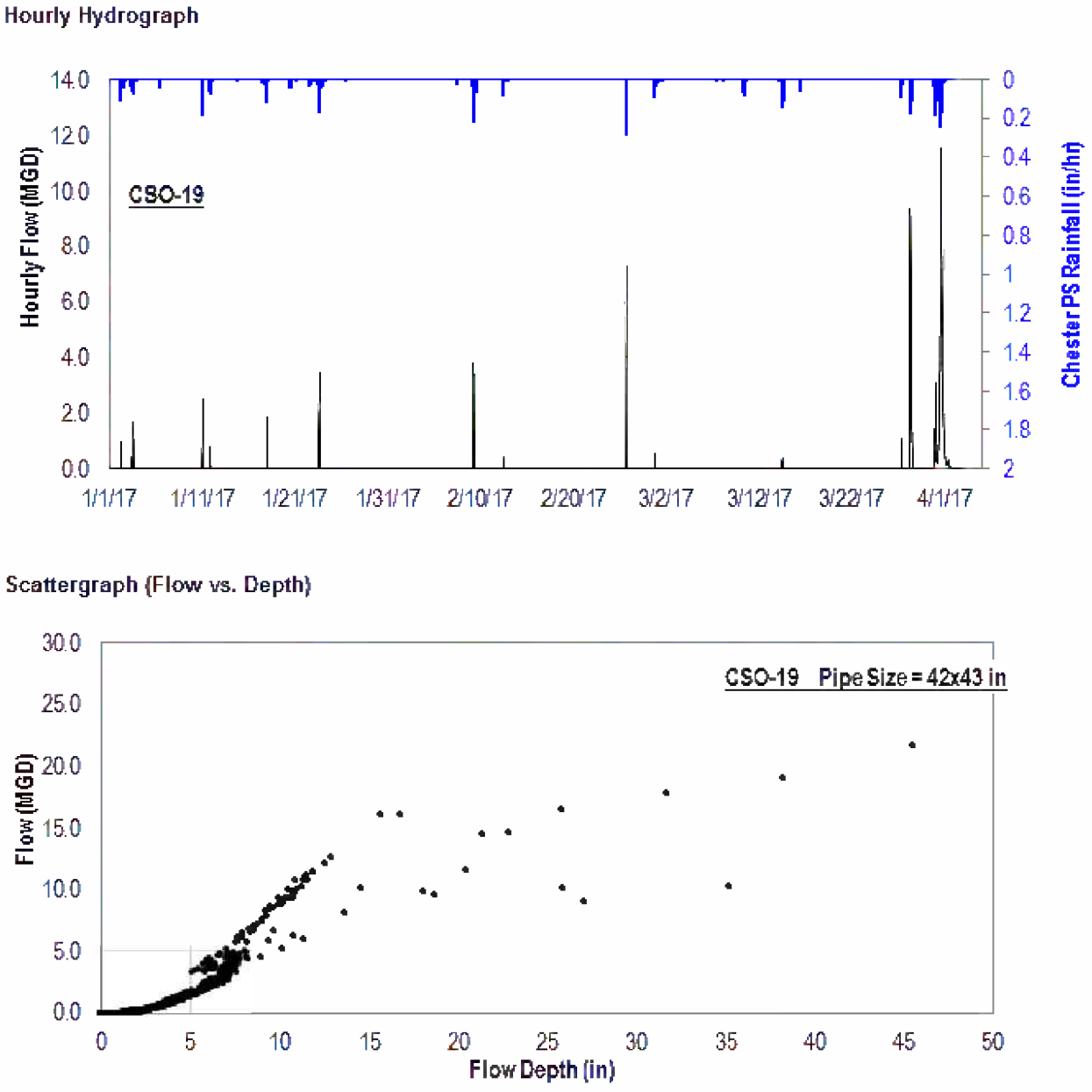


Figure 38: Flow Monitoring Data, CSO-19



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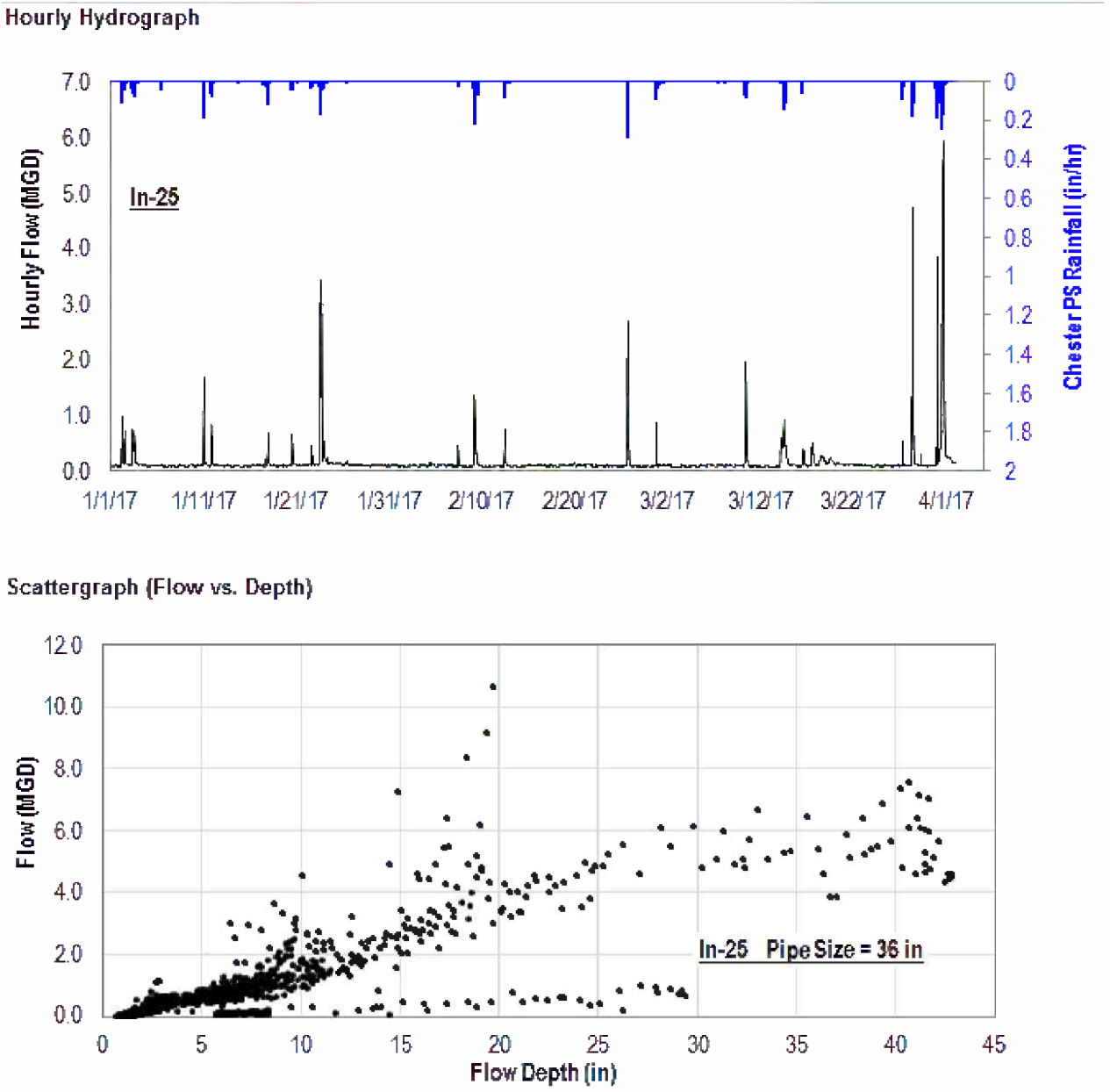


Figure 40: Flow Monitoring Data, In-26

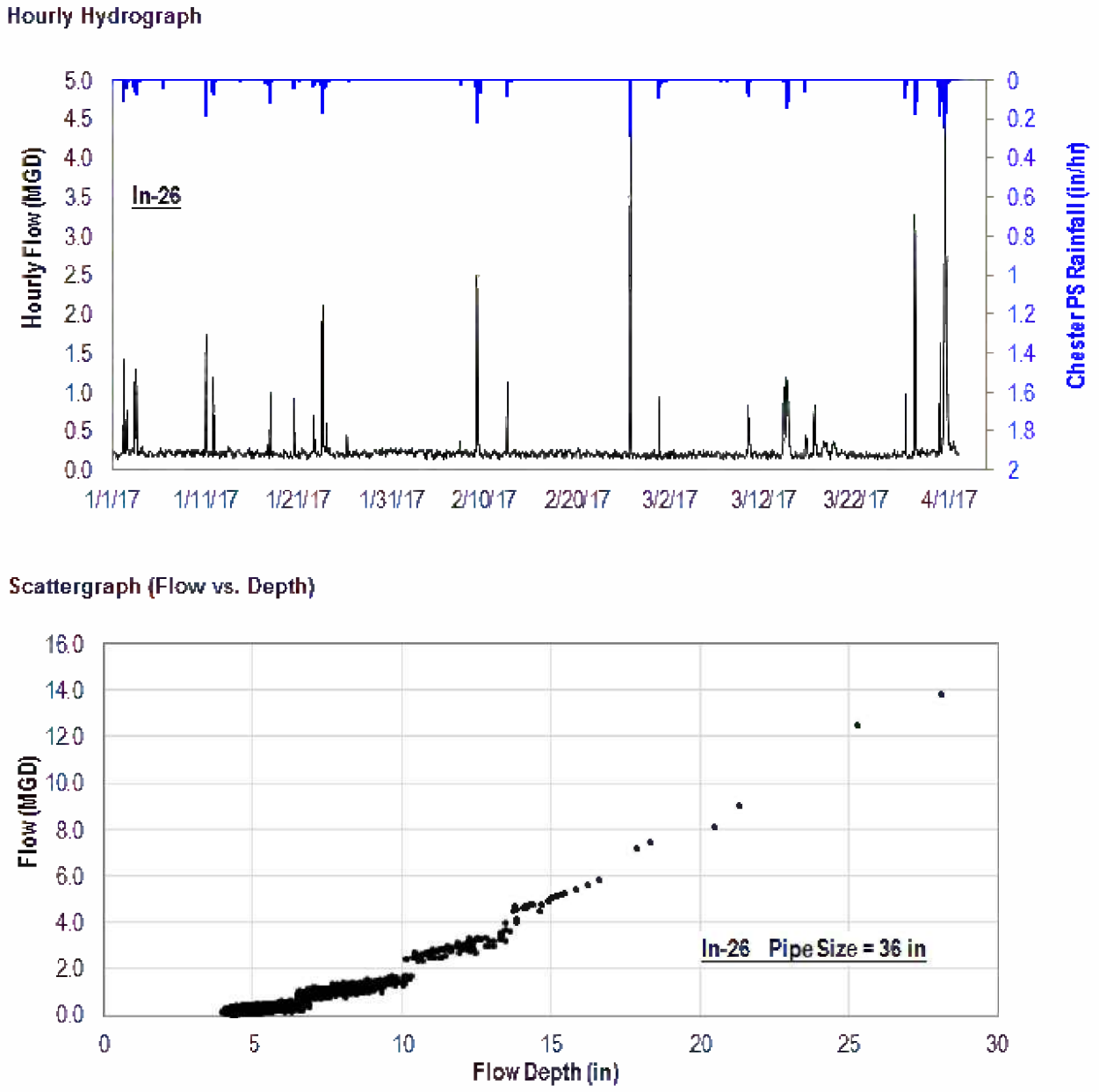


Figure 41: Flow Monitoring Data, INT-2nd St

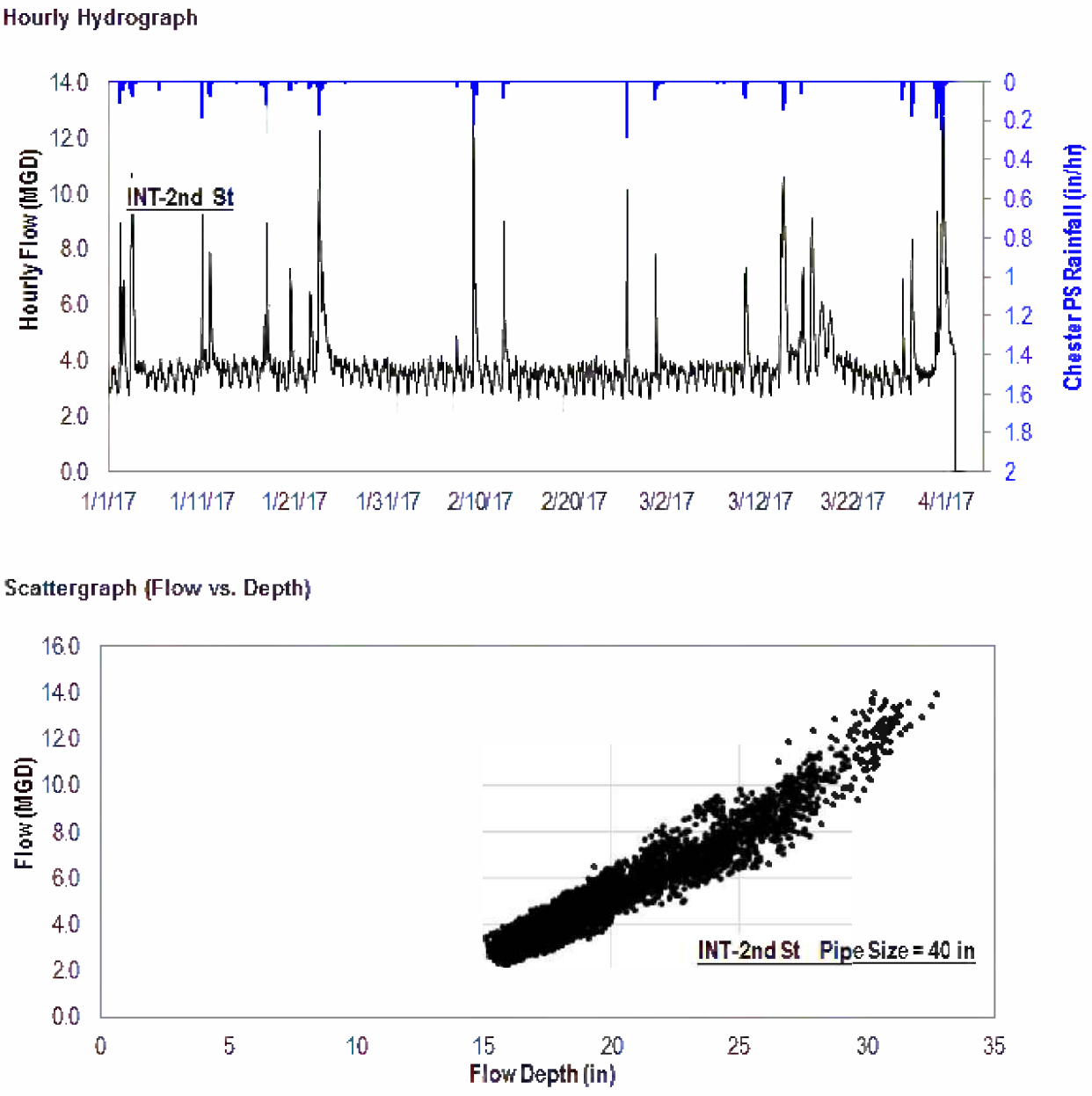


Figure 42: Flow Monitoring Data, INT-DRI

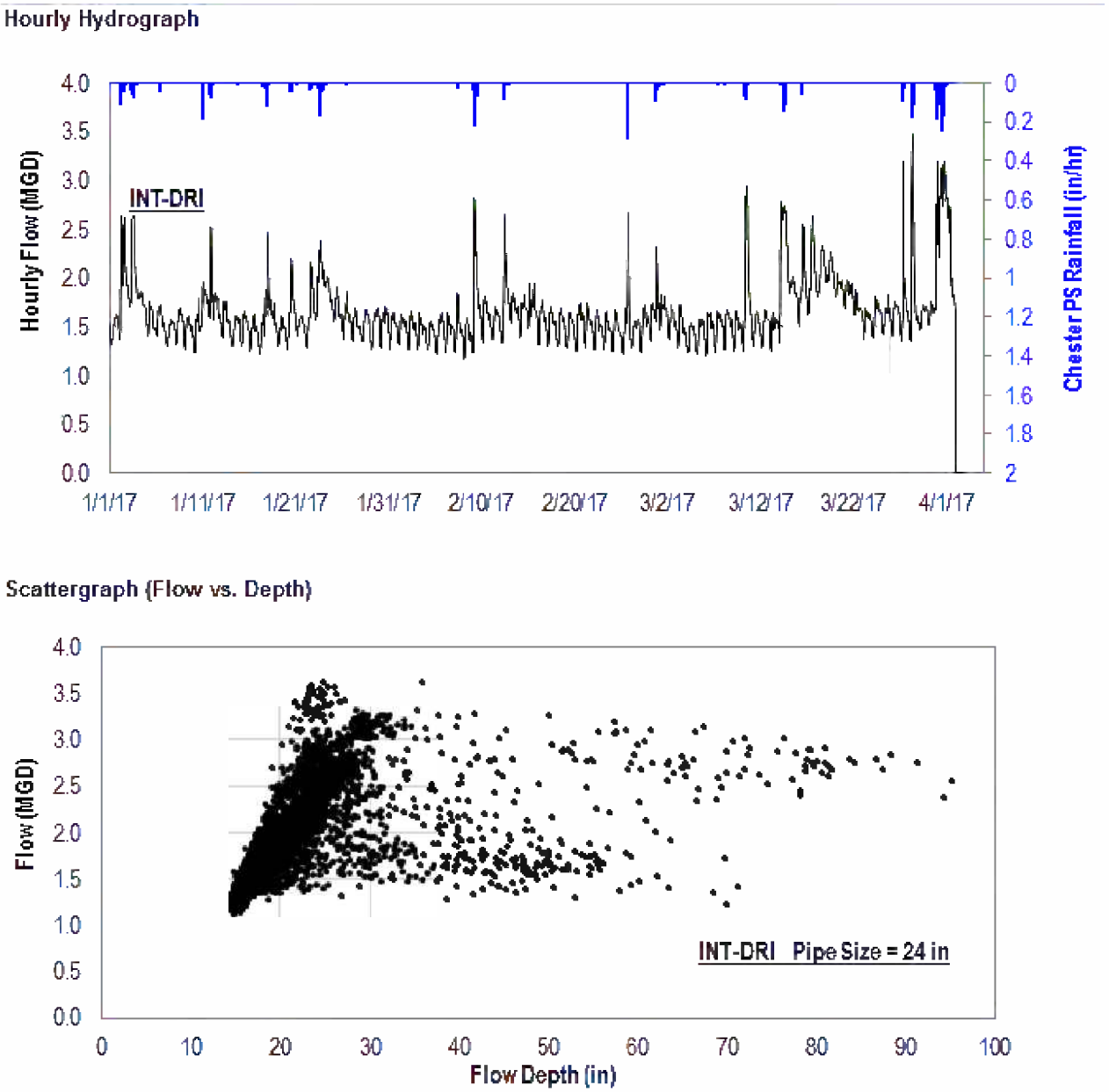


Figure 43: Flow Monitoring Data, INT-Ridley 2

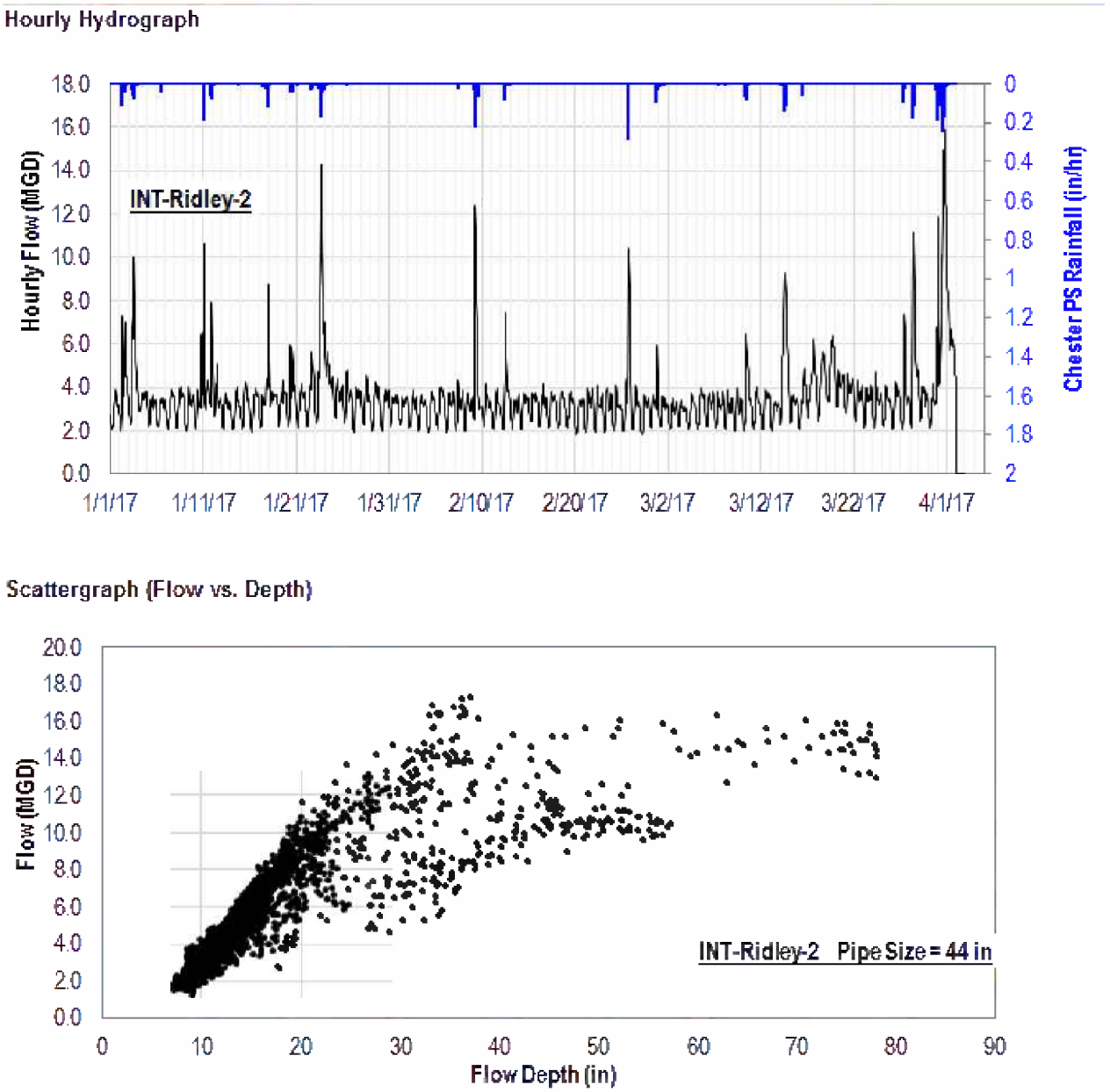


Figure 44: Flow Monitoring Data, INT-Ridley 3

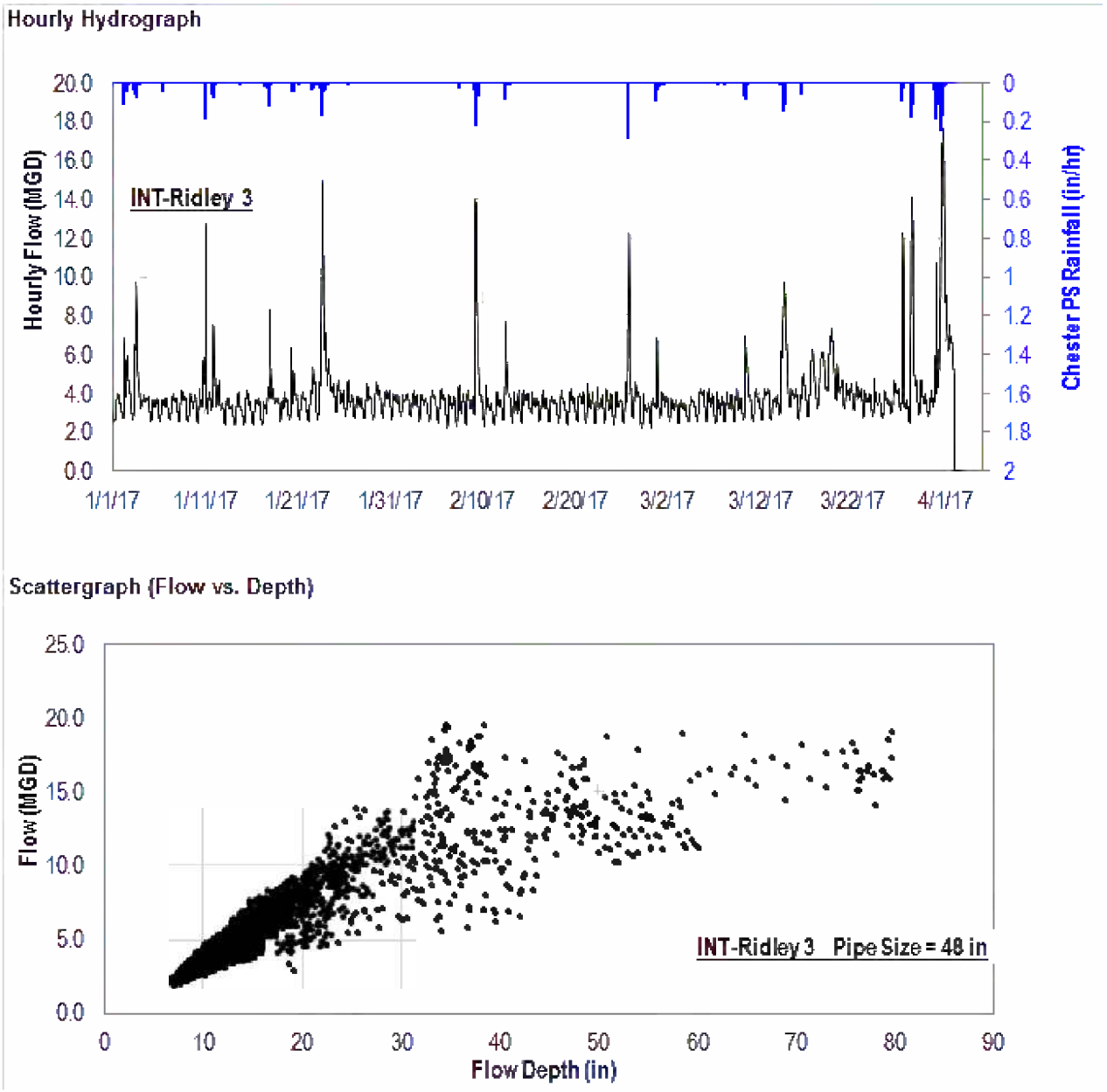


Figure 45: Flow Monitoring Data, INT-WEI

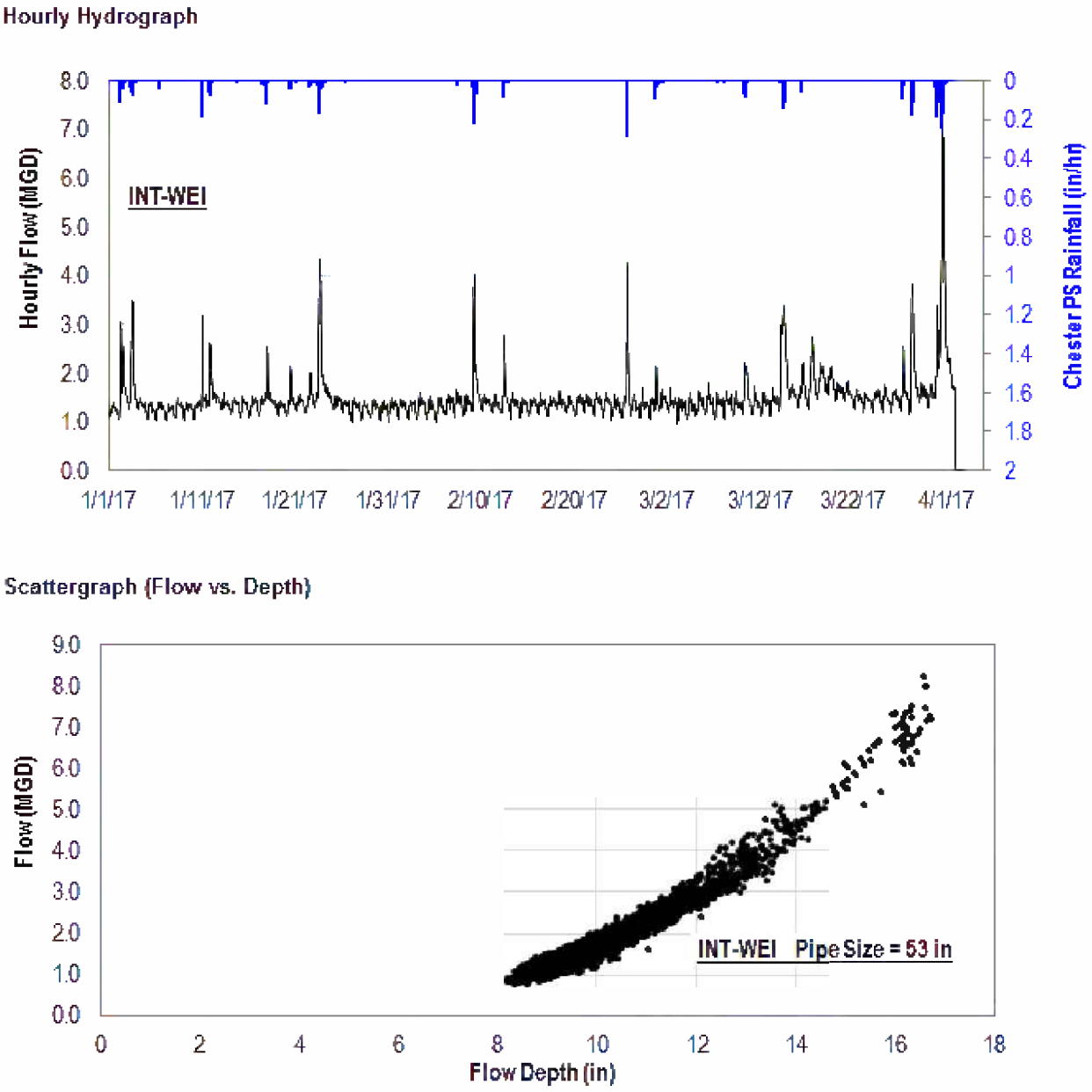


Figure 46: Flow Monitoring Data, Sep-1

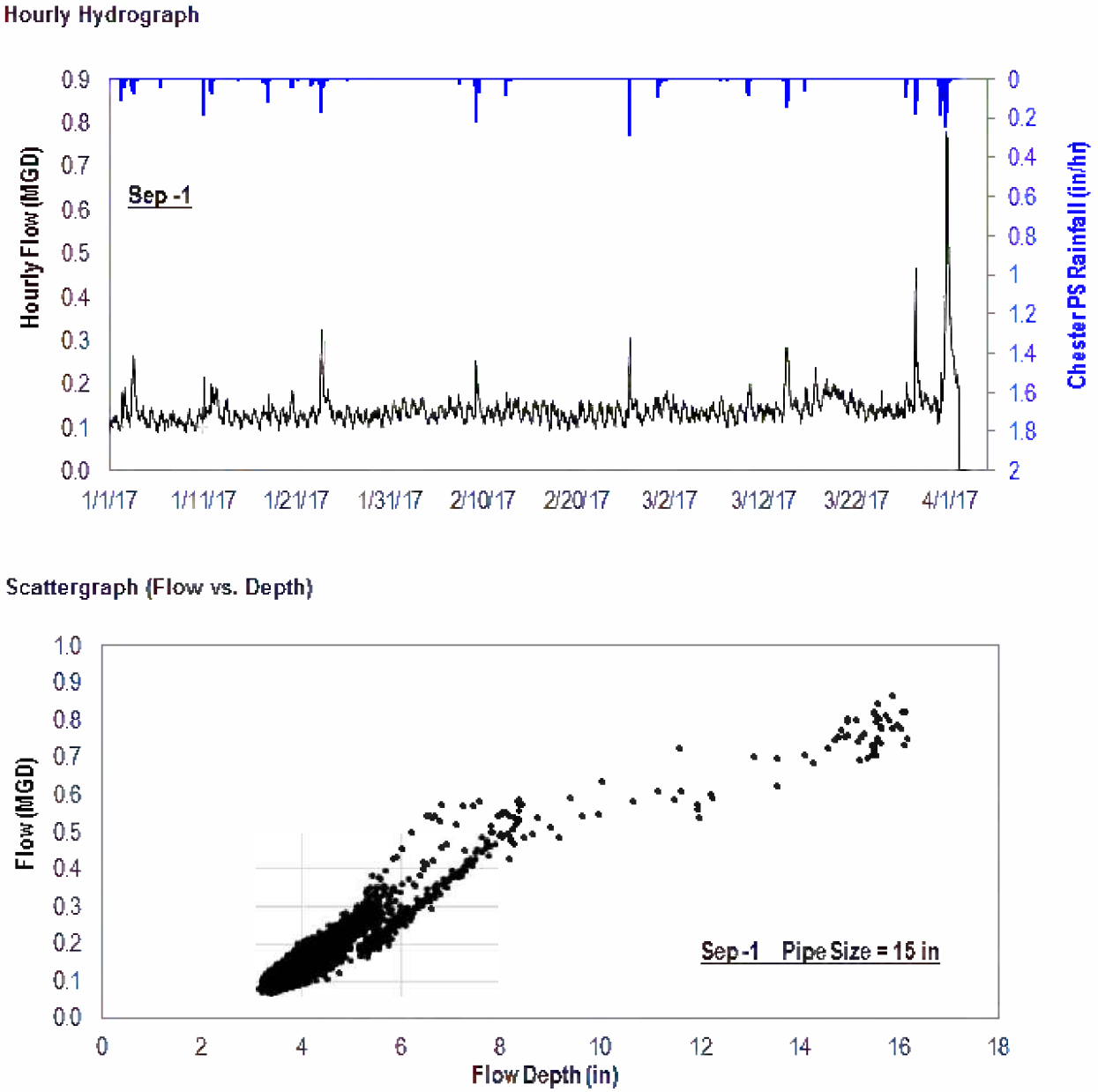


Figure 47: Flow Monitoring Data, Sep-2

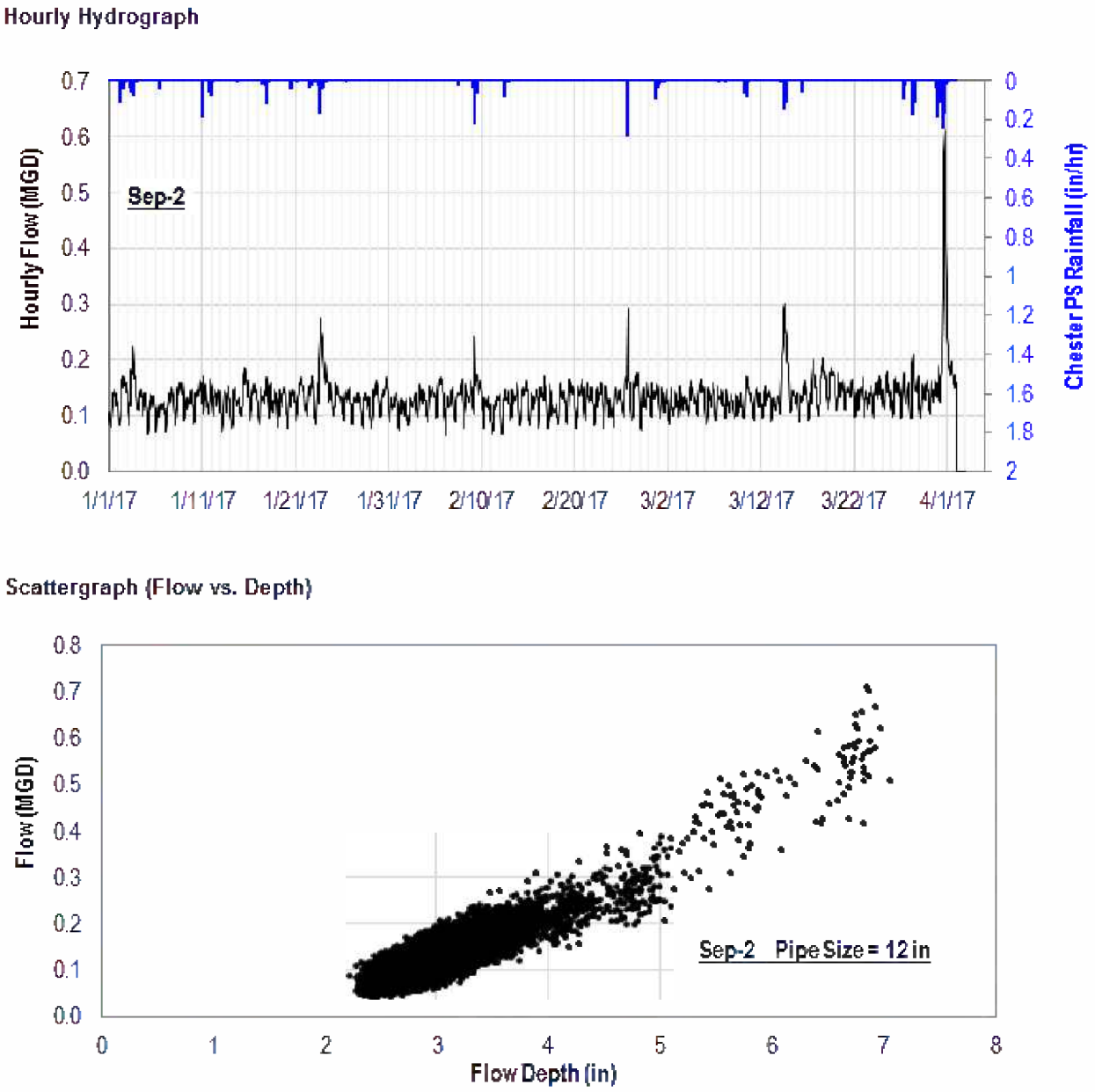


Figure 48: Flow Monitoring Data, Sep-3

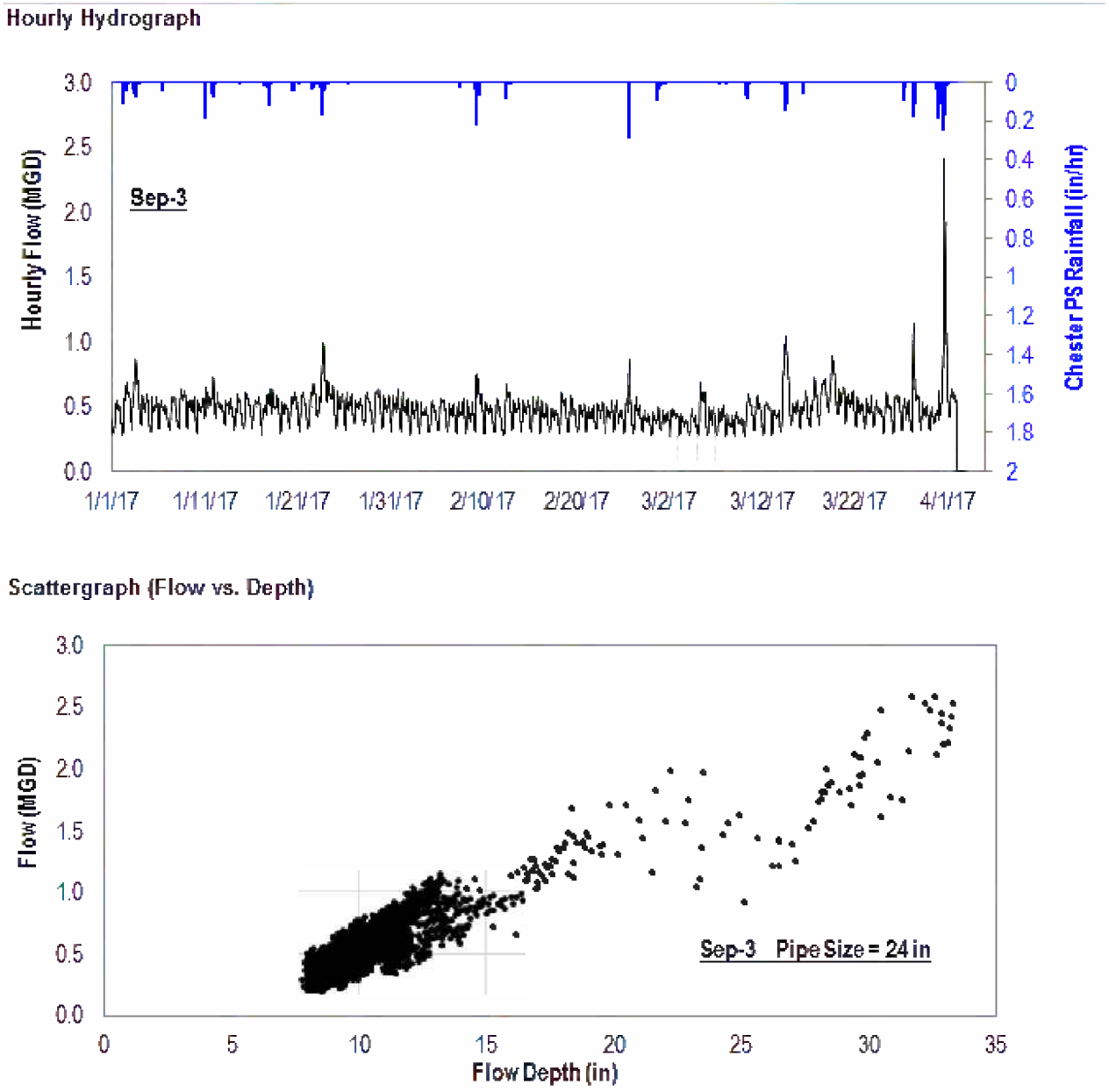
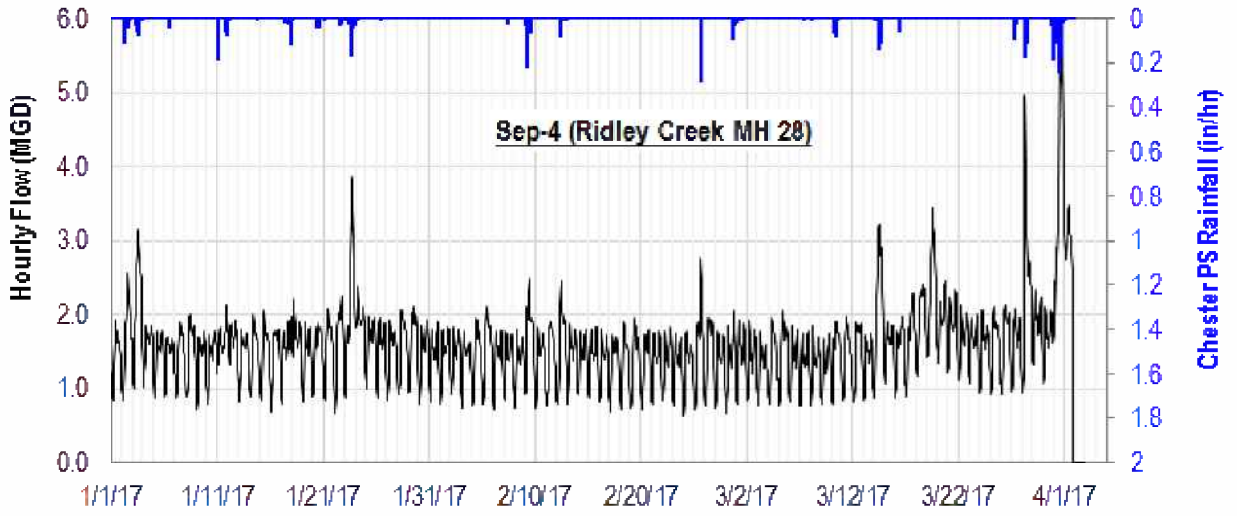


Figure 49: Flow Monitoring Data, Sep-4

Hourly Hydrograph



Scattergraph (Flow vs. Depth)

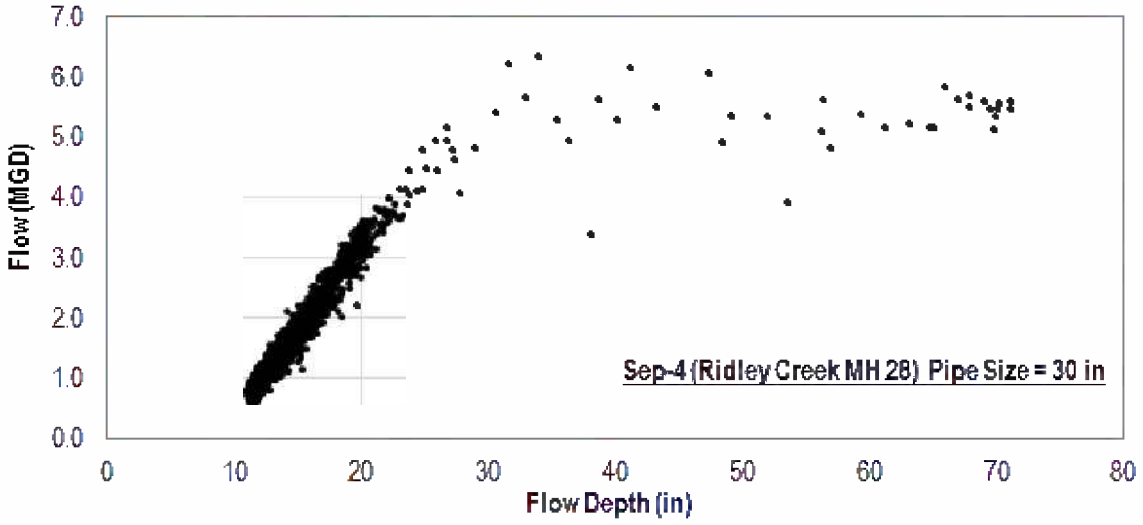


Figure 50: Flow Monitoring Data, Side-1

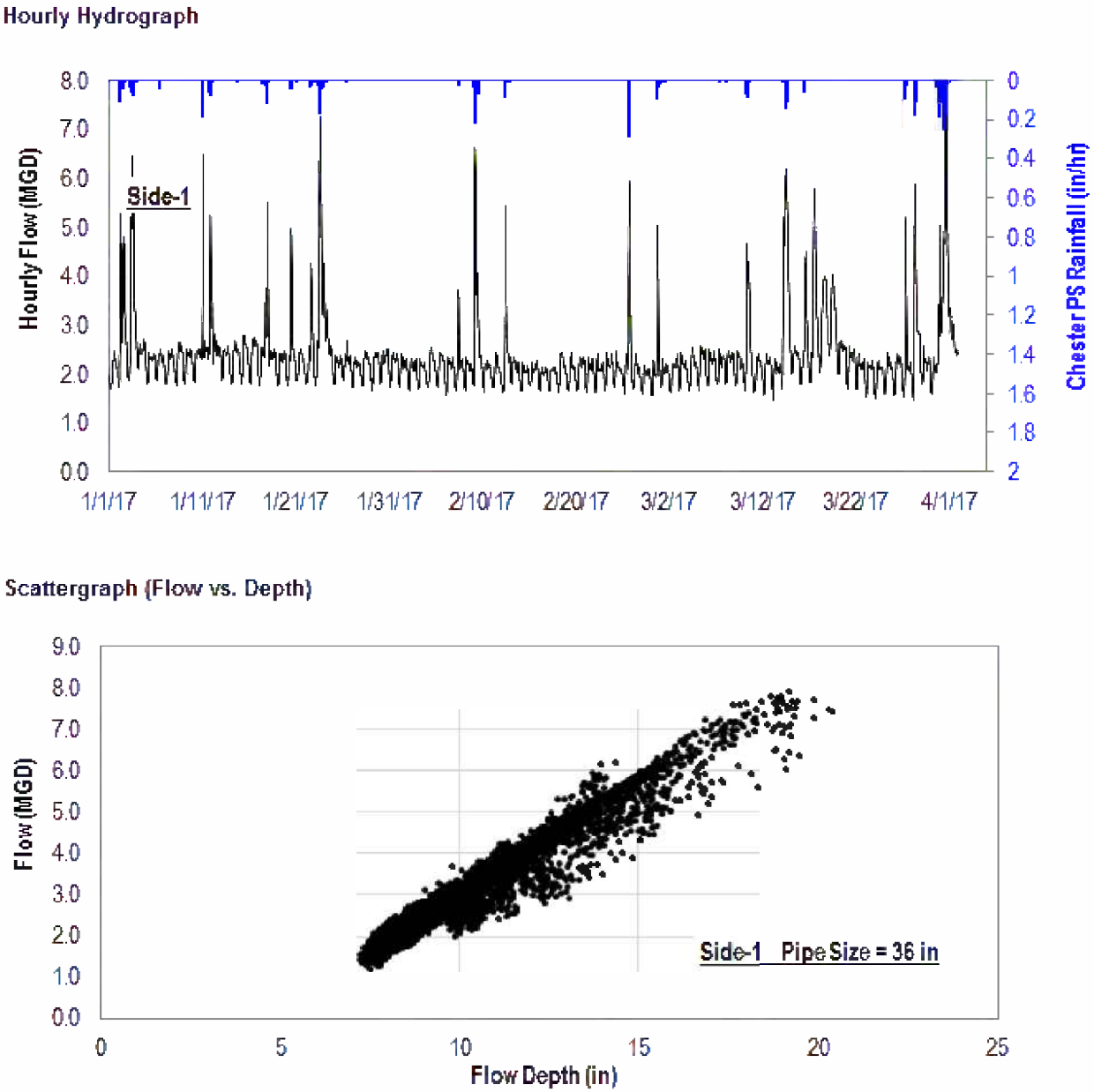
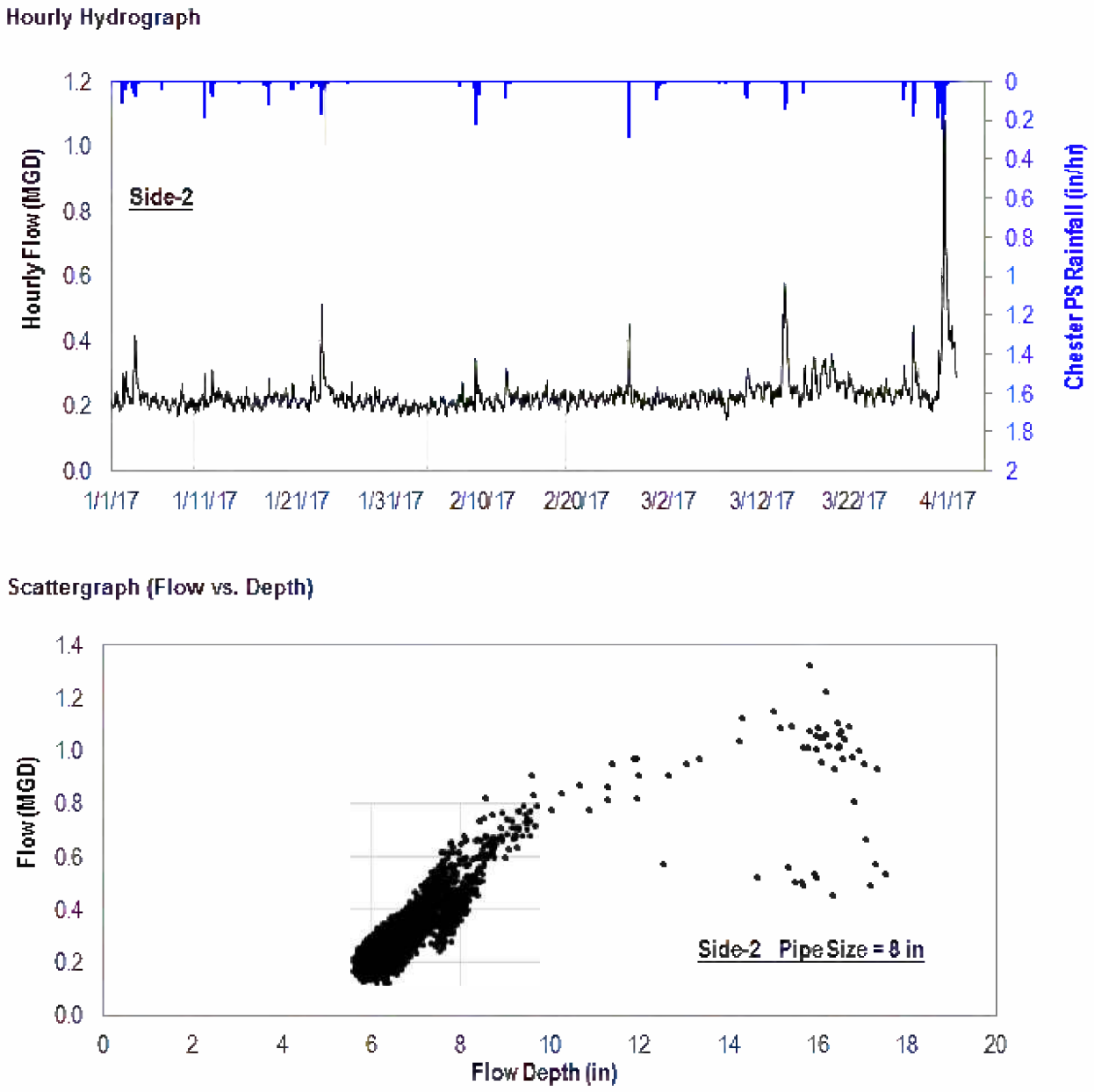


Figure 51: Flow Monitoring Data, Side-2



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GREELEY AND HANSEN

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

July 29, 2016

FED EX – NEXT DAY

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Chief
NPDES Enforcement Branch (3WP42)
Water Protection Division
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager – Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB
& DOJ Case Number 90-5-1-1-10972
Rainfall and Flow Monitoring Quarterly Report No. 1
Period of March 18, 2016 – June 30, 2016

Dear Sir/Madam:

By this letter, the Delaware County Regional Water Quality Control Authority is enclosing a copy of the above mentioned report in accordance with the requirements of the Consent Decree.

If there are any questions, please contact me. Thank you.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
enclosure

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☐FAX: 610-876-2728

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☐FAX: 610-876-1460

PURCHASING & STORES
☐610-876-5523
☐FAX: 610-497-7959

PLANT & MAINTENANCE
☐610-876-5523
☐FAX: 610-497-7950

cc: via email
Margaret Hill, Blank Rome
Marlene Finizio, Greeley and Hansen
Michael Hope, Greeley and Hansen
Ed Bothwell, DELCORA
Charles Hurst, DELCORA
Michael DiSantis, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
File – Consent Order – LTCP CSO

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

October 25, 2016

FED EX – NEXT DAY

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Chief
NPDES Enforcement Branch (3WP42)
Water Protection Division
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager – Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB
& DOJ Case Number 90-5-1-1-10972
Rainfall and Flow Monitoring Quarterly Report No. 2
Period of July 1, 2016 – September 30, 2016

Dear Sir/Madam:

By this letter, the Delaware County Regional Water Quality Control Authority is enclosing a copy of the above mentioned report in accordance with the requirements of the Consent Decree.

If there are any questions, please contact me. Thank you.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
enclosure

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John Pileggi, DELCORA
Robert Willert, DELCORA
File – Consent Order – LTCP CSO

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

January 26, 2017

FED EX – NEXT DAY

Chief, Environmental Enforcement
Section
Environment and Natural
Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Chief
NPDES Enforcement Branch (3WP42)
Water Protection Division
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager – Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB
& DOJ Case Number 90-5-1-1-10972
Rainfall and Flow Monitoring Quarterly Report No. 3
Period of October 1, 2016 – December 31, 2016

Dear Sir/Madam:

By this letter, the Delaware County Regional Water Quality Control Authority is enclosing a copy of the above mentioned report in accordance with the requirements of the Consent Decree.

If there are any questions, please contact me. Thank you.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
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John Pileggi, DELCORA
Robert Willert, DELCORA
File – Consent Order – LTCP CSO

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

April 28, 2017

FED EX – NEXT DAY

Chief, Environmental Enforcement
Section
Environment and Natural
Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

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NPDES Enforcement Branch (3WP42)
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U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager – Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB
& DOJ Case Number 90-5-1-1-10972
Rainfall and Flow Monitoring Quarterly Report No. 4
Period of January 1, 2017 – April 1, 2017

Dear Sir/Madam:

By this letter, the Delaware County Regional Water Quality Control Authority is enclosing a copy of the above mentioned report in accordance with the requirements of the Consent Decree.

If there are any questions, please contact me. Thank you.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
enclosure

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Michael DiSantis, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
File – Consent Order – LTCP CSO

APPENDIX H

Water Quality Monitoring and Modeling Work Plan

- DELCORA Water Quality Modeling and Monitoring Work Plan - Final dated January 2017 (Revised July 2017)
- USEPA Approval of the Water Quality Modeling and Monitoring Work Plan Update dated April 16, 2018

Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Water Quality Modeling and Monitoring Work Plan

Final

January 2017

(Revised July 2017)

GREELEY AND HANSEN

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REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Water Quality Modeling and Monitoring Work Plan.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	1/9/17 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	1/9/17 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	1/9/17 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
0	1/11/2017	G&H/LimnoTech	Initial submittal to US EPA
1	July 2017	G&H/LimnoTech	• Updated Table of Contents • Page 1-8: Updated Figure 1-5 Project Team • Page 2-5: Updated Tables 2-1 and 2-2 • Page 2-7: Updated Table 2-3 • Page 3-6/3-7: Updated Appendix reference • Page 3-7: Changed DR-03 to DR-04 • Page 3-8: Updated Figure 3-2 • Page 3-9: Updated Table 3-1 • Page 3-10: Updated Table 3-2 • Page 3-11: Updated Table 3-3 • Page 3-13: Revised last paragraph for clarity • Page 3-14: Revised first, second and fifth paragraphs for clarity • Page 3-15: Revised second paragraph and Item 3 for clarity • Page 3-16: Revised items 1 & 4 • Page 3-17: Updated Sec. 3.5 appendix reference • Page 3-18: Updated Sec. 3.5.2 appendix reference • Page 3-21: Updated Sec. 3.5.4 appendix reference • Page 3-23: Updated Table 3-8 • Page 3-27: Updated Sec. 3.8.4 appendix reference

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Section 1 Introduction

1.1 Background of DELCORA's Facilities

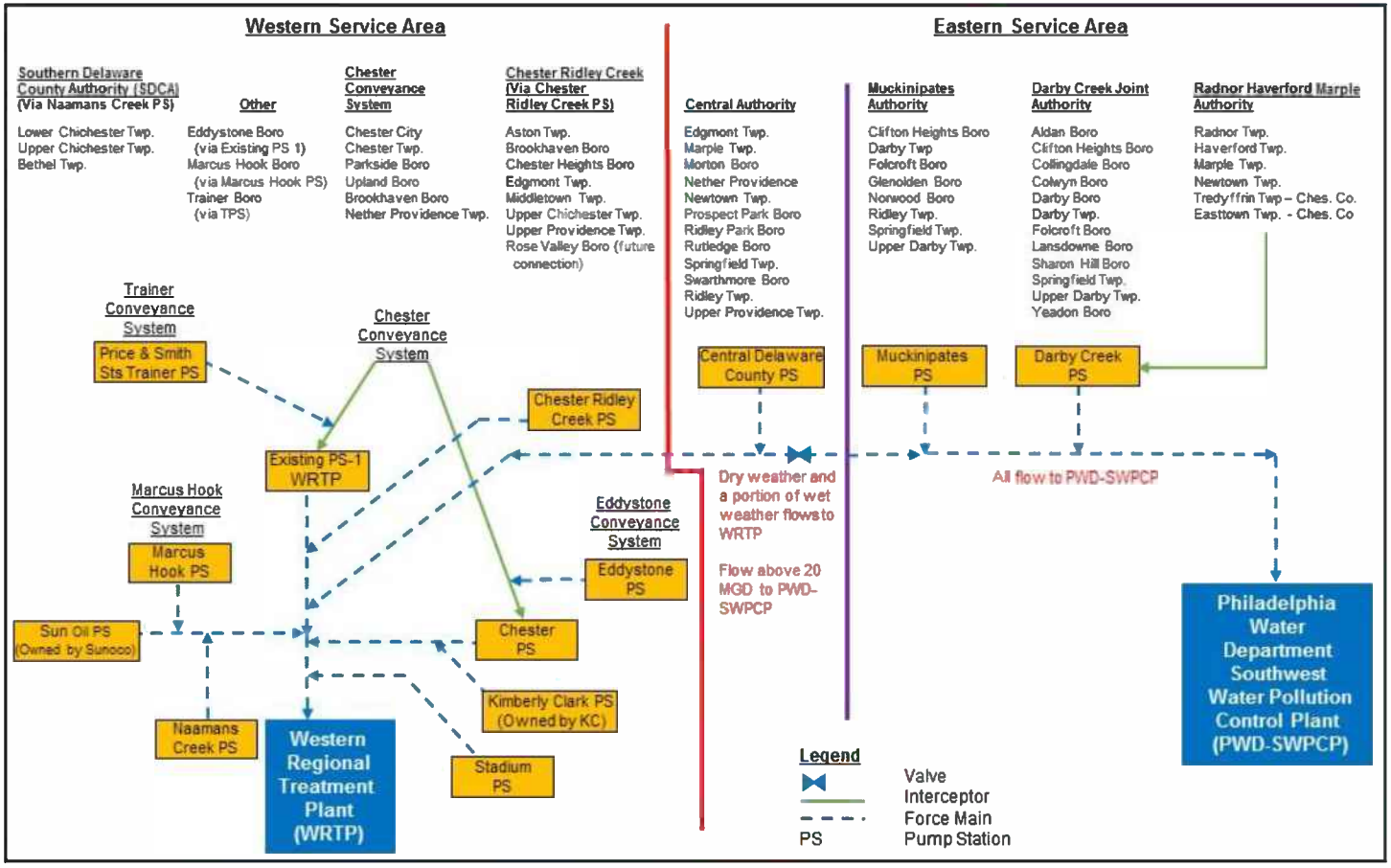
Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA, as shown on Figure 1-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

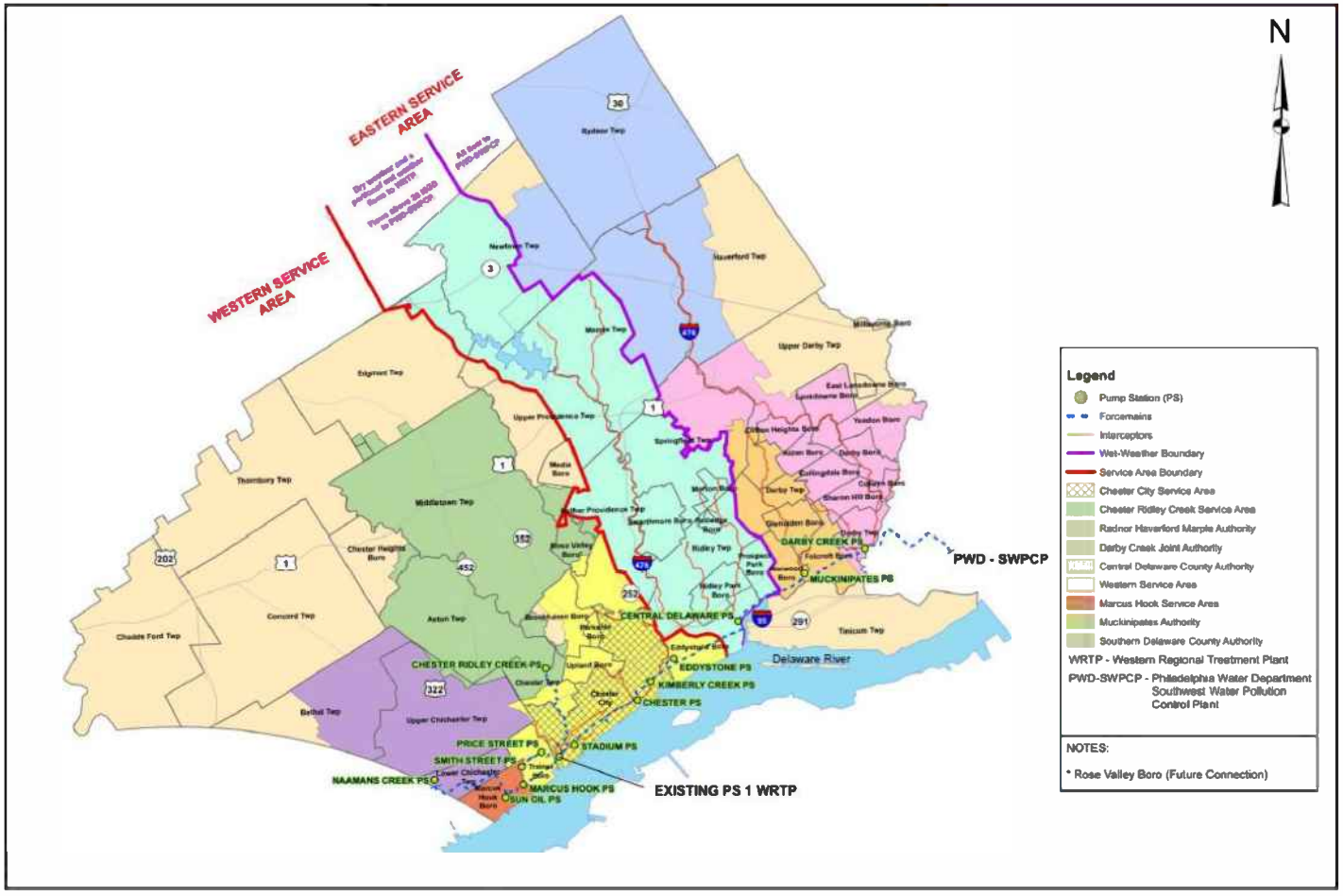
There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

Figure 1-1: DELCORA's Conveyance System



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN WESTON SOLUTIONS	Figure 1-1 DELCORA'S CONVEYANCE SYSTEM

Figure 1-2: DELCORA's Service Area



Part C – Other Requirements, Section V – Combined Sewer Overflows of the NPDES Permit details DELCORA's responsibilities with respect to the CSO system including reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum to the LTCP until the updated LTCP is approved.

1.2 Consent Decree

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within ninety (90) days after EPA reviews and approves the Alternatives Evaluation Approach, DELCORA shall submit to EPA and PADEP a Water Quality Model Plan for review and approval. Details of the Consent Decree requirements for Water Quality Modeling and Monitoring Plan are respectively found in Section 2.1 and 3.1.1.

1.3 CSO and Receiving Water System Description

The combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls. The Chester CSO system contains 26 permitted outfalls and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. However, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. Figure 1-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility. Figure 1-3 also provides a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 1-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

Figure 1-3: Location of Regulators and Combined Sewer Outfalls with Drainage Areas

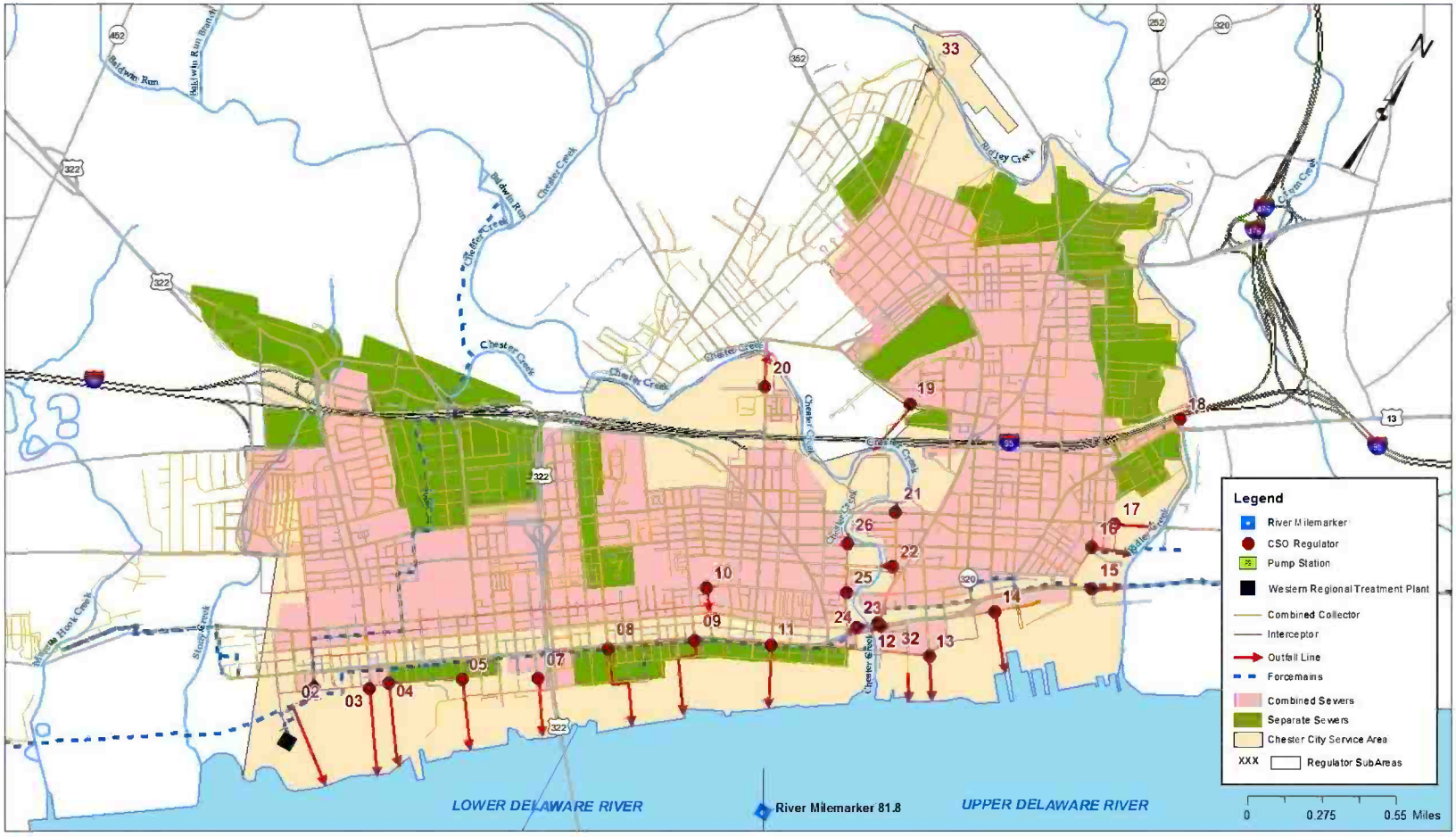
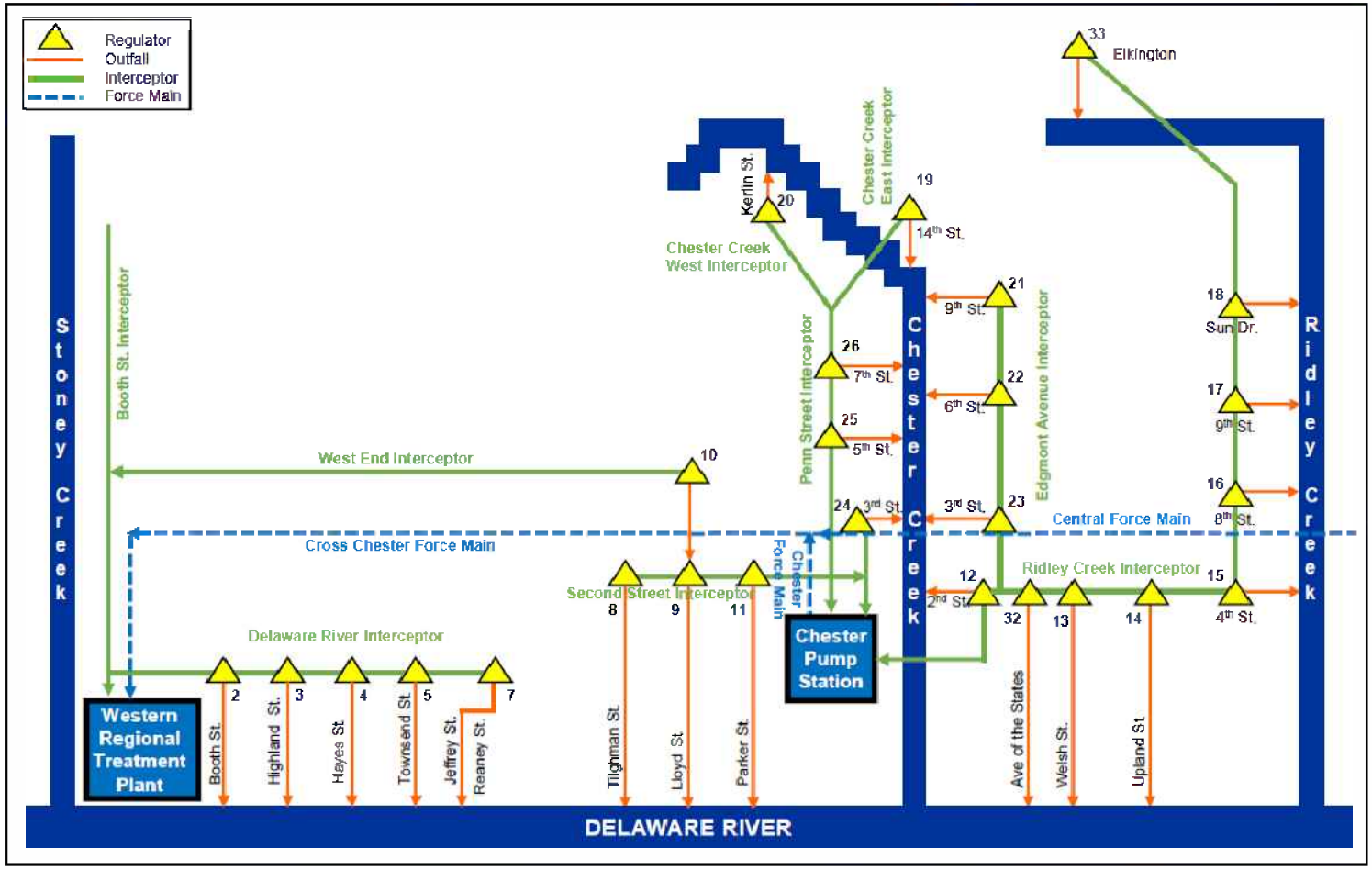

Legend
River Milemarker
CSO Regulator
Pump Station
Western Regional Treatment Plant
Combined Collector
Interceptor
Outfall Line
Forcemains
Combined Sewers
Separate Sewers
Chester City Service Area
XXX Regulator SubAreas
LOWER DELAWARE RIVER
River Milemarker 81.8
UPPER DELAWARE RIVER
0 0.275 0.55 Miles
Baldwin Run
Chester Creek
Ridley Creek
Crum Creek
Darby Creek
Stoney Creek
Muckinipattis Creek
Ridley Creek
Baldwin Run
Chester

Figure 1-4: Schematic of Chester CSO System



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

GREELEY AND HANSEN

Figure 1-4
SCHEMATIC OF CHESTER CSO SYSTEM

1.4 Work Plan Purpose and Objectives

The purpose and objective of the Water Quality Monitoring and Modeling Work Plan is to provide a blueprint for the water quality modeling and monitoring work that will be consistent with EPA requirements as listed in DELCORA's Consent Decree.

1.5 Project Team Organization

The proposed project team organization, including key project personnel and their corresponding responsibilities, are shown in Figure 1-5.

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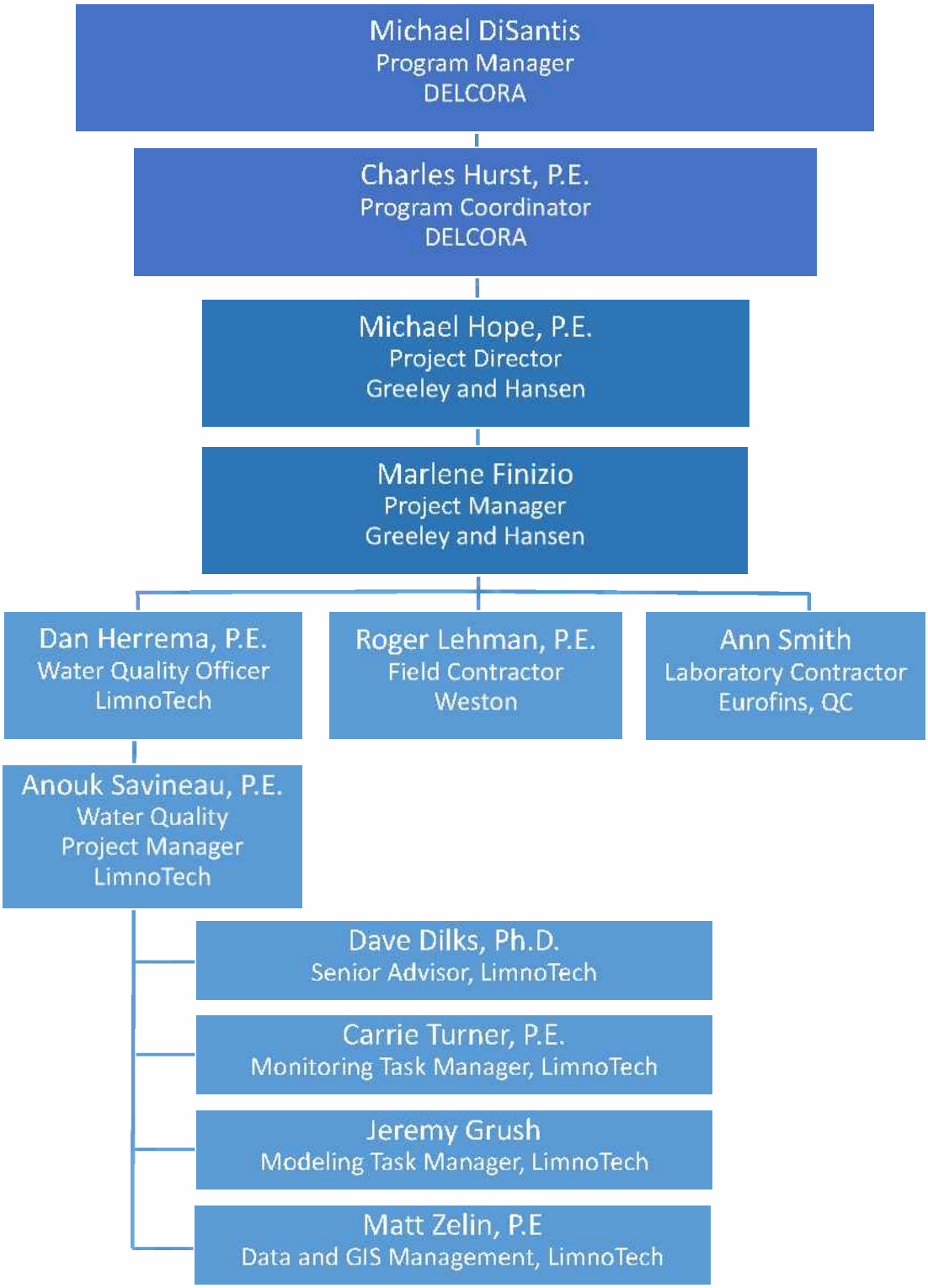
Figure 1-5: Project Team Organization



Section 2 Water Quality Model Plan

2.1 Regulatory Requirements

2.1.1 Consent Decree Requirements

The Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania on August 17, 2015, and was approved by the Federal District Court on November 10, 2015. The Consent Decree requires DELCORA to complete and submit a revised and updated LTCP to the USEPA and the PADEP for review and approval. Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within ninety (90) days after EPA reviews and approves the Alternatives Evaluation Approach, DELCORA shall submit to EPA and PADEP a Water Quality Model Plan for review and approval. For each water body[1] in which the Demonstration Approach is to be used, the Water Quality Model Plan shall address:

i. Background, Scope and Purpose, Description of System;

ii. Water quality modeling software to be employed;

iii. Model configuration and development, including reaches to be modeled, and segmentation and boundary conditions;

iv. Calibration and validation (dry weather and wet weather, including events and data to be employed, detailed information regarding all additional data collection activities (if needed), quantitative and qualitative calibration criteria, and utilization of H&H Model outputs;

v. Use of the Water Quality Model to evaluate Typical Year instream conditions for each identified pollutant of concern;

vi. Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to the Consent Decree.

The Consent Decree further specifies that within sixty (60) days after the approved Water Quality Model Plan is fully implemented according to the schedule included therein, DELCORA shall submit to EPA and PADEP a Water Quality Model Report for review and approval pursuant to Section VI (Review and Approval of Submittals) which shall specifically address each item set forth in Paragraph 15(a)(i)-(vi).

[1] Water bodies include the Delaware River, Chester Creek and Ridley Creek.

2.2 Model Selection/Software

This section describes the objectives and criteria used to select the appropriate modeling approach and model software.

2.2.1 Objectives

The objective of the water quality modeling is to assess the impacts of the DELCORA combined sewer system overflows on the bacteria concentrations in the receiving waters, both under existing conditions and future LTCP alternatives conditions, and assess these impacts against applicable water quality standards. In order to achieve these objectives, a linked CSO, watershed, and receiving water model will be created. The CSO model, also called the "H&H" model, is currently being developed for the Long Term Control Plan, with calibration and validation to be completed in April 2017. The H&H model is designed to simulate CSO discharges from the DELCORA service area within the City of Chester. The watershed model is a new model that will be created to model the non-CSO areas that are within the DELCORA service area and the extent of the receiving water model. The receiving water quality model is also a new model that will be developed to simulate the bacteria concentrations in the receiving waters, including the Delaware River, Chester Creek and Ridley Creek. The receiving water quality model will account for bacteria load contributions from various sources such as upstream, CSO, and stormwater loads, as well as processes that account for bacteria transport and decay.

There are several objectives to consider when selecting appropriate modeling software for the watershed and receiving water model, including:

- Technical objectives: Can the model software adequately represent the physical, chemical, and temporal characteristics of the project site? Can it address the complexities of the project site without being overly complex or overly simplistic?
- Regulatory objectives: Can the model software produce results that can be used to evaluate water quality against applicable water quality standards? Does it have a proven track record with similar regulatory projects? Will it help fulfill regulatory requirements as described in the Consent Decree?
- User objectives: Does the end user have the necessary hardware and expertise to properly apply the model software to its fullest potential? Are there financial constraints to be considered with the model?

These objectives and how they were applied to select the watershed and receiving water models are further described in sections 2.2.3 and 2.2.4 respectively. The selection of the CSO H&H model was previously described in the H&H Model Update and Calibration Plan (DELCORA, 2015).

2.2.2 Review of Existing Studies

There have been numerous water quality modeling studies performed on the Delaware River and its associated tributaries. Some of these studies were used to inform the DELCORA work plan, and may be used in the future to further inform or develop the water quality modeling and monitoring efforts. A brief overview of these studies is provided below.

- The Philadelphia Water Department's "Tidal Waters Water Quality Model for Bacteria and Dissolved Oxygen Model" was completed in June 2015 (PWD, 2015) using EFDC as the model framework. The model was developed in response to requirements in the 2011 Consent Order and Agreement between the Pennsylvania Department of Environmental Protection (PDEP) and the Philadelphia Water Department (PWD). The objectives of the model were to represent bacteria and DO in the tidal receiving waters. The model's extent is from the head of tide at Trenton, New Jersey to near Delaware City, Delaware. Also included were 28 tributaries to the Delaware River including eight miles of the tidal portion of the Schuylkill River.
- The Delaware River Basin Commission's "DYNHYD5 Hydrodynamic Model (Version 2.0) and Chloride Water Quality Model for the Delaware Estuary" was completed in December 2003 (DRBC, 2003). The model was used for the development of the Stage 1 TMDLs for polychlorinated biphenyls (PCBs) for the Delaware River Estuary. The model's extent is from Trenton, NJ to the Mouth of the Delaware River. PCBs and chloride were the only water quality parameters modeled. Note that DRBC is currently evaluating the nutrient criteria strategy for the Delaware River and has an initiative to create a new eutrophication model to address dissolved oxygen issues in the river (DRBC, 2012). The new model would include an improved hydrodynamic model of the tidal Delaware River and a dissolved oxygen and nutrient water quality model.
- The University of Delaware's Center for Applied Coastal Research developed a "Hydrodynamic Model of Delaware Bay and the Adjacent Coastal Region" (UD 2011) using the Regional Ocean Modeling System (ROMS) framework. The latest model update was performed in 2011, with other similar studies performed since the 1990s. The purpose of this model is further characterize the hydrodynamics of the Delaware Bay and surrounding area. Salinity is the only water quality parameter modeled. The models domain extends into the offshore into the Atlantic Ocean and into the Delaware Bay.
- Hydraulic models have also been created for the purpose of FEMA's National Flood Insurance Program to analyze risk of flooding. These models were developed for FEMA by federal contractors. For Chester and Ridley Creek, the most recent modeling effort is likely from the 1970's. These models were only used to assess flood risk so no water quality parameters are modeled. The model extent for these two creeks extends from their confluence with Delaware River upstream into Delaware County.

Limited topographic and bathymetric surveys were performed for these models which will be useful in characterizing the bathymetry of Chester and Ridley Creek.

2.2.3 Watershed Model Selection

Many watershed model software packages are available and these models vary in their recognition by USEPA and their applicability to the Delaware River and its tributaries. The proposed watershed model framework for this project is EPA Storm Water Management Model (SWMM), which is supported by the USEPA and has been successfully applied by the project team at similar sites and for related purposes, including in East Rutherford, NJ, Washington, DC, and Richmond, VA. SWMM is a dynamic rainfall-runoff simulation model used for single event or continuous simulation of runoff quantity and quality from primarily urban areas (USEPA, 2015). A review of the Chester Creek and Ridley Creek watersheds using the USGS StreamStats[2] tool show that these two watersheds are 42% and 37% urban respectively. Additionally, the current H&H model for the DELCORA service area is also built using the SWMM software, so choosing SWMM for the watershed model provides consistency in the suite of models used by DELCORA.

A variety of enhanced SWMM platforms are available that integrate the EPA SWMM software with user friendly interfaces and GIS capabilities. For this project, PCSWMM, developed by CHI, will be used. Once the watershed model is built, the model files can be provided as PCSWMM or EPA SWMM files.

2.2.3.1 Attributes

The main attributes of the proposed watershed model are that it will be able to predict dry and wet weather flows and associated bacteria loads. The watershed model will provide necessary spatial resolution to account for different subcatchment physical characteristics such as slope, imperviousness, length and width, and soils. Additional, it will be able to predict variations in timing, peak flows, and flow volumes.

The inputs and outputs of the SWMM model are described in more detail in the following section.

2.2.3.2 Inputs and Outputs

Model inputs are site-specific estimates of environmental conditions or assumptions that influence modeled water quantity and quality. Model outputs are results of model calculations that describe conditions related to water quantity and quality. Table 2-1 describes the SWMM watershed model inputs and outputs that will be used for this project.

[2] http://water.usgs.gov/osw/streamstats/

Table 2-1: Watershed Model Inputs and Outputs

Process	Inputs	Outputs
Runoff Calculations	Area, width, imperviousness, slope, roughness, depression storage, soil infiltration, meteorology (precipitation, temperature)	Catchment runoff volume and flow rate, hydrograph of flow vs. time.
Water Quality Calculations	Event Mean Concentration for stormwater and CSO outfalls	Bacteria concentrations in dry and wet weather flows, pollutographs of pollutant concentration vs. time
Routing Calculations	Pipe and/or channel geometry, slope, roughness.	Dry and wet weather flow volumes and rates, hydrographs of flow vs. time

The runoff component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads according to their landuse, landcover, and soil characteristics (USEPA, 2014). Additional information on the main model inputs that will have to be defined for the runoff component of SWMM are shown in Table 2-2.

Table 2-2: SWMM Runoff Model Inputs

Inputs	Source of Information
Area	Delineated in GIS using topography and sewer network data
Width	Calculated in GIS based on the watershed delineation
Slope	Calculated in GIS using topography
Imperviousness	Calculated in GIS using NLCD data or estimated from landuse data
Roughness	Based on published values for impervious and pervious area
Depression Storage	Based on published values for different land covers
Soil Infiltration	Based on soil data and characteristics published by USGS (SSURGO). The Horton method is the preferred method to account for infiltration losses for this project.
Meteorology	Precipitation, temperature, evaporation data obtained from nearby weather stations

To calculate the bacteria loads associated with the watershed flows, bacteria event mean concentrations (EMCs) will be assigned to the flows. An EMC represents the average pollutant (bacteria) concentration present in runoff. The appropriate EMCs will be obtained through the sampling efforts as described in Section 3.

For the purpose of this project, the predicted runoff from the watershed model will be directly connected to the receiving water quality model. In other words, routing through the pipe/channel system will not be simulated unless the calibration of the receiving water model demonstrates a need for additional resolution in flow timing is needed. If explicit routing is needed, pipe and/or channel attributes such as slope, roughness, or cross-sectional geometry will be obtained from DELCORA or field studies. Routing would further be accomplished by applying the kinematic or dynamic wave routing method.

2.2.4 Receiving Water Quality Model Selection

Many water quality model frameworks are available and these models vary in their recognition by USEPA, adaptability for project-specifics needs, and their applicability to the Delaware River and its tributaries. The proposed water quality model framework for this project is EFDC (Environmental Fluid Dynamics Code), which is supported by the USEPA and has been successfully applied by the project team at similar sites and for related purposes. It may be beneficial to couple EFDC with another model to reduce simulation run times. EFDC could be used to compute hydrodynamics and those results could be linked to the RCA (Row-column AESOP) water quality model for water quality calculations. This potential approach would reduce model run times by allowing for a longer time step and for a smaller water quality model extent. RCA, like EFDC, is a highly regarded water quality model that has been applied at numerous sites.

EFDC is a state-of-the-art finite difference model that can be used to simulate hydrodynamic and water quality behavior in one, two, or three dimensions in riverine, lacustrine, and estuarine environments (TetraTech 2007a, 2007b). The model was developed by John Hamrick at the Virginia Institute of Marine Science in the 1980s and 1990s, and it is currently maintained under support from the USEPA. The model has been applied to hundreds of water bodies, including Chesapeake Bay and the Delaware River. Recently, LimnoTech has successfully applied EFDC to a number of estuarine sites including Newark Bay, East Rutherford, NJ, and San Diego Bay. The EFDC model is both public domain and open source, meaning that the model can be used free of charge, and the original source code can be modified to tailor the model to the specific needs of a particular application. As a result, EFDC provides a powerful and highly flexible framework for simulating hydrodynamic behavior and water quality dynamics for the Delaware River and Chester Creek and Ridley Creek.

The RCA model is a part of a family of generalized water quality models developed by HydroQual, Inc. and known as AESOP (Advanced Ecological Systems Operating Program) (HydroQual, 2004). The RCA model framework is capable of simulating water quality dynamics on a fine-scale, multi-dimensional computational grid based on linkage to an external hydrodynamic model application. RCA is specifically designed to interface with the EFDC model via a series of binary files generated by the latter model. The general transport fields predicted by EFDC (or another hydrodynamic model) are used by RCA to advect and disperse water quality constituents throughout the water column.

2.2.4.1 Attributes

To compute the movement (transport) and concentrations of pollutants, a water quality model must represent the primary physical and kinetic processes that influence transport and pollutant concentrations. It is anticipated that the following processes will be necessary to represent in this model application:

- Loading of local bacterial pathogens from the watershed, MS4s, CSOs, treatment plant(s), and other known sources to Chester Creek, Ridley Creek, and the Delaware River;
- Transport of pathogens from the riverine portions of creeks to the Delaware River estuary;
- Transport of pathogens via tidal currents and mixing within the Delaware River estuary; and,
- Net losses of pathogens during transport.

These attributes are described in more detail in the following section.

2.2.4.2 Inputs and Outputs

Model inputs are site-specific estimates of environmental conditions or assumptions that influence modeled water quality. Model outputs are results of model calculations that describe conditions related to water quality. Table 2-3 below describes model inputs and outputs relating to the primary physical and kinetic processes described in the previous section.

Table 2-3: EFDC Model Inputs and Outputs

Water Quality Model Process	Related Inputs	Related Outputs
Bacterial pathogen loadings	Pollutant concentrations for: • Delaware River boundaries • Chester Creek upstream watershed • Ridley Creek upstream watershed • CSOs • MS4 areas • WWTPs	• Pollution in-stream concentrations
Transport of pathogens within the riverine portions of creeks	Flow rates for: • Creeks • CSOs • MS4 areas • WWTPs Stream bathymetry	• Water depths and velocities in the creeks
Transport of pathogens via tidal currents and mixing within the Delaware River estuary	• Delaware River and major tributary flow rates, • Tidal water levels, and • Delaware River bathymetry	• Water depths and velocities in the Delaware River
Net losses of pathogens during transport	• First order bacteria decay rate • Water temperatures • Parameters influencing dependence of decay on water temperature	• Pollutant in-stream concentrations

2.2.5 Data Sources

Table 2-4 below describes data sources that are expected to help inform model inputs relating to the primary physical and kinetic processes described above.

Table 2-4: Data Sources Supporting Model Inputs

Water Quality Model Process	Related Inputs	Data Sources
Bacterial pathogen loadings	Pollutant concentrations for: • Creeks • CSOs • MS4 areas • WWTPs	• Bacterial pathogen concentration data (existing data and data proposed in Section 3 of this work plan to be collected) • WWTP DMR (discharge monitoring report data) • Literature-based event mean concentration data
Transport of pathogens within the riverine portions of local creeks	Flow rates for: • Creeks • CSOs • MS4 areas • WWTPs Stream bathymetry	• USGS flow data • Collection system model overflow rates • Watershed model flow rates • Bathymetric data
Transport of pathogens via tidal currents and mixing within the Delaware River estuary	• Delaware River and major tributary flow rates • Tidal water levels • Delaware River bathymetry	• USGS flow data • NOAA water level data • NOAA Delaware River bathymetric data
Net losses of pathogens during transport	• First order bacteria decay rate • Water temperatures • Parameters influencing dependence of decay on water temperature	• USGS and/or NOAA water temperature data • Bacterial pathogen concentration data (existing data and data proposed in Section 3 of this work plan to be collected)

2.3 Model Development and Configuration

2.3.1 Watershed Model

The watershed model will be developed and configured in order to calculate the runoff and bacteria loads generated by the Ridley Creek and Chester Creek watersheds, as well as by the separate stormwater areas within the DELCORA service area.

2.3.1.1 Extent

The flows and bacteria loads from the upstream portion of the Ridley Creek and Chester Creek watershed area will be represented through the use of boundary conditions. These boundary

conditions will be determined through an analysis of USGS flow gage data and bacteria monitoring data. The portions of the Ridley Creek and Chester Creek watersheds that are within the DELCORA service area (and a small area upstream of the DELCORA service area) will be explicitly modeled using SWMM. Figure 2-1 below shows the extent of the proposed watershed model.

2.3.1.2 Segmentation

As described in the section above, the Ridley Creek and Chester Creek watersheds will be divided into upstream and downstream areas. The upstream area will be represented through the use of boundary conditions that describe the flow and load that are generated from the upstream area under different meteorological conditions. The downstream area will be divided into relatively small and homogenous catchments.

Figure 2-1: Proposed Extent of the Watershed Model

2.3.2 Receiving Water Quality Model

A few considerations guide the design of a receiving water quality model. First, models are designed to cover the locations of interest with respect to site-specific management questions. Second, the spatial extent of a model should be chosen to allow for accurate calculations of transport. This requires that the model's edges (boundaries) occur at locations where environmental conditions (e.g. flow rates) are well known and readily defined. For instance, it is often beneficial to locate a model boundary at the head of tide where tidal flows are zero, or at a monitoring location where tidal water levels are known. Third, an appropriate spatial resolution should be determined to balance the level of detail in the model against the run times of simulations. Finally, the model boundaries should be sufficiently distant from the source such that the pollutant mass assumptions from these boundaries would not significantly affect conditions simulated in the area of interest. The proposed model extent and spatial resolution are described in the following sections.

2.3.2.1 Extent and Reaches

On the Delaware River, we propose that the receiving water model extends from NOAA station 8551762 (Delaware City, DE) to the head of tide at Trenton near USGS station 01463500 (Delaware River at Trenton, NJ). Environmental conditions at these locations are well defined by data and the locations are sufficiently far from Delaware County that model results are not expected to be strongly influenced by water quality assumptions at the boundaries.

We propose that the receiving water model extends through the tidally influenced portion of the creeks and through all reaches adjacent to the DELCORA combined sewer system. This is because the receiving water model is better suited for representing tidal conditions at the mouth of the creeks than the watershed model, and representing CSOs exclusively in the receiving water model simplifies the modeling process. Tidal transport will likely influence the duration of time that pathogen sources influence the lower reaches of each creek. In some cases, it may be beneficial to extend the model farther in to the creeks (i.e. upstream of the tidally influenced reaches) to a sampling or monitoring location.

2.3.2.2 Segmentation

The segmentation of a model defines the degree of spatial detail in the model results and also determines how much time is required for a simulation to run. Determining an appropriate degree of spatial detail is related to both the detail necessary to address management questions and the degree of detail necessary to accurately model the processes of an environmental system. Occasionally, model segmentation must be iteratively refined during the model development process to reach a suitable degree of detail.

We propose that the receiving water quality model have roughly the following characteristics:

- Five to ten cells spanning the Delaware River cross section;
- One cell spanning the cross section of each creek;
- 2,000 to 4,000 total grid cells within the model extent;
- Typical Delaware River cell dimensions of roughly 150-300 feet (width) by 1,000 to 2,000 feet (length). Typical creek cell lengths of 200 to 400 feet; and,
- Five cells spanning the water depth.

The Delaware River is relatively deep (30-40 feet deep) near the location of maximum DELCORA impact, so a three-dimensional model is recommended for computing near-surface pathogen concentrations, which are occasionally elevated relative to those at greater depths due to discharge of CSOs near the water surface. A depth-averaged (two-dimensional) model would instantaneously mix pollutant concentrations over the water depth and understate near-surface concentrations.

2.3.2.3 Linkage with CSO (H&H) Model

The CSO H&H model will be linked to the receiving water quality model. The H&H model will be run for the calibration period as well as for each CSO alternative of interest, and CSO outfall results will be inserted into the EFDC model at the appropriate grid location in EFDC.

2.3.3 Linkage with Watershed Model

The watershed model will be linked to the receiving water quality model. The watershed model will be run for the appropriate meteorological period and results will be inserted into the EFDC model at the appropriate grid locations in EFDC.

2.3.4 Water Quality Parameters

The water quality parameters that will be evaluated in the water quality model are fecal coliform bacteria, *Enterococcus* bacteria, and *Escherichia coliform* (*E. coli*). These parameters are discussed in detail in the Identification of Sensitive Areas and Pollutants of Concern Report (DELCORA, 2016).

2.3.5 Boundary Conditions

Boundary conditions define environmental conditions at the edges of the model spatial domain and influence model calculations within the model domain. Boundary conditions will be used in both the watershed model and receiving water quality model.

Two types of boundary conditions are required in the watershed model: flow boundary conditions and water quality boundary conditions. As explained in Section 2.3.1, the flows

and loads from the upstream portion of the Ridley Creek and Chester Creek watersheds will be represented through the use of boundary conditions. These boundary conditions will be determined through the analysis of USGS flow gage data and bacteria monitoring data. The flow and bacteria boundary conditions will vary according to meteorological and seasonal conditions.

Two types of boundary conditions are also required in the receiving water quality model: hydrodynamic boundary conditions and water quality boundary conditions. Hydrodynamic boundary conditions will include a water level boundary condition, which will define how water levels vary with the tides and other atmospheric conditions, and inflow boundary conditions, which will define flow rates into the model from freshwater sources such as from the Delaware River above Trenton, major tributaries, creeks of interest, MS4s, CSOs, and treatment plants. Water quality boundary conditions define the pollutant concentrations associated with all inflows to the model. Water quality boundary conditions will be defined based on the available sampling data for all pollutant sources of interest.

2.4 Model Calibration and Validation

Model calibration is described in USEPA guidance (USEPA, 1994) as the "process of adjusting model parameters within physically defensible ranges until the resulting predictions give the best possible fit to the observed data." Calibration will occur for the runoff and water quality components of the watershed model, as well for the hydrodynamic and water quality components of the receiving water quality model. Calibration will occur through the use of available monitoring data.

2.4.1 Calibration Objectives

The objectives for the hydrodynamic model calibration are to determine a set of model inputs (primarily bed roughness and turbulent mixing parameters) that produce model results consistent with the observed data. During the hydrodynamic model calibration, comparisons between modeled and observed water surface elevations and velocities will be made. The comparisons will allow for any adjustments to be made.

The objectives for the water quality model calibration are to interpret the water quality data to improve initial estimates of pollutant loads and potentially constrain assumptions related to bacterial decay. For instance, model tests would be run with different assumptions about pollutant concentrations in combined sewer overflows. Those tests would be evaluated for consistency with the receiving water sampling data to determine a range of pollutant concentration assumptions that are supportable. Likewise, model tests would be run with different assumptions about bacterial decay, and those tests would be evaluated to refine inputs related to decay.

2.4.2 Data for Calibration/Validation

Data available for the hydrodynamic model calibration include NOAA water level and velocity data, and USGS water level and flow data. Primary hydrodynamic model calibration stations include the following NOAA stations:

- Water level gages: #8540433 (Philadelphia, PA), #8546252 (Bridesburg, PA), #8539094 (Burlington, NJ), and #8548989 (Newbold, PA).
- Current velocity meter: Station dB0301 (Philadelphia, PA).

Model results will be compared to hourly water level and current velocity data at these locations.

Data available for the water quality calibration are pathogen grab sample data. Section 3 of this work plan summarizes the currently available water quality data by sample location. We propose to supplement these data with an additional sampling program described in Section 3 of this work plan.

2.4.3 Calibration Criteria

Hydraulic calibration will primarily focus on reproducing observed water levels and current velocities in the Delaware River. This approach provides a robust calibration by focusing on the hydraulic attributes that are the primary dependent variables of the hydrodynamic model. Calibration goodness will be determined by qualitative visual comparison of model and data time series, one-to-one plots, and cumulative frequency distributions (CFDs). Calibration will involve adjustment of the roughness height to values that best replicate water level and velocities at NOAA stations.

Bacteria models are often evaluated qualitatively with multiple tools such as time series plots, CFDs, and 1:1 plots. Because bacteria concentrations vary over many orders of magnitude and sources can be numerous, distributed, and highly variable with time, bacteria model results are not often held to quantitative calibration criteria. Instead, a rule of thumb is that modeled bacteria concentrations should mostly be consistent with observed bacteria concentrations within an order of magnitude. Agreement of model and data within a factor of two indicates a high degree of model performance.

2.4.4 Model Sensitivity

Model sensitivity tests complement and illustrate the model calibration. Model sensitivity tests are model simulations in which uncertain inputs are varied to assess their significance in determining, for instance, pollutant concentrations. These tests are useful for evaluating whether the model calibration is optimized within the limits of the available data, and for identifying uncertainty in significant model inputs. For instance, model sensitivity tests varying the assumed CSO pollutant concentrations would illustrate how a range of assumptions are more or less consistent with stream sampling data.

Model sensitivity tests will be conducted for the following inputs:

- Major pollutant loads (including at least CSO, MS4, and local watershed loads).
- Parameters influencing bacteria decay rates.

Results of model sensitivity tests will be summarized using plots such as CFDs, box plots, or time series plots.

2.5 Model Typical Year Application

An evaluation of the typical hydrologic period was conducted for DELCORA and is detailed in the report entitled "Typical Hydrologic Period Report" (DELCORA, 2016). The typical year that will be applied to evaluate CSO scenarios will also be used for the receiving water quality model. The recommended period for typical year application is 1994-1996.

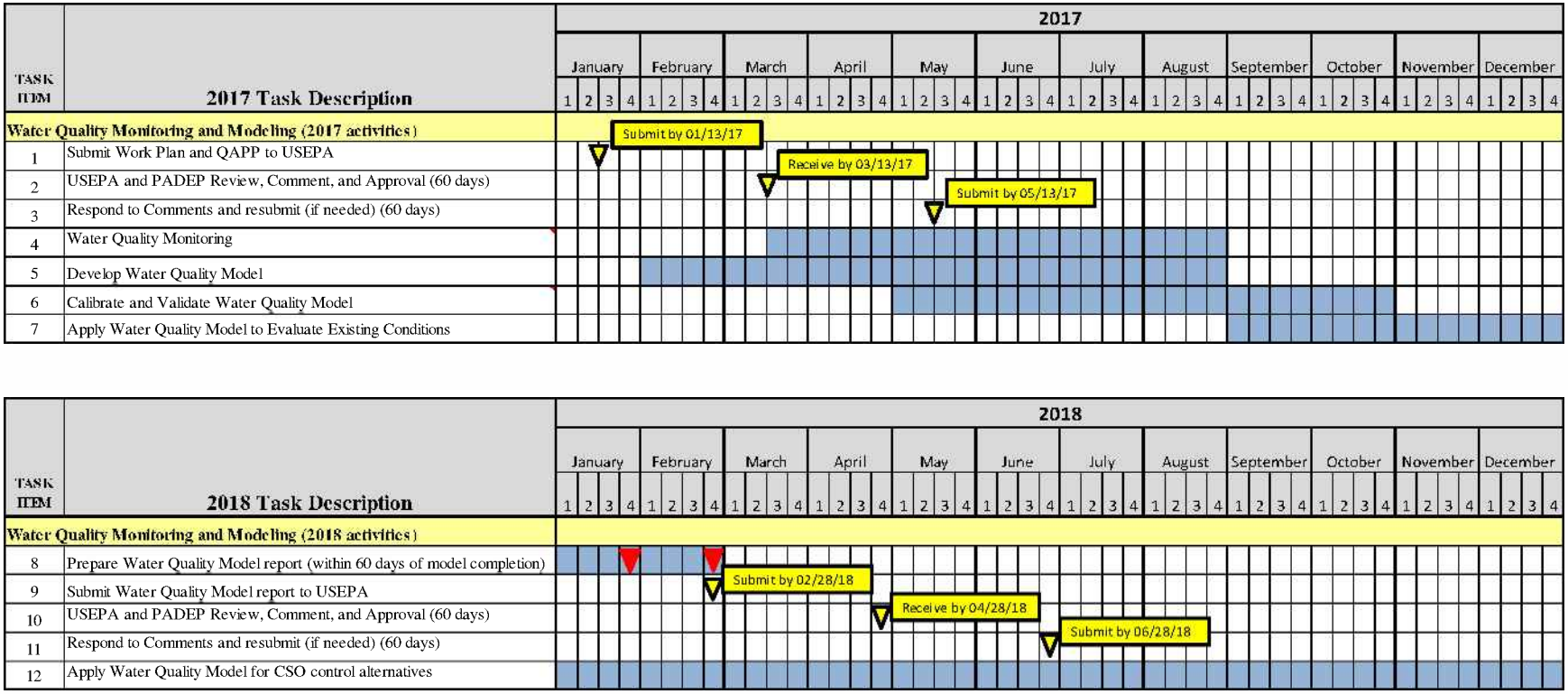
2.6 Model Development Schedule

The schedule for model development and application is shown in Figure 2-2 below. All tasks related to the water quality modeling development and application are included in the schedule. The schedule is integrated into the LTCP development consistent with other dates required to the Consent Decree.

2.7 Model Documentation

A report will be provided that summarizes the development, calibration, application, and results of the receiving water model. In accordance with the Consent Decree, this report will be submitted to EPA and PADEP within sixty (60) days after the approved Water Quality Model Plan is fully implemented according to the schedule included herein.

Figure 2-2: Schedule for Model Development and Application



Section 3 Monitoring Work Plan

3.1 Regulatory Requirements

3.1.1 Consent Decree Requirements

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraph V.A.10.e and V.A.10.f require that the development of the LTCP include

V.A.10.e. Develop and implementation of a Water Quality Model

V.A.10.f Characterization of the service area and the Receiving Waters as required by CSO Control Policy Paragraph II.C.1 and associated guidance.

Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within 90 days after review and approval of the Alternatives Evaluation Approach, DELCORA shall submit a report to the USEPA and PADEP that describes the use of the Water Quality Model to support the Demonstration Approach consistent with Section II.C.4 of the CSO Control Policy and the Paragraph V.13 of the Consent Decree (Alternatives Evaluation). Section V.A.15.a of the Consent Decree specifically states:

For each water body in which the Demonstration Approach is to be used, the Water Quality Model Plan shall address:

(i) Background, Scope and Purpose, Description of the System;

(ii) Water quality modeling software to be employed;

(iii) Model configuration and development, including reaches to be modeled, and segmentation and boundary conditions;

(iv) Calibration and validation (dry and wet weather), including events and data to be employed, detailed information regarding all additional data collection activities (if needed), quantitative and qualitative calibration criteria, and utilization of H&H Model outputs;

(v) Use of the Water Quality Model to evaluate Typical Year in-stream conditions for each identified pollutant of concern;

(vi) Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to this Consent Decree.

3.3 Existing Water Quality Monitoring Overview

The Water Quality Monitoring Program (WQMP) is designed to collect data that will be used to assess water quality concerns identified in the Delaware River watershed and its tributaries, Chester Creek and Ridley Creek, in the vicinity of Chester, PA. Pollutants of concern (POCs) were identified in the Identification of Sensitive Areas and Pollutants of Concern Report (Greeley and Hansen, 2016). These POCs are fecal coliform, *E. coli*, and *Enterococcus* and are the primary focus of the WQMP. In completing the initial step of characterizing the watershed, historical data was compiled, reviewed and assessed to determine the need to augment existing data to address the watershed issues identified. This review indicated that one of the POCs, *E. coli*, has not been sampled in all the receiving waters and the data that have been collected for the remaining POCs are of insufficient frequency and spatial density to be useful in the modeling process.

3.3.1 Historic Sampling

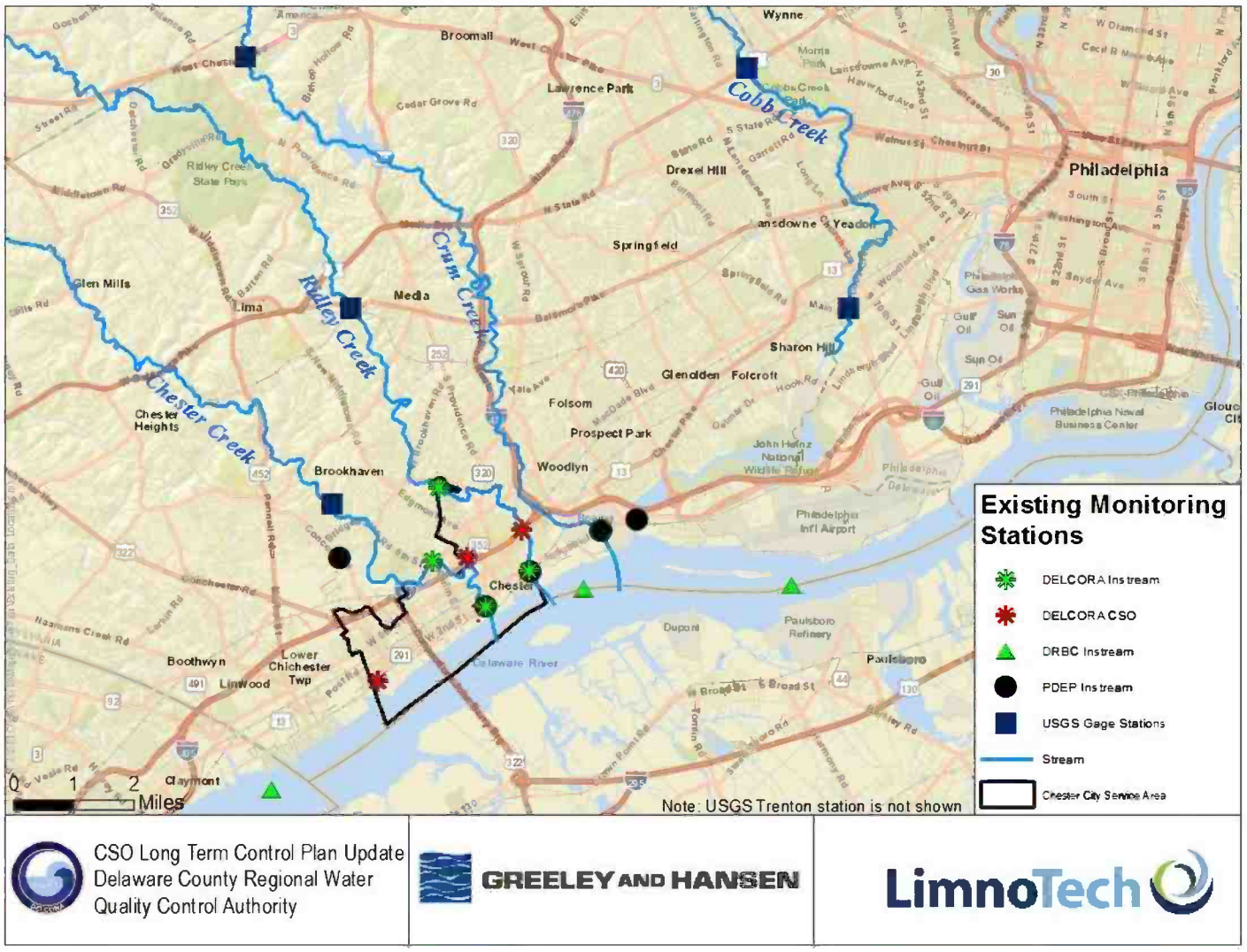
The Water Quality Model requires robust flow and water quality datasets to build confidence in its use as a tool for CSO planning. Data are needed in the modeled receiving waters for use in model calibration and validation as well as for the predominant wet weather sources, such as DELCORA's CSOs and the City of Chester's MS4 runoff to estimate pollutant loadings to the model. The existing water quality data were reviewed for their adequacy in meeting the data needs of the water quality model for the POCs (fecal coliform, *E. coli*, and *Enterococcus*). The review indicated that Chester Creek and Ridley Creek have limited POC data. Although the Delaware River has more extensive POC data, it lacks the temporal frequency needed to characterize wet weather impacts from DELCORA's CSOs. It would be difficult to constrain the Water Quality Model's representation of DELCORA's sources on the receiving waters without additional monitoring data designed specifically for calibrating and validating a robust water quality model. Existing flow data were also reviewed for adequacy; reports of mean daily stream discharge are available from several stream gages along the Delaware River and in tributaries near the DELCORA service area, ranging from as early as 1912 to the present. The existing flow and water quality data are described in this section.

Flow data for the Delaware River and tributaries in the DELCORA service area were obtained from the USGS National Water Information System. Reports of mean daily stream discharge were available from five stream gages in DELCORA service area measuring daily mean discharge: Crum Creek near Newtown Square, PA (1980-2016); Chester Creek near Chester, PA (1931-2016); Ridley Creek near Media, PA (1986-2016); Cobbs Creek at U.S. Highway No. 1 at Philadelphia, PA (1964-2016); and Cobbs Creek at Mt. Moriah Cemetery, Philadelphia, PA (2005-2016). Though not in service area, mean daily discharge data were also obtained from the gage at the Delaware River at Trenton, NJ (1912-2016) because it is expected that these data will be used to inform the upstream boundary for the hydraulic portion of the water quality model. The USGS Pennsylvania Water Science Center has conducted water quality sampling at various points in the state. However, none of their sampling locations are near to the DELCORA service area or local waterways.

Monthly effluent data from DELCORA's WWTP are available from the Pennsylvania Department of Environmental Protection's (PADEP) eDMR website (*www.dep.pa.gov/edmr*). Reported data include monthly geometric mean and instantaneous maximum values for fecal coliform from 2009 through 2016. PADEP also monitors water quality of tidal streams that empty into the Delaware River, through the Pennsylvania Water Quality Tributary Project funded by the Delaware River Basin Commission (DRBC). This program monitored for fecal coliform levels in Chester Creek, Ridley Creek, Darby Creek, Crum Creek, and others twice annually from 2007-2010. PADEP also operates the PA Surface Water Quality Monitoring Network, through which Baldwin Run (a tributary to Chester Creek) was sampled monthly for fecal coliform from 1998-1999.

The Delaware River Basin Commission operates its Boat Run program to monitor ambient, sampling for *E. coli*, *Enterococcus*, and fecal coliform at various sites along the Delaware River (Figure 3-1). Samples were collected from each station between one and three times each month from March through November every year since 1999. Through this program, data are available at three sites near DELCORA: Eddystone (2005-2016), Paulsboro (1999-2016), and Marcus Hook (1999-2016).

Figure 3-1: Historical Flow and Water Quality Sampling Locations Near DELCORA Service Area.



Since 2009, DELCORA has also done their own sampling at CSO outfall sites and in receiving waters. In 2010, a survey was conducted to measure fecal coliform levels in Ridley and Chester Creeks during wet and dry weather. There were two sample sites in each creek, and over the course of the study, six surveys were conducted. Four surveys occurred during dry weather, one during a wet event, and one during a wet event after a storm. During each survey, one sample was collected at each site. In 2009, DELCORA began sampling in the CSO system as required by their NPDES permit. Four outfalls and pump stations were sampled once annually for fecal coliform from 2009-2011, and three outfalls were sampled once annually for fecal coliform from 2012-2014. In 2015, four outfalls and pump stations were sampled for fecal coliform and *Enterococcus*, on three separate occasions. *E. coli* was not measured in any of these surveys.

The extent of existing water quality data and its adequacy to support the Water Quality Model development and calibration can be summarized as follows:

- Some CSO water quality data has been collected but mostly for fecal coliform. There are no CSO data for *E. coli*. Another limitation in the CSO data is that the CSO samples did not coincide with in-stream sampling, making it difficult to directly link CSO loads to in-stream impacts.
- No water quality sampling for the POCs has been done of the stormwater runoff in the separated areas of the DELCORA service area.
- Delaware River has the most data of the receiving waters and it has data for all three POCs. However, the data were collected at regular intervals, independent of weather condition, and typically only one sample per location per survey was collected. These periodic sampling events do not provide enough data to characterize DELCORA loads on the river.
- The tributaries (Chester Creek and Ridley Creek) have been sampled sporadically and rarely within the tidal zone adjacent to DELCORA's service area. Wet weather data collected by DELCORA, consisting of only one sample per event, are not sufficient to characterize the magnitude and duration of the POCs' pollutographs over a storm event. Data are most robust for fecal coliform. There is less data for *Enterococcus* and none for *E. coli*. In addition, no sampling has been conducted in these tributaries since 2010.

The monitoring program presented in this work plan and QAPP builds on the sampling that has already been done while addressing the limitations identified in the existing data. This work plan includes a comprehensive monitoring assessment of all of the POCs to characterize loads and in-stream conditions. These data will be used to inform the Water Quality Model development, calibration and validation.

3.3.2 Ongoing Sampling

There is no routine on-going monitoring for the pollutants of concern in the tributary waterways adjacent to the DELCORA service area. The Delaware River Basin Commission samples the Delaware River near Chester approximately once a month between April and October. The analysis of these samples includes fecal coliform, *E. coli*, and *Enterococcus*, which are the pollutants of concern (POCs).

3.4 Sampling and Analysis Plan Overview

The WQMP is designed to collect data that will be used to develop and calibrate watershed and receiving water quality models which will be used to assess water quality concerns for the POCs identified in the Identification of Sensitive Areas and Pollutants of Concern Report (Greeley and Hansen, 2016). These POCs are fecal coliform, *E. coli*, and *Enterococcus*. Additional *in situ* parameters, such as salinity, temperature, and conductivity will also be collected to inform the development of the Water Quality Model.

Water quality monitoring will be undertaken at up to thirteen (13) in-stream locations (seven of which are Delaware River sampling locations), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) stormwater locations in the City of Chester municipal separate storm sewer system, as shown in Figure 3-2. Water quality monitoring and sampling will be conducted as follows:

- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area will be sampled for water quality for (3) dry weather events; one of which will be targeted for collection during a tributary low-flow period (less than 25th percentile flow). The mid-stream and far-shore Delaware River locations will not be sampled during the dry weather surveys because it is expected that water quality in the river will be relatively uniform laterally due to the lack of active sources during dry weather. These dry weather events would preferably be distributed across the sampling season, which is assumed to be March through June of 2017. Grab samples and *in situ* measurements will be collected at each location during each event.
- All thirteen (13) in-stream locations will be sampled for water quality using grab samples and *in situ* monitoring for three (3) discrete wet weather events, according to the surface water quality monitoring program protocols described in this Monitoring Work Plan.
- Up to four (4) CSO and two (2) stormwater outfall locations will be sampled for water quality for the same three (3) discrete wet weather events according to the outfall monitoring program protocols described in this Monitoring Work Plan. Samples for all outfalls will be collected as grab samples.
- Field Standard Operating Procedures (SOPs) and the Sampling Analysis Plan (SAP) referenced in the following sections of the Water Quality Monitoring Work Plan are

provided in Appendix C of the Water Quality Modeling and Monitoring Quality Assurance Project Plan (QAPP).

The sampling events are planned to be distributed across the sampling season, which is assumed to be March through June 2017. Additionally, bathymetry surveys in the lower portion of the tributaries may be required to inform the development of the Water Quality Model, pending delivery of HEC models with transect information for these portions of the receiving waters.

3.4.1 Sampling Locations

Monitoring locations have been selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters are designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in Figure 3-2 and listed in Table 3-1, Table 3-2, and Table 3-3.

The tables include summaries of the rationales for each sampling location selected. The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater and Chester CSO pollutant loads. The Delaware River sampling locations will provide a characterization of water quality entering the Chester CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples will be collected across the transect corresponding to the DR-04 sampling location during each sampling round, when sampling across the river is feasible, to characterize lateral variability in the Delaware River during storm events. Delaware River conditions may be too hazardous for safe collection of one or more samples and/or sampling rounds (e.g. during periods of heavy barge traffic, small craft advisories, lightning, etc.). When these conditions occur, sampling will not be conducted in the river for safety reasons.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency of overflow, their overflow volume, and their accessibility. The stormwater sampling locations were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the study area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

Note that it may be necessary to adjust the one or more sampling locations in response to hazards, construction or other factors that affect the safety of field sampling personnel. The CSO and stormwater sampling locations will be finalized prior to the initiation of the sampling program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources.

Figure 3-2: Proposed Receiving Water (RW), Combined Sewer (CSO), and Stormwater (SW) Monitoring Locations

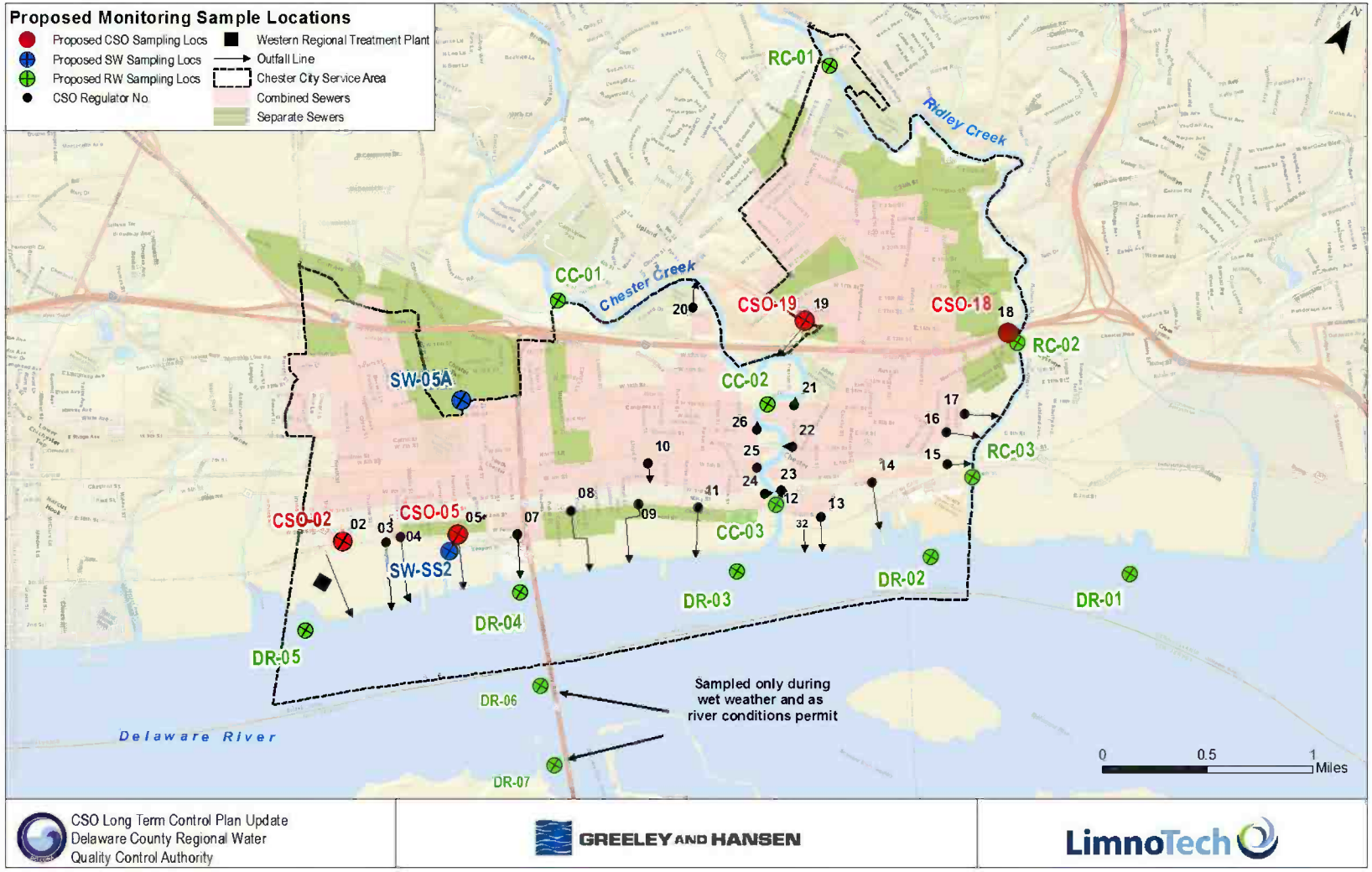


Table 3-1. Tributary Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CC-01	39.850122	-75.386348	Chester Creek	Tributary	Chester Creek at Upland-Incinerator Rd.	Upstream of all City sources and upstream of tidal influence
CC-02	39.850709	-75.365530	Chester Creek	Tributary	Chester Creek at the 9th St Bridge; 54 W 9th St	Characterize impacts from non-CSO urban runoff sources
CC-03	39.845227	-75.360284	Chester Creek	Tributary	Chester Creek at E 2nd St., William Penn's Landing Park	Characterize impacts from all CSOs discharging to Chester Creek
RC-01	39.873264	-75.375183	Ridley Creek	Tributary	Ridley Creek at Chester Park Drive Bridge; 298 East Elkington Blvd	Upstream of all City sources and upstream of tidal influence
RC-02	39.863016	-75.348686	Ridley Creek	Tributary	Ridley Creek at Morton Ave. Bridge; 1300 Sun Drive	Characterize impacts from non-CSO urban runoff sources
RC-03	39.853435	-75.346350	Ridley Creek	Tributary	Ridley Creek at East 4th St. (Harrah's) Bridge	Characterize impacts from all CSOs discharging to Ridley Creek

Notes:
[1] **GPS Coordinates, WGS 1984**

Table 3-2. Main Stem Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
DR-01	39.85282	-75.3299	Delaware River	Main stem	Delaware River between Ridley Creek and Crum Creek	"Upstream" of DELCORA's CSO discharges[2]
DR-02	39.84715	-75.3462	Delaware River	Main stem	Delaware River between CSO-14 and Ridley Creek	Characterize Ridley Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03	39.8398	-75.3606	Delaware River	Main stem	Delaware River between CSO-11 and Chester Creek	Characterize Chester Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-04	39.83132	-75.3766	Delaware River	Main stem	Delaware River at the boat launch off Highway 322	Priority area, in the lower Delaware River (Primary contact area)
DR-05	39.82182	-75.3917	Delaware River	Main stem	Delaware River between CSO-002 and Stony Creek	"Downstream" of DELCORA's CSO discharges[2], in the Atlantic sturgeon sensitive area
DR-06[3]	39.82636	-75.371	Delaware River	Main stem	Delaware River mid-stream along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events
DR-07[3]	39.82203	-75.3665	Delaware River	Main stem	Delaware River far shore (left descending bank) along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events

Notes:

[1] GPS Coordinates, WGS 1984

[2] "Upstream" and "downstream" subject to tidal conditions at time of sampling

[3] These locations will be sampled during the wet weather events only, when river conditions permit. POC concentrations are assumed to be laterally well-mixed during dry weather due to the absence of significant pollutant sources.

Table 3-3. CSO and Stormwater Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CSO-19	39.857132	-75.366105	Chester Creek	CSO	14th and Crozer Hospital; 1 Medical Center Blvd	Discharges to Chester Creek, one of the largest volume CSOs in DELCORA system
CSO-05	39.832598	-75.383958	Delaware River	CSO	Front and Townsend; 101 Townsend St	Discharges to Delaware River, one of the largest volume CSOs in DELCORA system
CSO-02	39.828334	-75.392570	Delaware River	CSO	Front and Booth; 100 Booth St	Aggregates cumulative effect of CS conditions, one of the largest volume CSOs in DELCORA system
CSO-18	39.863501	-75.349203	Ridley Creek	CSO	Sun Drive and Hancock St.; 1310 Sun Dr	Discharges to Ridley Creek
SW-05A	39.838501	-75.387708	Chester Creek	SW	7th and Engle Street; by tennis courts	Characterize runoff quality from predominantly residential area representative of the residential portion of the study area
SW-SS2	39.832853	-75.384193	Delaware River	SW	Front and Townsend; 105 Townsend St	Characterize runoff quality from predominantly commercial/industrial area representative of the commercial/industrial portion of the study area

Notes:
[1] GPS Coordinates, WGS 1984

3.4.2 Analytical Parameters

All of the in-stream dry and wet weather samples will be analyzed for the parameters shown in Table 3-4. The outfall samples will be analyzed for only *E. coli*, *Enterococcus* and fecal coliform.

Table 3-4: Analytical and Field Parameters

Parameter	Description	Sampling Program	Type of Measurement
E. coli	Escherichia coli	Dry, Wet	Grab
Enterococcus	Enterococcus sp.	Dry, Wet	Grab
Fecal coliform	Fecal coliform	Dry, Wet	Grab
wTemp	Water temperature	Dry, Wet, Receiving Water Only	In-situ
Cond	Conductivity	Dry, Wet, Receiving Water Only	In-situ
Salinity	Salinity	Dry, Wet, Receiving Water Only	In-situ

3.4.3 Sampling Schedule

3.4.3.1 Dry Weather Sampling

Collection of water quality samples will be performed for three (3) dry weather events; with one dry weather sampling event planned to be collected during a low-flow period (less than 25th percentile flow) in Chester Creek and Ridley Creek (if possible). Two rounds of sampling will be conducted for each dry weather survey: one round to be completed during ebb (outgoing) tide and the second round to be completed during flood (incoming) tide.

Dry weather event samples will be taken at up to eleven (11) locations:

- **Three (3) locations on Chester Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Three (3) locations on Ridley Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Five (5) locations on the Delaware River** that will characterize water quality in the vicinity of DELCORA's CSO discharges. Sampling locations have been selected to

separate to the extent possible the effect of DELCORA's CSOs on water quality from other sources contributing pollutants to the waterways. Sampling will be conducted near the shoreline adjacent to the City of Chester.

The locations of these stations are shown in Figure 3-2. Details for these stations are provided in Table 3-1, Table 3-2, and Table 3-3. The set of parameters for which the samples will be analyzed is provided in Table 3-4. In-situ measurements of physical parameters, such as salinity, temperature, and conductivity will be collected at each sampling location with a sonde. In the Delaware River, *in situ* measurements will be made at three depths at each sampling location during each round of sampling.

3.4.3.2 Wet Weather Sampling

Collection of water quality samples will be performed for three (3) wet weather events. The purpose of the wet weather sampling is to characterize the impact of CSO discharges and non-CSO source runoff on in-stream water quality. The wet weather events will span a range of precipitation, flow and seasonal conditions.

Wet weather event samples will be taken at all 13 in-stream locations as well as at up to six source locations in the intervals described below:

- **Six (6) In-Stream Tributary Sampling Locations:** Three (3) locations will be on Chester Creek and three (3) locations on Ridley Creek. The locations will be the same locations used for the dry weather surveys. Tributary locations will be sampled up to five times per event at the following approximate intervals: Hour 0.5-2.5, Hour 4.5-6.5, Hour 8.5-10.5, Hour 14.5-16.5, and Hour 22-24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. A total of 30 samples will be collected during each wet weather sampling event from in-stream locations. One field blank and one field duplicate will be collected during each event to be used as field quality control (QC).
- **Up to Seven (7) In-Stream Delaware River Locations:** Up to seven locations will be on the Delaware River and will be sampled up to ten times per event at the following approximate intervals: Hour 0, Hour 2, Hour 4, Hour 6, Hour 9, Hour 12, Hour 15, Hour 18, Hour 21, and Hour 24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. The frequency of sampling is intended to capture in-stream impacts in the vicinity of DELCORA's service area from both DELCORA's CSOs as well as upstream sources. Two additional locations on the Delaware River, one at mid-stream and one near the far shore, have been added to characterize lateral variability in water quality during storm event conditions, when sampling across the river is feasible. The sampling regimen is also designed to allow a semi-quantitative mass balance to be computed over a complete tidal cycle. A total of 70 samples may be collected during each wet weather sampling event. If river conditions are unsafe for sampling (e.g. small craft advisories, heavy barge traffic, etc.), sampling may be suspended for one or more locations and/or sampling rounds. One field blank and one field duplicate will be collected during each event to be used as field QC.

- **Up to Six (6) Outfall Locations:** Sampling will be conducted at up to two (2) stormwater outfalls and up to four (4) combined sewer overflow outfalls. It is assumed that each of the outfall locations will have up to eight sets of samples collected for each event at the following intervals: 1st flush, 30 minutes, and 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours. If a location is not flowing, no sample will be collected. As many as 48 samples may be collected during each wet weather sampling event, depending on the number of monitored outfalls and if all monitored outfalls discharge for 24 hours. However, the actual number of samples is likely to be less than the amount indicated since it is unlikely that all of the monitored outfalls will discharge for the full 24 hour monitoring period. One field blank and one field duplicate will be collected during each event to be used as field QC.

The locations of these stations are shown in Figure 3-2. Details for these stations are provided in Table 3-1, Table 3-2, and Table 3-3. The set of parameters for which the samples will be analyzed are summarized in Table 3-4. *In-situ* measurements will not be collected at the outfall locations.

Sampling crews will conduct all wet weather event sampling using the protocols described in the Quality Assurance Project Plan. Samples will be delivered to the laboratory where the samples will be analyzed for the laboratory parameters identified in Table 3-4.

Determination to mobilize for a Wet Weather Event will be a collaborative effort between Greeley and Hansen, LimnoTech, the Weston Solutions, and Eurofins QC. The intent is to identify a 4 to 6 hour window in which a wet weather event may commence 24 hours in advance to assist in mobilization of the sampling crews.

3.4.3.3 Bathymetric Sampling

The project team has requested HEC models of the receiving waters from the U.S. Army Corps of Engineers. However, in the absence of these models, additional bathymetry data is needed for the tributaries to inform the development of the water quality model. If required, bathymetry surveys will be conducted in approximately the lower three miles of both Chester Creek and Ridley Creek, corresponding to the approximate extent of the water quality model domain. Because these reaches are in the tidal zone, they are unlikely to be wadeable so each transect will be characterized using a boat and a combination of sonar and ADCP profiler equipment. Transects will be spaced approximately every 0.25 miles or at significant morphometric features (e.g. dams, islands, etc.).

3.4.4 Sample Event Initiation Protocol

This section describes the protocols that will be used to initiate the dry and wet weather sampling events.

3.4.4.1 Dry Weather Sampling Protocol

Collection of dry weather water quality samples will be performed for three (3) events; one of which occurred during a low-flow period (less than 25th percentile flow). These events will be distributed across the sampling season, March through June of 2017. The criteria used to define a dry weather event are the following:

- No precipitation within the upstream watershed at least 48 hours before the event;
- No precipitation forecasted for a minimum of three days; and,
- For the low-flow survey, conditions when the in-stream flow at the USGS gage in Chester Creek (01477000) is less than the 25th percentile flow at this location will be targeted for sampling.

Decisions to initiate a dry weather event are given below:

1. Authorization for dry weather events will be determined by Greeley and Hansen, LimnoTech, the field sampling and laboratory contractor personnel as described in Section 3.4.1. LimnoTech will monitor predicted rainfall conditions to identify potential sampling event dates.
2. When the criteria described in the previous section are met (e.g. no rainfall the previous 48 hours), the Chester Creek and Ridley Creek flows are at a desirable level, and no rain is in the near forecast, the team members will be notified of an upcoming dry weather sampling event. The sampling teams will begin mobilizing equipment, bottles and personnel so that they can get into the field before conditions change.
3. The Field Manager will notify the laboratory contact that the sampling teams are planning on conducting a dry weather sampling event.
4. The Field Manager will notify LimnoTech if weather conditions change during the event.
5. Once the decision to conduct sampling has been determined, the Field Manager will confirm with the laboratory that sampling has begun.

3.4.4.2 Wet Weather Sampling Protocol

Three (3) wet weather events will be monitored over the study period. The wet weather events will span a range of precipitation, flow, and seasonal conditions. The goal is to sample storms of at least 0.5 inches of precipitation. The criteria used to define a wet weather event include:

- No precipitation within the upstream watershed 48 hours before the event;

- Forecasts for a 60% (or greater) chance of rain over the entire DELCORA project area; and,
- Approximately 0.50 inches of rainfall forecasted over a six-hour period.

Decisions to initiate and continue sampling for wet weather events are given below:

1. Authorization for wet weather events will be determined by Greeley and Hansen, LimnoTech, the field and laboratory contractor personnel as described in Section 3.4.2. LimnoTech will monitor predicted rainfall conditions to identify potential sampling event dates.
2. Sampling will begin approximately in March and conducted until approximately the end of June. If the water temperature is below 10°C when samples are collected, it is noted that the sample results are not reflective of conditions to assess the potential risk to human health.
3. When precipitation is forecasted meeting the criteria for a wet weather sampling event, the wet weather sampling teams will be put on alert. This alert will be considered "Go" status, unless otherwise notified. The sampling teams will begin mobilizing equipment, bottles and personnel so that they can get into the field as soon as possible after the precipitation begins.
4. The Water Quality Project Manager will notify the laboratory contact that the sampling teams are on alert.
5. The Field Manager's sampling teams will mobilize approximately 2-3 hours before the precipitation is forecasted to begin. Forecast tools include the National Weather Service website (forecast.weather.gov), Weather Underground website (www.wunderground.com), the Weather Channel website (www.twc.com), the Aviation forecast model (http://weather.rap.ucar.edu/model/index.php?model=gfs), local TV weather forecasts, and DELCORA's rain gage network data.
6. Sampling at the outfalls will begin during the first flush when water begins flowing out of the discharges. The field crews will be at the outfall locations waiting to collect the first flush water as soon as it happens.
7. The in-stream locations will be initiated at 0.5 hour after the start of rainfall for the first round of sampling. Subsequent in-stream sampling will be conducted at the intervals described in Section 3.4.3.2. The Field Manager will confirm with the laboratory Technical Director that sampling has begun.
8. Greeley and Hansen, LimnoTech and the Field Manager will continue to monitor the precipitation as the rain event progresses. If the storm conditions are significantly smaller than forecasted (either in rainfall depth or geographical extent), the sampling event will be aborted as soon as can be reasonably determined by Greeley and Hansen, LimnoTech and/or the Field Manager Local rain gages within the study area will be monitored for the event precipitation totals.

9. Samples collected during an aborted wet weather event will be discarded when directed by LimnoTech, after consultation with Greeley and Hansen. The laboratory will be notified as soon as possible by LimnoTech to stop the analysis on any samples they may have already received.

In-stream wet weather sampling will be conducted by 3 crews of two-person teams. Each crew will be responsible for sampling one of the receiving waters. For the outfall locations, a one or two person team will be deployed to each outfall to collect the samples in each round as individual grab samples. Due to the timing of sampling rounds, additional crews will be needed to relieve the sampling teams collecting the first few rounds of samples.

3.5 Field Sampling Methods and Procedures

This section provides a description of the field sampling collection methods, sampling equipment, and decontamination procedures that will be used during the monitoring program. The field sampling methods and procedures will be in accordance with the SOPs provided in Appendix C of the Water Quality Modeling and Monitoring QAPP.

3.5.1 Receiving Water and Source Sample Collection Methods

The physical, microbiological and chemical data that will be collected from the waterbodies are obtained either through direct (*in situ*) measurements or through analysis of a water sample. The microbiological and chemical data collected from the outfall discharges will be obtained through laboratory analysis of the water samples. The general collection procedures for receiving water and outfall sampling are as follows:

1. Clean all sampling equipment prior to sample collection according to the procedures in the SOP for Equipment Cleaning.
2. Don appropriate personal protective equipment (as required by the Field Safety Instructions).
3. Collect samples by dipping a container on a pole, into the water. The water is then poured into a bucket (until enough sample volume has been collected) and then poured from the bucket into the clean sample containers.
4. Care should be taken to avoid capturing bottom sediment or surface foam/scum during sample collection.
5. If field preservation is required, the appropriate preservative will be placed into the sample container prior to sample collection.
6. If field filtering is required, an appropriate sample aliquot will be filtered into the sample container.
7. Label all sample containers with the date, time, site location, sampling personnel, and other requested information.

8. Record sample collection information on the field logs and then store the samples in a cooler with ice as described in the SOP for the Shipping and Handling of Samples.
9. Handle, pack, and ship samples according to the procedures in the SOP for the Shipping and Handling of Samples, including the completion of a Chain-of-Custody (COC) form for each cooler shipped to the laboratory for analyses.

3.5.2 In situ Measurements (Receiving Water Only)

Instantaneous water quality measurements (such as salinity, temperature, and conductivity) using field instruments will be collected at the receiving water locations as specified in the following sections of this Water Quality Monitoring Work Plan. These measurements, along with calibration and maintenance, will be conducted following the SOPs for Water Quality Field Measurements in Appendix C of the Water Quality Modeling and Monitoring QAPP.

Field instruments will be calibrated before initiating monitoring activities for each event and a post-monitoring calibration check will be conducted at the end of the event. All calibration and maintenance activities will be documented on the Instrument Calibration Sheet (see Appendix C of the Water Quality Modeling and Monitoring QAPP). The field instrument calibration must be conducted in accordance with the SOP.

Salinity, temperature, and conductivity will be measured at all in-stream sampling locations using a YSI 6920 or similar instrument during both wet and dry sampling events, prior to sample collection. Measurements will be made mid-channel at mid-depth in the tributaries, whenever possible. In the Delaware River, measurements will be made at the surface, mid-depth and near the bottom, whenever possible. Measurements will be documented in the field logs. Documentation will include: date/time, location, type of measurement, personnel, equipment identification, and general site observations (e.g. weather, stream conditions).

3.5.3 Sampling Equipment

The sampling equipment required for the DELCORA monitoring program is included in Table 3-5.

Table 3-5: Sampling Equipment List

Sampling Activity	Required Equipment	
General Equipment (Required for all sampling activities)	Field log book with weather-proof paper and pen ("Rite-in-the-Rain") or field data sheets Pens and pencils Maps Sample bottles Sample bottle labels Chain-of-custody in zip lock bag Coolers with ice Stainless steel sample bucket and rope	Sample pole Sampling gloves Hand spray bottles with Liquinox solution Scrub brush Distilled water (10 gallons) Hip or chest waders Sun screen PPE as specified in FSI Monitoring Work Plan/QAPP Phone Emergency Contact List Field Safety Instruction
Wet Weather In-Stream Sampling	General Equipment Rain Gear Headlamps for night sampling & extra batteries Hydrolab/YSI multi-parameter sonde and instrument Instrument (sonde) calibration sheet Calibration materials and solutions Sonde instrument manual Sonde service kit Extra batteries for instruments (sondes) Laptop with appropriate power cable, data download cables, and software	
Wet Weather Outfall Sampling	General Equipment Rain Gear Headlamps for night sampling & extra batteries	
Dry Weather Sampling	General Equipment Hydrolab/YSI multi-parameter sonde and instrument Instrument (sonde) calibration sheet Calibration materials and solutions Sonde instrument manual Sonde service kit Extra batteries for instruments (sondes) Laptop with appropriate power cable, data and download cables, and software	

Table 3-6 presents a summary of the number of bottles and coolers needed for each day of each dry weather event. Table 3-7 presents a summary of the number of bottles and coolers needed for each crew for each wet weather sampling circuit. Three (3) bottles at each location are needed to collect the volume of sample required for the laboratory analyses (see footnote in Table 3-6 and Table 3-7). The laboratory will supply the bottles for each location and sample round to the Field Manager in advance of the event.

Table 3-6: Cooler and Bottle Requirements for Each Dry Weather Event

Sample Type	# of Two Person Teams	# of Locations	Locations per Team	Sampling Rounds	Number of Field QC Samples[1]	Number of Bottle Sets per Crew[2]	Number of Coolers per Crew
Chester Creek Tributary	1	3	3	2	1 FB 1 FDUP	8	2
Ridley Creek Tributary	1	3	3	2	1 FDUP	7	2
Delaware River	1	5	5	2	1 FB 1 FDUP	12	2

Notes:
[1] FB = field blank; FDUP = field duplicate
[2] The Bottle Set at each sampling location requires 3 125 ml plastic sterile bottles (bacteria)

Table 3-7: Cooler and Bottle Requirements for Each Wet Weather Event

Sample Type	# of Two Person Teams	# of Locations	Locations per Team	Sampling Rounds	Number of Field QC Samples[1]	Number of Bottle Sets per Crew[2]	Number of Coolers per Crew[3]
Chester Creek Tributary In-Stream	1	3	3	5	1 FB[4] 1 FDUP	17	3
Ridley Creek Tributary In-Stream	1	3	3	5	1 FB[4] 1 FDUP	17	3
Delaware River In-stream	1	7	7	10	1 FB[5] 2 FDUP	73	3
Outfall-Manual	6	6	1	8	1 FB 1 FDUP	8 (10 for crew doing field QC)	3

Notes:
[1] FB = field blank; FDUP = field duplicate.
[2] The Bottle Set at each sampling location requires 3 125 ml plastic sterile bottles (bacteria)
[3] The number of coolers is based on the frequency of sample delivery to the lab to maintain the 8-hour hold time for bacteria samples.
[4] It is assumed that each crew will also collect 1 field duplicate and prepare 1 field blank during one of the first three rounds of sampling (HR 0.5, HR 4.5, HR 8.5).
[5] It is assumed that the crew will collect 1 field duplicate in the first three rounds of sampling (HR 0, HR 2, HR 4), and will prepare 1 field blank and collect 1 field duplicate again in the remaining seven rounds of sampling (HR 6, HR 9, HR 12, HR 15, HR 18, HR 21, HR 24).

3.5.4 Equipment Decontamination

If sampling equipment, such as buckets, etc., are to be reused at more than one location in the field, they must be cleaned prior to collecting the next sample. Prior to leaving a site, the equipment must be rinsed at least three (3) times with distilled water. A brush may be used to remove deposits of material or sediment if necessary. At the next sampling site, the equipment must be rinsed at least three (3) times at each location with creek water prior to sampling.

Standard cleaning procedures for equipment decontamination are provided in SOP (included as Appendix C in the Water Quality Modeling and Monitoring QAPP).

3.6 Sample Handling, Storage and Shipment

Sample handling will be performed so as to collect, store, submit to the laboratory, and analyze representative samples using methods as specified in this section. Sample containers, volumes, preservatives and holding times are summarized in Table 3-8. Sample bottles (including those requiring preservative) will be provided by the laboratory in advance of each event. The laboratory will notify the Field Manager when sample bottles are ready for pickup. Sample bottles will be stored by the Field Manager until use.

3.6.1 Sample Handling

Sample packaging and shipping procedures are designed to ensure that the samples and the chain-of-custody forms will arrive at the laboratory intact and together.

1. All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The laboratory will pre-label each bottle with all information except for the date and time of sample collection using the method described below. The person collecting the sample will complete the label with date and time. No bottle sets will be distributed without the pre-labeling unless specifically agreed upon among Greeley and Hansen, LimnoTech, the field sampling and laboratory contractors prior to the sampling event.

   Use indelible waterproof marking pen and include:

   - *Sample identification code (ID)*– will include*:*
     - Site designation number - sampling round number, as follows:

—	—	-	—	—	—	-	—	-	—
1	2		3	4	5		6		7

Where,

Characters 1-5: Sample Site ID (column 1 in Table Table 3-1, Table 3-2 and Table 3-3)

Character 6: Sampling round number

Character 7: B - Blank sample qualifier (if required)

- Duplicate samples will be labeled with a sample ID of:

"DUP ___ ___ ___- ___ ___".
1 2 3 4 5

Where

Characters 1-3: Duplicate ID number (numbers will be assigned to each sampling crew)

Characters 4-6: Designation of RW for receiving water sample duplicate or OF for outfall sample duplicate

A blank line will be placed in the location, date and time boxes of the sample label so the laboratory does not know where the sample was collected. The duplicate number in the duplicate sample ID will be assigned in the field and recorded in the field log book.

- Blank samples will be given a normal sample ID, with a B qualifier at the end of the ID.

- *Sample type (water);*
- *Analysis required;*
- *Date sampled;*
- *Time sampled;*
- *Name or initials of person who collected the sample;*
- *Mode of collection (composite or grab);*
- *Preservation added, if applicable.*

2. Check the caps on the sample containers so that they are tightly sealed.
3. Cover the label with clear packing tape to secure the label onto the container and prevent the label from being illegible if wet.
4. Store samples in coolers with ice to maintain the samples at ≤6 degrees Celsius until they are received in the laboratory.
5. Complete the information needed on the field log book and the chain-of-custody, primarily sample date and time and any notes regarding deviations from the planned sampling protocol (e.g. limited volume precluded collecting the full volume required).

Table 3-8: Guidelines for Water Sample Container Preparation and Preservation

Parameter	Sample Container	Sample Volume	Storage Requirement	Preservative	Sample Holding Time	Analytical Method	Detection Limit
Fecal coliform	Plastic-Sterile	125 ml	Refrigerate to ≤6°C	Sodium Thiosulfate	8 Hours	SM 9222D	10 no./100 ml
E coli	Plastic-Sterile	125 ml	Refrigerate to ≤6°C	Sodium Thiosulfate	8 Hours	EPA 1603	10 no./100 ml
Enterococcus	Plastic-Sterile	125 ml	Refrigerate to ≤6°C	Sodium Thiosulfate	8 Hours	EPA 1600	10 no./100 ml

3.6.2 Sample Transport

Samples will be properly packaged for transport to the laboratory as summarized below.

1. Using packaging tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport;
2. Place the sealed container upright in the cooler;
3. Place additional cushioning material around the sides of each sample container as needed;
4. Place ice on top of sample containers. Do not pack ice so tightly that it may prevent the addition of sufficient cushioning material. Ensure that bottle caps will not be submerged in water if ice melts;
5. Fill the remaining space in the cooler with vermiculite or other cushioning material if the coolers are being shipped;
6. Place the chain-of-custody forms in a large Ziploc© type bag and tape the forms to the inside of the cooler lid; and,
7. Close the cooler lid and fasten with packaging tape. Wrap strapping or packaging tape around both ends of the cooler at least twice, if coolers are being shipped.

All shipments will be accompanied by the chain-of-custody form identifying the contents. It is preferred that a separate chain-of-custody form be completed for and placed in each shipping container/cooler. The original form will accompany the shipment and copies will be retained by the sampler for the project records.

During the dry weather and wet weather sampling events, representatives from the firm conducting the field sampling will be responsible for delivering the samples to the laboratory quickly enough so that hold times can be achieved for the bacteria parameters (8 hours from the time of sample collection). The Field Manager will manage the coordination of field crews and couriers during the sampling event.

3.7 Sample Documentation

3.7.1 Field Data Collection Forms

The field log book will serve as a daily record of events, observations and measurements during all field activities. All information pertinent to sampling activities will be recorded in the field logs and will include:

- Names of field crew and specifically the author of the field log;
- Date and time of the sample round beginning and ending;
- Location of sampling activity;
- Date and time of collection;
- Sample identification numbers; and,
- Field measurements.

Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, stream flow description, etc.)

The field log book may also include:

- Sampling method;
- Sampling equipment used;
- Number and volume of samples collected ;
- Type of sample;
- Summary of any meetings or discussions with the public, state agency, etc.; and,
- Levels of safety protection.

Field meters will be calibrated daily in accordance with the manufacturer's recommendations. Standards, solutions used, concentrations and readings taken will be recorded daily in Instrument Calibration Sheet.

3.7.2 Sample Chain-of-Custody Forms

A chain-of-custody is a legally-binding record of the date and time periods that samples were in the possession (e.g. custody) of the parties indicated. Transfers between parties are documented by the custodial party signing over custody to the receiving party and the receiving party signing for receipt of the samples. Completed chain-of-custody forms will be required for all samples to be analyzed.

Chain-of-custody forms will be prepared in advance by the laboratory for each sampling location and round of sampling. Chain-of-custody forms will be initiated by the sampling crews in the field

during the sampling events and must remain with the samples at all times. The samples and signed chain-of-custody form will remain in the possession of the sampling crew until samples are either delivered to the lab or placed in the custody of the personnel responsible for their delivery to the laboratory.

The chain-of-custody form will contain the sample's unique identification number, sample date and time, sample description, sample type and analyses required. Copies will be made prior to shipment for field documentation. The original chain-of-custody form will accompany the samples to the laboratory.

3.7.3 Data Submittal

Instrument Calibration Sheets and copies of the field log book will be turned over to the LimnoTech Water Quality Monitoring Program Task Manager following each monitoring event. Following review by the LimnoTech Water Quality Monitoring Program Task Manager, all field logs, photographs and chain-of-custody forms will be included in the project database.

3.8 Quality Control

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The monitoring data that will be collected is intended to meet the quality assurance objectives described in the QAPP. Data quality will be measured in terms of accuracy and precision, completeness, representativeness, comparability, and the required detection limits for the analytical methods. Each of these data quality indicators is defined in the QAPP. QC samples will be collected in the field to support the assessment of data quality. The QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;
- QA/QC samples; and,
- Equipment calibration.

3.8.1 Training

All field staff will receive training covering the QAPP and this Water Quality Monitoring Work Plan. The training will include proper procedures for sample collection, handling and submission and general field procedures. Specific emphasis will be placed on QA/QC issues as well as on health and safety. The training will also cover the operation, maintenance, and calibration of field equipment including multi-parameter sondes and all other on-site equipment used throughout the field program. SOPs for all program elements will be distributed to staff and will be available at all times.

3.8.2 Field Quality Control

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in SOPs for Collection of Discrete Water Samples and SOPs for Water Quality Field Measurements will be followed to ensure field quality control.

3.8.3 QA/QC Samples

This section describes the type and frequency of QC samples for the monitoring program.

3.8.3.1 Field Blanks

Field accuracy will be assessed through the use of field or equipment blanks. In order for the accuracy assessment to be relevant, all appropriate protocols concerning sample collection, handling, preservation, and hold times must be maintained. Equipment that is used to collect samples for analysis may become cross-contaminated through the normal course of monitoring. If not properly cleaned and rinsed, samples may be contaminated during sampling from previous locations.

Field blanks will consist of a distilled water rinse of sampling equipment collected into separate sample containers and submitted to the laboratory to assess the quality of the data resulting from the monitoring program. Field blanks should be collected after the sampling equipment has been cleaned in accordance with appropriate specified cleaning procedures. The laboratory will provide the sampling crews with the water to be used to prepare the field blanks.

Field blanks will be collected at a frequency of one blank during each sampling event per sampling crew.

3.8.3.2 Field Duplicates

Precision is a measure of the agreement between two or more measurements. Duplicate or replicate samples will be taken for a portion of the samples to assess field precision. A field duplicate is defined as a sample produced when a single sample is split into two or more aliquots immediately after the sample is collected. Each aliquot is placed into a separate container and analyzed separately.

Field duplicates will be collected at a frequency at least one field duplicate per sampling crew.

3.8.4 Calibration of Field Equipment

Instantaneous water quality measurements (such as salinity, temperature, and conductivity) using field instruments will be collected as specified in the preceding sections of this Water Quality Monitoring Work Plan. Salinity, temperature, and conductivity will be measured at the specified sampling locations using an YSI 6920 or similar instrument, prior to sample collection. All field

instruments will be calibrated at the beginning of the day of sampling and checked again at the end of each day, as required by the QAPP. Field instrument calibration and sample measurement data will be recorded on the Instrument Calibration Sheet and in the field log book, respectively.

The field instrument calibration must be conducted in accordance with the SOP included in Appendix C of the Water Quality Modeling and Monitoring QAPP.

3.9 Program Safety

The most critical component of a sampling program is crew safety. Safety is of paramount importance as stream sampling can be extremely dangerous. The conditions are often wet and dark adding to the dangers. The element of danger is accentuated if personnel are unfamiliar with their surroundings and/or procedures. Consequently, staff must be properly trained in both safety and monitoring procedures, following a well thought out program.

Field Safety Instructions (FSI) have been developed by LimnoTech for the Water Quality Monitoring Program. The FSI include safety precaution information and emergency procedures. The LimnoTech FSI is the governing health and safety document for the sampling program.

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Section 4 References

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Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Water Quality Modeling and Monitoring Work Plan Update WQMMWP dated July 31, 2017. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). This letter served to iterate the original approval and formally notify you that EPA accepted the updated WQMMWP and is approved.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: P. Yeany, EPA
M. DeSantis, DELCORA
Tom Magee, PaDEP, SERO
C. Hurst, DELCORA

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APPENDIX I

Water Quality Monitoring and Modeling Quality Assurance Project Plan

- DELCORA Water Quality Monitoring and Modeling Quality Assurance Project Plan - Final dated January 2017 (Revised July 2017)
- USEPA Approval of the Water Quality Water Quality Modeling and Monitoring Work Plan Update dated April 16, 2018

Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Water Quality Monitoring and Modeling Quality Assurance Project Plan

Final

January 2017

(Revised July 2017)

GREELEY AND HANSEN

LimnoTech

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REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Water Quality Monitoring and Modeling Quality Assurance Project Plan.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	*Signature*	1/9/17 *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	1/9/17 *Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	1/9/17 *Date*

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
0	1/11/2017	G&H/LimnoTech	Initial submittal to US EPA
1	July 2017	G&H/LimnoTech	• Updated Table of Contents and List of Appendices • Page 1-9, Revised 2nd paragraph for clarity • Page 2-1: Updated Table 2-1 • Page 2-3: Formatted Figure 2-1 • Page 2-5: Revised paragraph under Section 2.2.1 for clarity • Page 2-8: Changed DR-03 to DR-04 • Page 2-9: Updated Figure 2-3 • Page 2-10: Updated Table 2-2 • Page 2-11: Updated Table 2-3 • Page 2-12: Updated Table 2-4 • Page 2-15, Revised Table 3-1 to Table 2-5. • Page 2-19: Updated Table 2-6 • Page 2-24: Revised Paragraph "Grit development" for clarity • Page 2-25: Revised first paragraph under 2.4.2.2 for clarity • Page 2-26: Revised the first paragraph under *EFDC Model Water Quality Calibration and Validation* for clarity • Page 2-30: Revised the first paragraph on the page for clarity • Page 2-30: Updated Appendix references • Page 3-4: Updated Appendix references • Page 4-5: Updated first bullet for clarity • Added Appendices A through C

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Section 1 Introduction

1.1 Background of DELCORA's Facilities

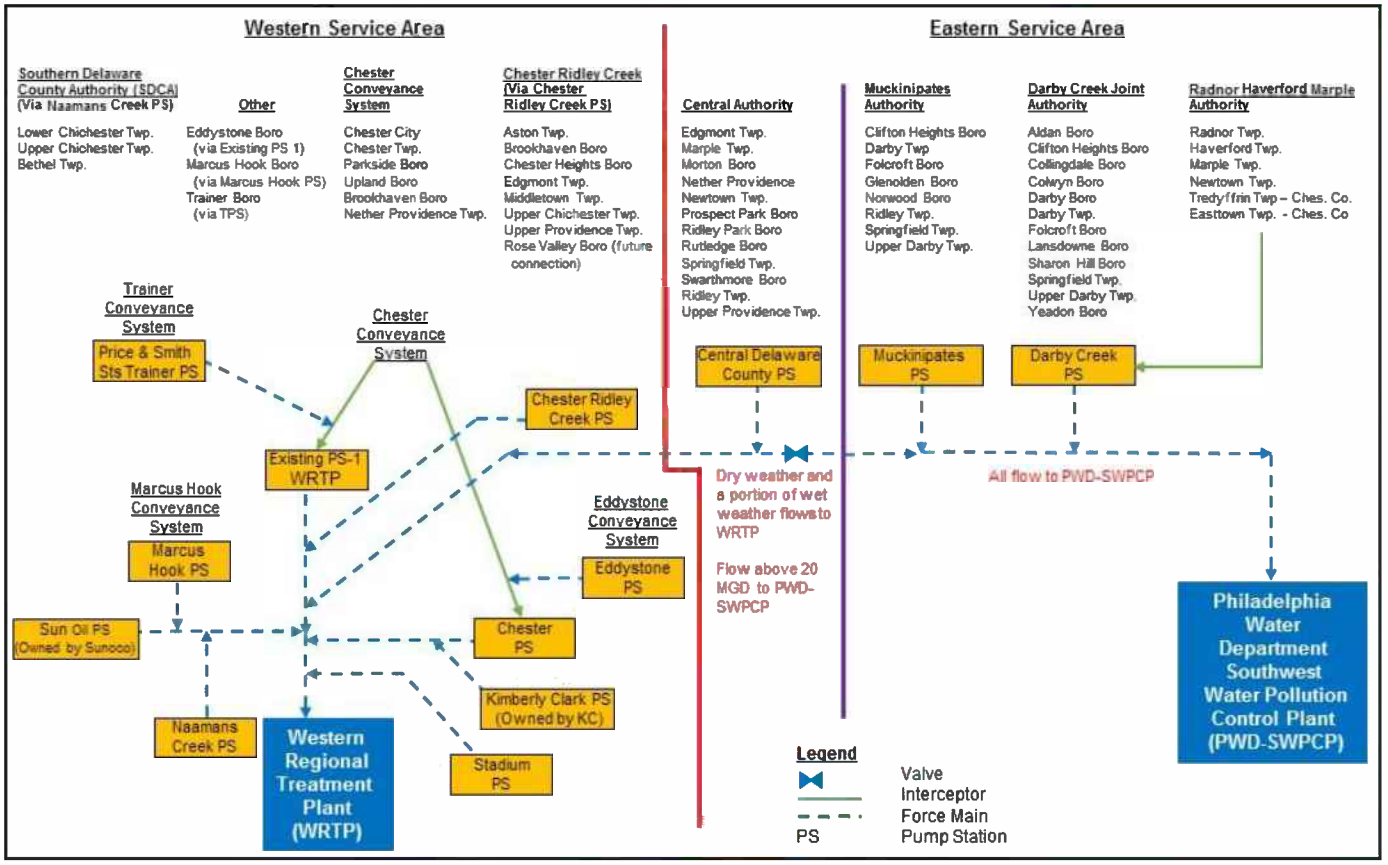
Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA, as shown on Figure 1-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

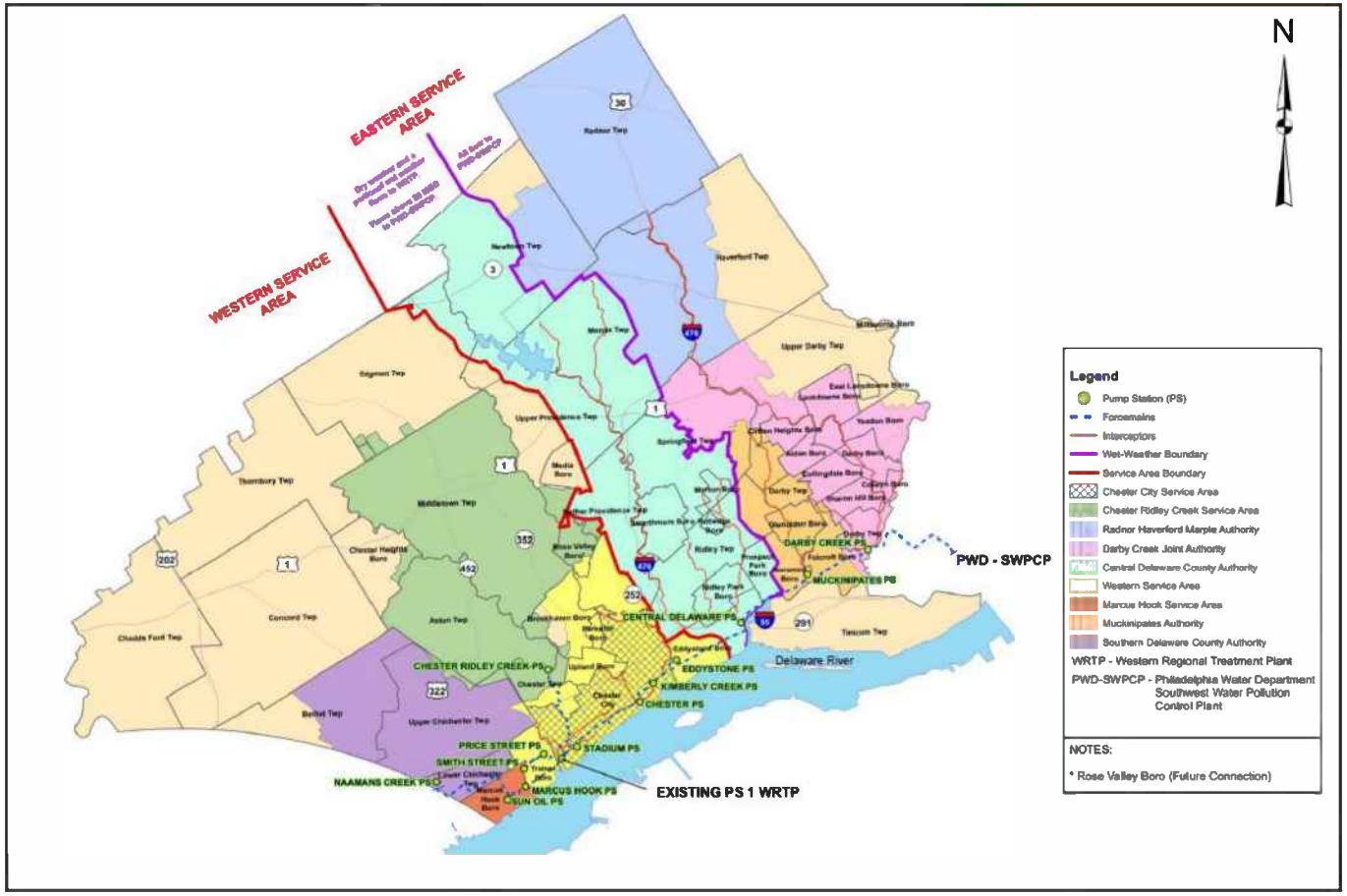
There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

Figure 1-1: DELCORA's Conveyance System



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN WESTON SOLUTIONS	Figure 1-1 DELCORA'S CONVEYANCE SYSTEM

Figure 1-2: DELCORA's Service Area



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN	Figure 1-2 DELCORA'S SERVICE AREA

Part C – Other Requirements, Section V – Combined Sewer Overflows of the NPDES Permit details DELCORA's responsibilities with respect to the CSO system including reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum to the LTCP until the updated LTCP is approved.

1.2 DELCORA Facilities

DELCORA's Western service area wastewater is treated at the WRTP located at 3201 W. Front Street in Chester, Pennsylvania. The WRTP treats all wastewater from Southern Delaware County Authority, Marcus Hook Borough, Trainer Borough, Upland Borough, Parkside Borough, Eddystone Borough, Chester Township and the City of Chester as well as a portion of the wastewater from Brookhaven Borough and Nether Providence Township. The City of Chester CSO system is described in detail in Section 1.3.2.

One of the facilities in the City of Chester is the 40-MGD Chester Pump Station and the 48-inch-diameter, PCCP force main that runs to the WRTP. DELCORA has completed construction of a 54-inch-diameter ductile iron force main to replace the existing force main. In 2002, DELCORA completed a force main that connects the Central Delaware Pump Station via a 3.4-mile, 24-inch ductile iron force main to the Chester Force Main. This connection allows DELCORA to send up to 27 MGD of flow from the CDPS to the WRTP, however, DELCORA's operating policy limits this flow to 20 MGD, with flows above this point to be directed to PWD SWPCP. Figure 1-1 shows the interconnections in DELCORA's system. The left side of the figure indicates the Western service area and the right side indicates the Eastern service area. This interconnectivity coupled with the legal agreements DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates.

1.2.1 City of Chester CSO System

As noted in Section 1.1, the combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's service area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The Chester CSO system contains 26 permitted outfalls as listed in Table 1-1, and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. Figure 1-1 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility.

Table 1-1: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River(2)	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W
Ridley Creek(2)	033	Elkington Blvd & Ridley Creek	39°52'22"N	75°22'29"W

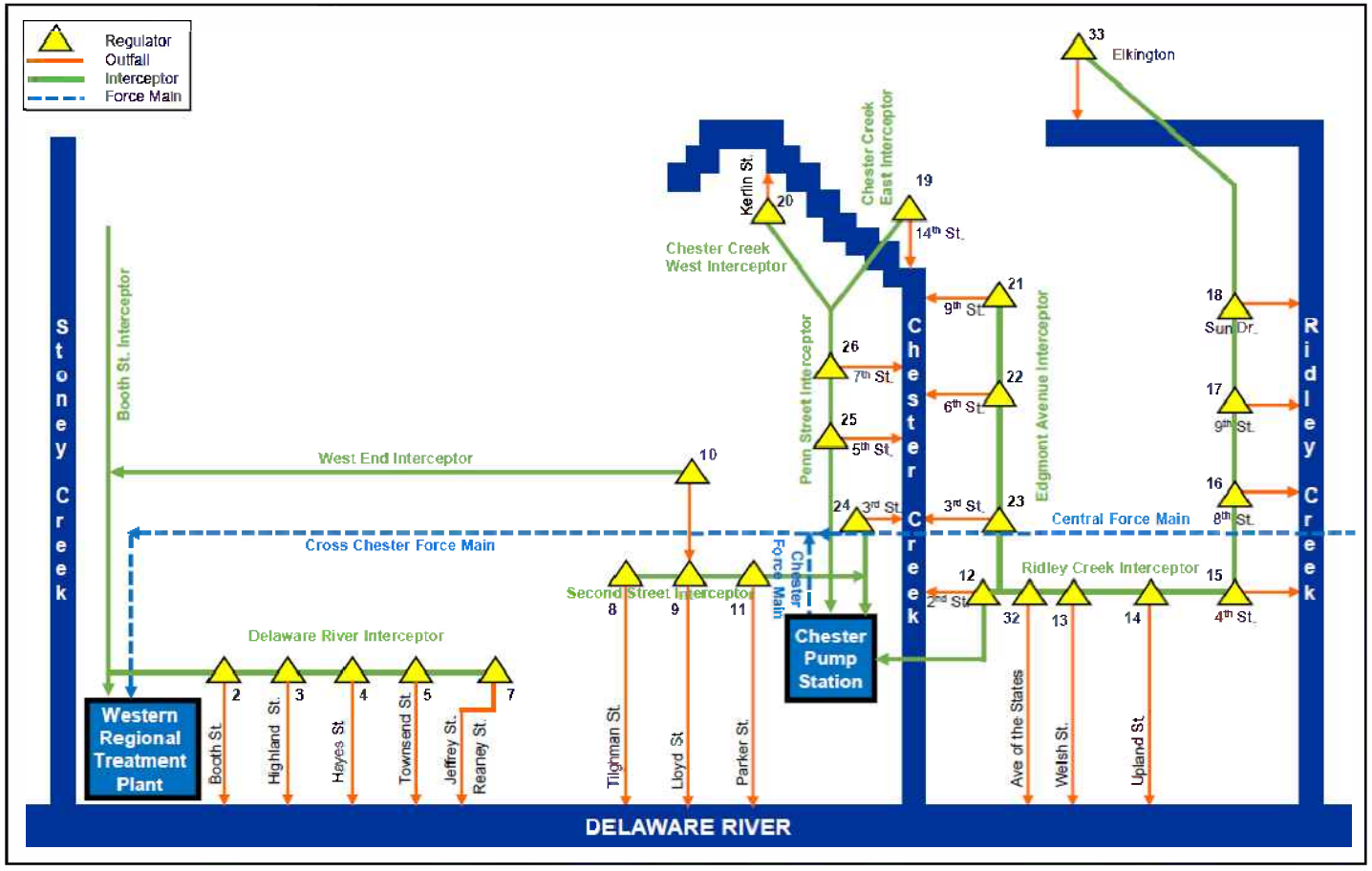
Notes:
(1) CSO #010 discharges to the Delaware River through CSO #009.
(2) No mechanical regulator used for this outfall.

Figure 1-3 provides a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 1-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

Figure 1-3: Location of Regulators and Combined Sewer Outfalls With Drainage Areas

CSO Long Term Control Plan Update Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN	Identification of Sensitive Areas and Pollutants of Concern Report Figure 1-3 Location of Regulators and Combined Sewer Outfalls With Drainage Areas

Figure 1-4: Schematic of Chester CSO System



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN	Figure 1-4 SCHEMATIC OF CHESTER CSO SYSTEM

1.3 Consent Decree

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraphs V.A.10.e and V.A.10.f require that the development of the LTCP include:

V.A.10.e. Develop and implementation of a Water Quality Model;

V.A.10.f Characterization of the service area and the Receiving Waters as required by CSO Control Policy Paragraph II.C.1 and associated guidance.

Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within 90 days after review and approval of the Alternatives Evaluation Approach, DELCORA shall submit a report to the USEPA and PADEP that describes the use of the Water Quality Model to support the Demonstration Approach consistent with Section II.C.4 of the CSO Control Policy and the Paragraph V.13 of the Consent Decree (Alternatives Evaluation). Section V.A.15.a of the Consent Decree specifically states:

For each water body in which the Demonstration Approach is to be used, the Water Quality Model Plan shall address:

(i) Background, Scope and Purpose, Description of the System;

(ii) Water quality modeling software to be employed;

(iii) Model configuration and development, including reaches to be modeled, and segmentation and boundary conditions;

(iv) Calibration and validation (dry and wet weather), including events and data to be employed, detailed information regarding all additional data collection activities (if needed), quantitative and qualitative calibration criteria, and utilization of H&H Model outputs;

(v) Use of the Water Quality Model to evaluate Typical Year in-stream conditions for each identified pollutant of concern;

(vi) Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to this Consent Decree.

1.4 QAPP Purpose and Objectives

This Quality Assurance Project Plan (QAPP) has been developed to meet the requirements of the DELCORA Consent Decree Paragraph Section V.A.15.a.(iv) requiring detailed information regarding all additional data collection and water quality modeling activities. The purpose of the QAPP is to document the necessary procedures required to assure that the project is executed in a manner consistent with applicable U.S. EPA guidance documents and with generally accepted and approved quality assurance objectives. This QAPP is organized in accordance with the basic groups and subgroup elements discussed in the U.S. EPA guidance for QAPPs. The four basic groups include project management (Group A); data generation and acquisition (Group B); assessment and oversight (Group C); and data validation and usability activities (Group D). The groups are subdivided into elements covering specific topics related to each group. The Section and Subsection headings of this QAPP include references to the U.S. EPA QAPP Guidance group letters and element numbers to facilitate cross-reference with the Guidance.

The QAPP integrates quality control policies and project-specific work tasks to successfully conduct water quality monitoring and modeling to support the CSO Long Term Control Plan update. Greeley & Hansen will serve as the contracting authority for the project and provide overall project management. LimnoTech will serve as technical advisors for the sampling program and to provide the data integration and interaction role. The field contractor (Weston Solutions) will conduct the actual sampling program. The laboratory contractor (Eurofin QC) will perform laboratory analysis for the project.

The QAPP has been designed and organized in terms of compliance with U.S. EPA requirements. It is the overall intent of the QAPP to provide professional guidelines for activities by all personnel on the project and to ensure that quality assurance/quality control QA/QC procedures are followed.

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Section 2 Project Management (Group A)

2.1 Project/Task Organization (A.4)

Each of the organizations included in the project team has established an organizational structure for providing technical direction and administrative control to accomplish quality-related activities for the development of the project. Key project personnel and their corresponding responsibilities are listed in Table 2-1 below and shown in Figure 2-1.

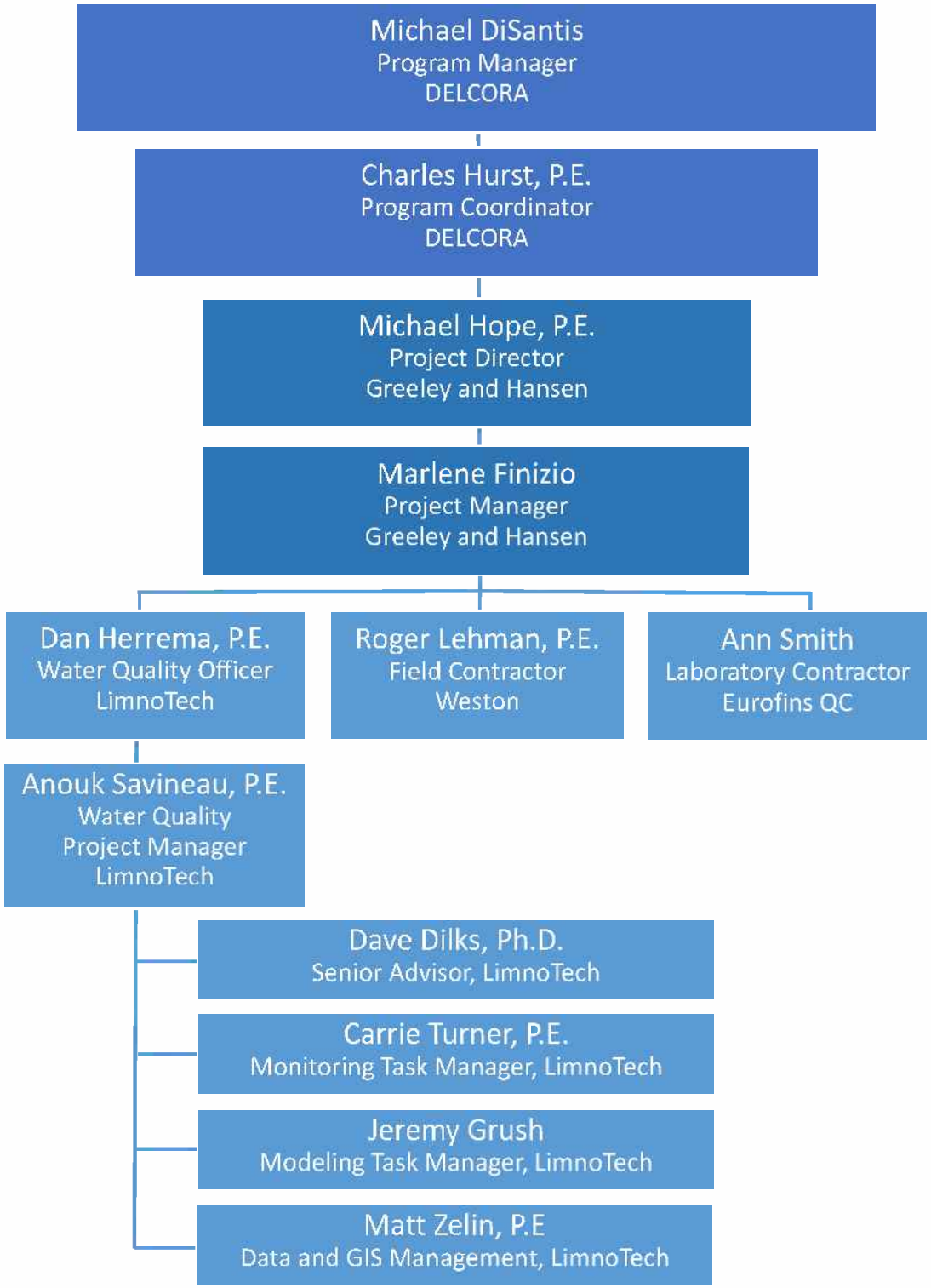
Table 2-1: Key Personnel for the Water Quality Monitoring and Modeling QAPP

Name/Affiliation	Project Title	Responsibility
Michael DiSantis DELCORA	Program Manager	Project oversight
Charles Hurst, P.E. DELCORA	Program Coordinator	Program management and coordination between contractors and DELCORA staff
Michael Hope, P.E. Greeley and Hansen	Project Director	Project direction, review/approval of work products
Marlene Finizio Greeley and Hansen	Project Manager	Project management, coordination of overall work
Anouk Savineau, P.E. LimnoTech	Water Quality Monitoring and Modeling Program Manager	Overall water quality monitoring and modeling task coordination.
Carrie Turner, P.E. LimnoTech	Water Quality Monitoring Program Task Leader	Monitor conditions, decisions to initiate sampling events, compare data to QAPP objectives.
Roger Lehman, P.E. Weston Solutions, Inc.	Field Project Manager	Receiving water and overflow sample collection, manage field staff and equipment development.
Ann Smith Eurofins QC	Laboratory Technical Director	Supply sample bottles and chain-of-custodies. Ensure sample analysis is conducted to meet objectives of QAPP, coordinate sample transfer.
Ray Fratti Eurofins QC	Laboratory QA/QC Manager	QA/QC review of laboratory data to ensure QAPP objectives are met.
Jeremy Grush LimnoTech	Water Quality Modeling Task Leader	Develop, calibrate and validate water quality model consistent with Work Plan.
Matt Zelin, P.E. LimnoTech	Water Quality Data Management Task Leader	Develop, manage, and maintain the water quality database. All data collected during the course of the study will be entered into a database.

The remainder of the project team is made up of engineers, scientists, and technicians. The disciplines represented include environmental assessment and modeling. Staff members within each organization will report to their project manager for technical and administrative direction. Each staff member has responsibility for performance of assigned quality control duties in the course of accomplishing identified sub-tasks. The quality control duties include:

- Completing the assigned task on or before schedule and in a quality manner in accordance with established procedures; and
- Ascertaining that the work performed is technically correct and meets all aspects of the QAPP.

Figure 2-1: Project Team Organization



2.2 Problem Definition/Background (A.5)

The Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities, described in Section 1.2 and shown diagrammatically in Figure 1-1, provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia. DELCORA serves a significant and widespread portion of Delaware County and has a total service area of approximately 82,977 acres (Figure 1-2).

The combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The Chester combined sewer system includes 25 combined sewer overflow outfall locations that discharge to three receiving water bodies: the Delaware River, Chester Creek and Ridley Creek. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated, and maintained by two governmental entities, the City and DELCORA. Figure 1-3 shows the CSO regulators and outfalls that are DELCORA's responsibility. DELCORA's responsibilities with respect to the CSO system include reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum.

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. The Water Quality Monitoring Program is one component of this Water Quality Model requirements in the Consent Decree (see Section 1.3) that will provide DELCORA with reliable and technically sound data to inform the development, calibration and validation of the Water Quality Model and decisions on CSO control alternatives.

As part of DELCORA's LTCP requirements, pollutants of concern (POCs) were identified and documented in the "Identification of Sensitive Areas and Pollutants of Concern Report" (Greeley and Hansen 2016). Three POCs were identified: fecal coliform, *Escherichia coliform* (*E. coli*), and Enterococcus. Available data for the POCs in the DELCORA combined sewer service area and adjacent watersheds are insufficient for developing a Water Quality Model that meets the requirements of the Consent Decree.

A Water Quality Monitoring Work Plan has been developed to ensure that additional monitoring activities undertaken to support the development of the Water Quality Model and the LTCP update result in representative water quality and quantity information. A Water Quality Model Work Plan has also been developed to ensure that the Water Quality Model meets the requirements set forth in the Consent Decree (Section 1.3). This portion of the work plan describes the water quality model development, methods used to specify CSO and background sources, and the approach to model calibration and validation. This QAPP

describes the quality assurance/quality control component of the sampling program and the water quality model development.

2.2.1 Water Quality Monitoring Objectives

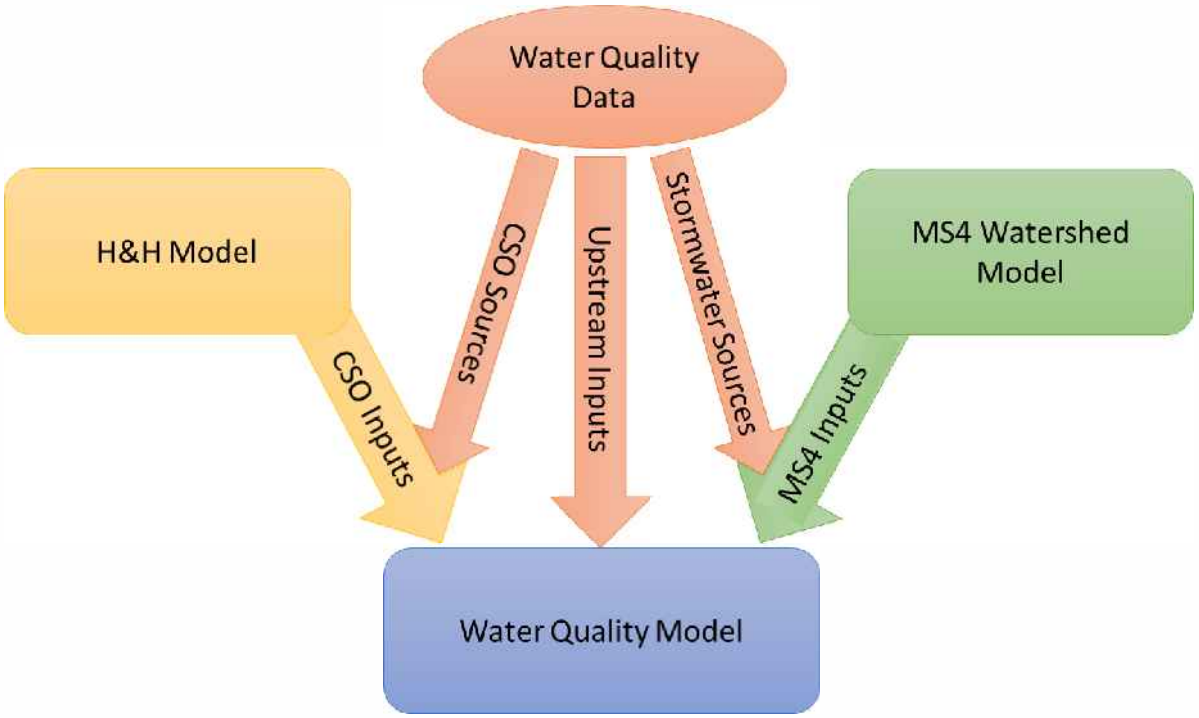
Under the Consent Decree requirements, DELCORA submitted a Pollutant of Concern report in February 2016, subsequently revised in May 2016 (Greeley and Hansen, 2016) that identified three indicator bacteria (fecal coliform, *Escherichia coliform* (*E. coli*), and enterococcus) as pollutants of concern (POC) that are potentially impacting the river during CSO discharges. The water quality monitoring objectives are to collect water quality data for the POCs during dry and wet weather event periods that can be used to characterize the bacteria sources in the Delaware River, Chester Creek, and Ridley Creek in the vicinity of the City of Chester, PA, and to calibrate and validate the Water Quality Model, consistent with the Consent Decree requirements in Paragraph V.A.15.a. Additional in situ parameters, such as salinity, temperature, and conductivity will also be collected to inform the development of the Water Quality Model.

2.2.2 Water Quality Modeling Objectives

The water quality modeling objectives are to develop a calibrated and validated Water Quality Model that can be used to assess impacts of the DELCORA combined sewer system overflows on current POC concentrations in the receiving waters as well as the relative water quality benefits from CSO control alternatives considered for DELCORA's LTCP update consistent with the Consent Decree requirements in Paragraph V.A.15.a described in Section 1.3 of this report. The water quality impacts in the receiving waters will rely primarily on comparisons to applicable water quality standards or guidelines.

In order to achieve these objectives, a CSO, a watershed, and a receiving water quality model will be created and connected (Figure 2-2). The CSO model, also called the "H&H" model, is currently being developed for the Long Term Control Plan, with calibration and validation to be completed in April 2017. The H&H model is designed to simulate CSO discharges from the DELCORA service area within the City of Chester. The watershed model is a new model that will be created to model the non-CSO areas that are adjacent to the spatial domain of the receiving water model. The watershed model will simulate discharges from these non-CSO or background sources. The receiving water model is also a new model that will be used to simulate the bacteria POC concentrations in the receiving waters, including the Delaware River, Chester Creek and Ridley Creek.

Figure 2-2: DELCORA Water Quality Modeling Framework



This project requires development and calibration of a receiving water quality model that can accurately simulate water quality in the Delaware River, Chester Creek and Ridley Creek. The project also requires a watershed model that can accurately simulate water quality in the portion of the watershed in the vicinity of Chester, PA outside the combined sewer system service area. Both models need to be capable of simulating the system under a range of environmental conditions so that they can be used to evaluate the benefits of CSO reduction scenarios. There are several objectives to consider when selecting appropriate modeling software for the watershed and receiving water model, including:

- Technical objectives: can the model software adequately represent the physical, chemical, and temporal characteristics of the project site? Can it address the complexities of the project site without being overly complex or overly simplistic?
- Regulatory objectives: Can the model software produce results that can be used to evaluate water quality against applicable water quality standards. Does it have a proven track record with similar regulatory projects? Will it help fulfill regulatory requirements as described in the Consent Decree?
- User objectives: does the end user have the necessary hardware and expertise to properly apply the model software to its fullest potential? Are there financial constraints to be considered with the model?

Careful selection of the most suitable modeling platform was conducted prior to model development as discussed in the Water Quality Model Work Plan. A number of factors were considered in selecting the watershed and water quality models, including understanding of the project, knowledge of the available data gained through review of existing data, the project modeling objectives defined in the Consent Decree, and knowledge of available modeling platforms The modeling objectives, the model attributes to support model objectives, and the recommended modeling platform are described in the following sections of this QAPP.

2.3 Project/Task Description (A.6) and Schedule

The Water Quality Monitoring Program (WQMP) is designed to collect data that will be used to develop and calibrate watershed and receiving water quality models which will be used to assess water quality concerns for the POCs identified in the Identification of Sensitive Areas and Pollutants of Concern Report (Greeley and Hansen, 2016). Existing water quality data provide insight into the conditions in rivers and streams in the project area but are of insufficient frequency and spatial density to fully support the modeling process. In addition, *E. coli*, one of the identified POCs, was not monitored in the available data.

The monitoring program will start in early spring 2017. The sampling events are planned to be distributed across the sampling season, which is assumed to be March through June 2017. Monitoring and sampling locations have been selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters are designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in Figure 2-3 and listed in Table 2-2, Table 2-3, and Table 2-4. Sampling locations may be moved slightly if the accessibility and safety of the selected locations of the stations are below expectations.

The WQMP is designed to collect data that will be used to assess water quality concerns identified in the Delaware River watershed and its tributaries, Chester Creek and Ridley Creek, in the vicinity of Chester, PA. In completing the initial step of characterizing the watershed, historical data was compiled, reviewed and assessed to determine the need to augment existing data to address the watershed issues identified. This review indicated that several of the POCs have not been sampled in the receiving waters and the data that have been collected are of insufficient frequency and spatial density to be useful in the modeling process.

As a result of the data review, the need for additional water quality information was identified. The need to further characterize the Delaware River, Chester Creek and Ridley Creek under dry and wet weather conditions is required to support water quality modeling, pollutant source identification, the subsequent development of a preferred alternative for controlling DELCORA's combined sewer overflows (CSO), and to allow DELCORA to complete its LTCP consistent with the Consent Decree. The need to characterize the watershed adjacent to

Chester's combined sewer system under wet weather conditions is also required to support water quality modeling and to allow DELCORA to complete its LTCP consistent with the Consent Decree.

Monitoring stations have been selected to characterize the watershed at a subwatershed level recognizing various political and hydrologic features, land use and potential pollutant sources. Site selection and analytical parameters are designed to characterize stream segments and pollutant sources primarily along the main stem and select tributaries. The sampling locations are shown in Figure 2-3 and listed in Table 2-2, Table 2-3, and Table 2-4. The tables include summaries of the rationales for each sampling location selected. The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater and Chester CSO pollutant loads. The Delaware River sampling locations will provide a characterization of water quality entering the Chester CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples will be collected across the transect corresponding to the DR-04 sampling location during each sampling round, when sampling across the river is feasible, to characterize lateral variability in the Delaware River during storm events. Delaware River conditions may be too hazardous for safe collection of one or more samples and/or sampling rounds (e.g. during periods of heavy barge traffic, small craft advisories, lightning, etc.). When these conditions occur, sampling will not be conducted in the river for safety reasons.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency of overflow, their overflow volume, and their accessibility. The stormwater sampling locations were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the study area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

Note that it may be necessary to adjust the one or more sampling locations in response to hazards, construction or other factors that affect the safety of field sampling personnel. The CSO and stormwater sampling locations will be finalized prior to the initiation of the sampling program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources.

Figure 2-3: Proposed Receiving Water (RW), Combined Sewer (CSO) and Stormwater (SW) Monitoring Locations

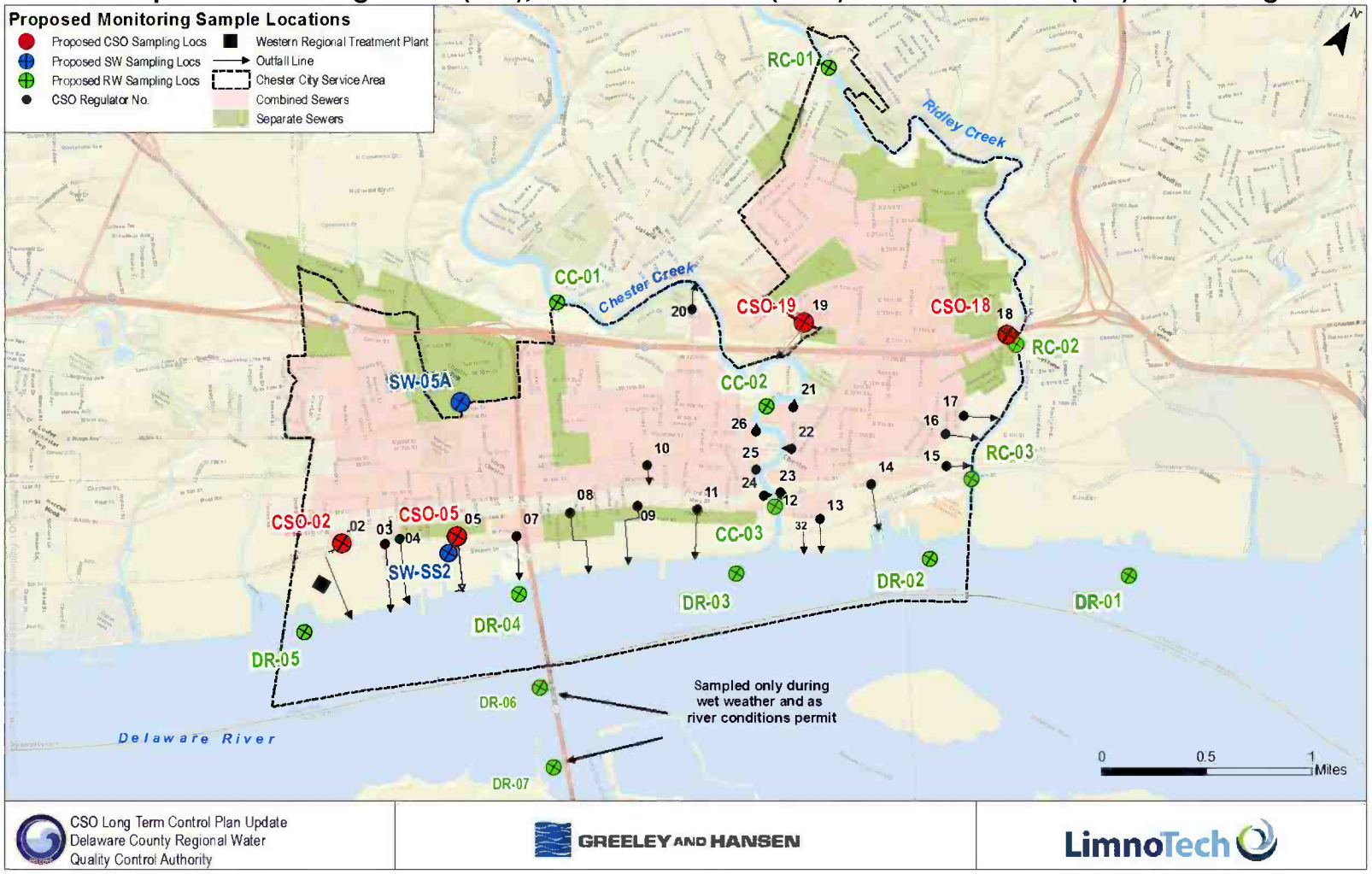


Table 2-2. Tributary Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CC-01	39.850122	-75.386348	Chester Creek	Tributary	Chester Creek at Upland-Incinerator Rd.	Upstream of all City sources and upstream of tidal influence
CC-02	39.850709	-75.365530	Chester Creek	Tributary	Chester Creek at the 9th St Bridge; 54 W 9th St	Characterize impacts from non-CSO urban runoff sources
CC-03	39.845227	-75.360284	Chester Creek	Tributary	Chester Creek at E 2nd St., William Penn's Landing Park	Characterize impacts from all CSOs discharging to Chester Creek
RC-01	39.873264	-75.375183	Ridley Creek	Tributary	Ridley Creek at Chester Park Drive Bridge; 298 East Elkington Blvd	Upstream of all City sources and upstream of tidal influence
RC-02	39.863016	-75.348686	Ridley Creek	Tributary	Ridley Creek at Morton Ave. Bridge; 1300 Sun Drive	Characterize impacts from non-CSO urban runoff sources
RC-03	39.853435	-75.346350	Ridley Creek	Tributary	Ridley Creek at East 4th St. (Harrah's) Bridge	Characterize impacts from all CSOs discharging to Ridley Creek

Notes:
[1] **GPS Coordinates, WGS 1984**

Table 2-3. Main Stem Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
DR-01	39.85282	-75.3299	Delaware River	Main stem	Delaware River between Ridley Creek and Crum Creek	"Upstream" of DELCORA's CSO discharges[2]
DR-02	39.84715	-75.3462	Delaware River	Main stem	Delaware River between CSO-14 and Ridley Creek	Characterize Ridley Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03	39.8398	-75.3606	Delaware River	Main stem	Delaware River between CSO-11 and Chester Creek	Characterize Chester Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-04	39.83132	-75.3766	Delaware River	Main stem	Delaware River at the boat launch off Highway 322	Priority area, in the lower Delaware River (Primary contact area)
DR-05	39.82182	-75.3917	Delaware River	Main stem	Delaware River between CSO-002 and Stony Creek	"Downstream" of DELCORA's CSO discharges[2], in the Atlantic sturgeon sensitive area
DR-06[3]	39.82636	-75.371	Delaware River	Main stem	Delaware River mid-stream along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events
DR-07[3]	39.82203	-75.3665	Delaware River	Main stem	Delaware River far shore (left descending bank) along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events

Notes:

[1] GPS Coordinates, WGS 1984

[2] "Upstream" and "downstream" subject to tidal conditions at time of sampling

[3] These locations will be sampled during the wet weather events only, when river conditions permit. POC concentrations are assumed to be laterally well-mixed during dry weather due to the absence of significant pollutant sources.

Table 2-4. CSO and Stormwater Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CSO-19	39.857132	-75.366105	Chester Creek	CSO	14th and Crozer Hospital; 1 Medical Center Blvd	Discharges to Chester Creek, one of the largest volume CSOs in DELCORA system
CSO-05	39.832598	-75.383958	Delaware River	CSO	Front and Townsend; 101 Townsend St	Discharges to Delaware River, one of the largest volume CSOs in DELCORA system
CSO-02	39.828334	-75.392570	Delaware River	CSO	Front and Booth; 100 Booth St	Aggregates cumulative effect of CS conditions, one of the volume CSOs in DELCORA system
CSO-18	39.863501	-75.349203	Ridley Creek	CSO	Sun Drive and Hancock St.; 1310 Sun Dr	Discharges to Ridley Creek
SW-05A	39.838501	-75.387708	Chester Creek	SW	7th and Engle Street; by tennis courts	Characterize runoff quality from predominantly residential area representative of the residential portion of the study area
SW-SS2	39.832853	-75.384193	Delaware River	SW	Front and Townsend; 105 Townsend St	Characterize runoff quality from predominantly commercial/industrial area representative of the commercial/industrial portion of the study area

Notes:
[1] **GPS Coordinates, WGS 1984**

2.3.1 Scope of Sampling

This section describes the scope of water quality sampling to be completed for this project.

Dry Weather Sampling

Collection of water quality samples will be performed for three (3) dry weather events; with one dry weather sampling event planned to be collected during a low-flow period (less than 25th percentile flow) in Chester Creek and Ridley Creek (if possible). Two rounds of sampling will be conducted for each dry weather survey: one round to be completed during ebb (outgoing) tide and the second round to be completed during flood (incoming) tide.

Dry weather event samples will be taken at up to eleven (11) locations:

- **Three (3) locations on Chester Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Three (3) locations on Ridley Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Five (5) locations on the Delaware River** that will characterize water quality in the vicinity of DELCORA's CSO discharges. Sampling locations have been selected to separate, to the extent possible, the effect of DELCORA's CSOs on water quality from other sources contributing pollutants to the waterways. Sampling will be conducted near the shoreline adjacent to the City of Chester.

The locations of these stations are shown in Figure 2-3. Details for these stations are provided in Table 2-2 and Table 2-3. The set of parameters for which the samples will be analyzed is provided in Table 2-4.

In-situ measurements of physical parameters, such as salinity, temperature, and conductivity will be collected at each sampling location with a sonde. In the Delaware River, in situ measurements will be made at three depths at each sampling location during each round of sampling. Grab samples will be collected near the surface in each waterway.

Wet Weather Event Sampling

Collection of water quality samples will be performed for three (3) wet weather events. The purpose of the wet weather sampling is to characterize the impact of CSO discharges and non-CSO source runoff on in-stream water quality. The wet weather events will span a range of precipitation, flow and seasonal conditions.

Wet weather event samples will be taken at all 13 in-stream locations as well as at up to six source locations in the intervals described below:

- **Six (6) In-Stream Tributary Sampling Locations:** Three (3) locations will be on Chester Creek and three (3) locations on Ridley Creek. The locations will be the same locations used for the dry weather surveys. Tributary locations will be sampled up to five times per event at the following approximate intervals: Hour 0.5-2.5, Hour 4.5-6.5, Hour 8.5-10.5, Hour 14.5-16.5, and Hour 22-24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. A total of 30 samples will be collected during each wet weather sampling event from in-stream locations. One field blank and one field duplicate will be collected during each event to be used as field quality control (QC).
- **Up to Seven (7) In-Stream Delaware River Locations:** Up to seven locations will be on the Delaware River and will be sampled up to ten times per event at the following approximate intervals: Hour 0, Hour 2, Hour 4, Hour 6, Hour 9, Hour 12, Hour 15, Hour 18, Hour 21, and Hour 24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. The frequency of sampling is intended to capture in-stream impacts in the vicinity of DELCORA's service area from both DELCORA's CSOs as well as upstream sources. Two additional locations on the Delaware River, one at mid-stream and one near the far shore, have been added to characterize lateral variability in water quality during storm event conditions, when sampling across the river is feasible. The sampling regimen is also designed to allow a semi-quantitative mass balance to be computed over a complete tidal cycle. A total of 70 samples may be collected during each wet weather sampling event. If river conditions are unsafe for sampling (e.g. small craft advisories, heavy barge traffic, etc.), sampling may be suspended for one or more locations and/or sampling rounds. One field blank and one field duplicate will be collected during each event to be used as field QC. Final selection of sampling locations and sampling intervals will be determined prior to the start of the sampling program and will be based on logistic considerations (e.g. can seven locations be sampled and dropped off to a courier within the 3 hour sampling window), safety and accessibility to the Delaware River, and available resources.
- **Up to Six (6) Outfall Locations:** Sampling will be conducted at up to two (2) stormwater outfalls and up to four (4) combined sewer overflow outfalls. The CSO and stormwater sampling locations will be finalized prior to the initiation of the sampling

program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources.

It is assumed that each of the outfall locations will have up to eight sets of samples collected for each event at the following intervals: 1st flush, 30 minutes, and 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours. If a location is not flowing, no sample will be collected. As many as 48 samples may be collected during each wet weather sampling event, depending on the number of monitored outfalls and if all monitored outfalls discharge for 24 hours. However, the actual number of samples is likely to be less than the amount indicated since it is unlikely that all of the monitored outfalls will discharge for the full 24 hour monitoring period. One field blank and one field duplicate will be collected during each event to be used as field QC.

The location of these stations are shown in Figure 2-3. Details for these stations are provided in Table 2-2, Table 2-3, and Table 2-4. The set of parameters for which the samples will be analyzed are summarized in Table 2-5. In situ measurements will not be collected at the outfall locations.

Sampling crews will conduct all wet weather event sampling using the protocols described in the Quality Assurance Project Plan. Samples will be delivered to the laboratory where the samples will be analyzed for the laboratory parameters identified in Table 2-5.

Determination to mobilize for a Wet Weather Event will be a collaborative effort between Greeley and Hansen, LimnoTech, the field sampling contractor and the laboratory contractor personnel. The intent is to identify a 4 to 6 hour window in which a wet weather event may commence 24 hours in advance to assist in mobilization of the sampling crews.

Table 2-5: Analytical and Field Parameters

Parameter	Description	Sampling Program	Type of Measurement
E. coli	Escherichia coliform	Dry, Wet	Grab
Enterococcus	Enterococcus sp.	Dry, Wet	Grab
Fecal coliform	Fecal coliform	Dry, Wet	Grab
wTemp	Water temperature	Dry, Wet Receiving Water Only	In-situ
Cond	Conductivity	Dry, Wet Receiving Water Only	In-situ
Salinity	Salinity	Dry, Wet Receiving Water Only	In-situ

Tributary Bathymetry

The project team has requested HEC models of the receiving waters from the U.S. Army Corps of Engineers. However, in the absence of these models, additional bathymetry data is needed for the tributaries to inform the development of the water quality model. If required, bathymetry surveys will be conducted in approximately the lower three miles of both Chester Creek and Ridley Creek, corresponding to the approximate extent of the water quality model

domain. Because these reaches are in the tidal zone, they are unlikely to be wadeable so each transect will be characterized using a boat and a combination of sonar and ADCP profiler equipment. Transects will be spaced approximately every 0.25 miles or at significant morphometric features (e.g. dams, islands, etc.).

2.3.2 Water Quality Model Attributes and Platform

The Water Quality Model is a tool that computes the movement and concentrations of pollutants in water bodies of interest. Many water quality model codes are available and these models vary in their recognition by USEPA and their applicability to the Delaware River and its tributaries. LimnoTech reviewed a range of potentially applicable hydrodynamic and water quality models and has identified USEPA's Environmental Fluid Dynamics Code (EFDC) as the model framework most appropriate for the DELCORA receiving waters. This modeling framework computes water depths and velocities to inform predictions of bacteria water quality conditions. EFDC is selected over other candidate modeling frameworks due to its flexible and scalable design, computational efficiency and wide application base at similar sites around the United States. This model is supported by USEPA and has been successfully applied by the project team at similar sites and to meet similar project objectives (Ohio River, James River, Berry's Creek).

It may be beneficial to couple EFDC with another model to reduce simulation run times. EFDC could be used to compute hydrodynamics and those results could be linked to the RCA (Row-column AESOP) water quality model for water quality calculations. This potential approach would reduce model run times by allowing for a longer time step and for a smaller water quality model extent. RCA, like EFDC, is a highly regarded water quality model that has been applied at numerous sites by the project team (Lake Erie, Mississippi River, Great Miami River).

LimnoTech also reviewed a range of potentially applicable watershed runoff models and has identified USEPA's Storm Water Management Model (SWMM) as the model framework most appropriate for the DELCORA watershed model. This modeling framework simulates hydrologic and water quality conditions in the watershed to estimate runoff and pollutant concentrations from areas outside the combined sewer system area in the vicinity of Chester, PA. This area is primarily within the City of Chester's municipal separate storm sewer system (MS4).

EFDC Background and General Capabilities

The EFDC model is a state-of-the-art finite difference model that can be used to simulate hydrodynamic and sediment transport behavior in one, two, or three dimensions in riverine, lacustrine, and estuarine environments. EFDC was developed at the Virginia Institute of Marine Science in the 1980s and 1990s, and the model is currently maintained under support from the U.S. EPA. Recently, LimnoTech has successfully applied EFDC to a number of sites, including the James River (near Lynchburg and Richmond), Berry's Creek (NJ), San Diego Bay (CA), the lower Great Miami River, the Ohio River (near Cincinnati (OH), Evansville

(IN) and Wheeling (WV), the lower Licking River (Northern Kentucky), Missisquoi Bay (Lake Champlain), Saginaw Bay (Lake Huron), Maumee Bay (Lake Erie), Saginaw River (Michigan), and the Tittabawassee River (Michigan). The EFDC model is both public domain and open source, meaning that the model can be used free of charge, and the original source code can be modified if necessary to tailor the model to the specific needs of a particular application.

The model input parameters include variable hydrologic inflows and outflows from tributaries and landside sources, their associated bacteria concentrations for the POCs, and water level boundary conditions. EFDC can represent the model grid using either a generalized vertical coordinate (GVC) system or a sigma system. Both options are capable of accurately describing vertical gradients in systems with rapidly changing bathymetry, if necessary. The model outputs will include the movement of water in the river (i.e., flows and velocities), water level, and bacteria densities throughout the model domain.

SWMM Background and General Capabilities

The proposed watershed model framework for this project is SWMM (Storm Water Management Model), which is supported by the USEPA and has been successfully applied by the project team at similar sites and for related purposes, including in East Rutherford, NJ, Washington, DC, and Richmond, VA. SWMM is a dynamic rainfall-runoff simulation model used for single event or continuous simulation of runoff quantity and quality from primarily urban areas (USEPA, 2015). A review of the Chester Creek and Ridley Creek watersheds using the USGS StreamStats[1] tool show that these two watersheds are 42% and 37% urban respectively. Additionally, the current H&H model for the DELCORA service area is also built using the SWMM software, so choosing SWMM for the watershed model provides consistency in the suite of models used by DELCORA.

SWMM can account for different subcatchment physical characteristics such as slope, imperviousness, length and width, and soils through the parameterization of spatial resolution. Additionally, it will be able to predict variations in timing, peak flows, and flow volumes.

A variety of enhanced SWMM platforms are available that integrate the EPA SWMM software with user friendly interfaces and GIS capabilities. For this project, PCSWMM, developed by CHI, will be used. Once the watershed model is built, the model files can be provided as PCSWMM or EPA SWMM files.

2.4 Quality Objectives and Criteria (A.7)

The monitoring information that will be collected to support the development of the updated LTCP will meet the quality assurance objectives outlined in this section. Data quality will be

[1] http://water.usgs.gov/osw/streamstats/

measured in terms of the data's accuracy and precision, completeness, representativeness, comparability, and the required detection limits for the analytical methods.

Model quality will be based on the successful calibration and validation to hydrodynamic and water quality data from the Sampling Program as well as the model's ability to be meet the project objectives.

2.4.1 Water Quality Monitoring

2.4.1.1 Accuracy

Accuracy is the measure of agreement between an observed value and an accepted reference value or true value. Table 2-6 provides a summary of the laboratory and field measurement accuracy objectives.

Table 2-6: Data Quality Objectives

Parameter	Data Accuracy Objectives (% R)		Data Precision Objectives				Required Detection Limits	
			Field Precision (RPD)		Analytical Precision (RPD)			
	Estimated By	Objective	Estimated By	Objective	Estimated By	Objective	Reference Method	RL*
Fecal coliform	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	SM 9222D	10 No./ 100 ml
Escherichia coliform (E. coli)	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	EPA 1603	10 No./ 100 ml
Enterococcus	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	EPA 1600	10 No./ 100 ml
Water Temperature	Factory calibration	NA	Readings	10%	NA	NA	Field Instrument/ EPA 170.1	0.1 °C*
Conductivity	Calibration check standard	Instrument reading within 10% of standard	Readings	10%	NA	NA	Field Instrument/ EPA 120.1	1 uS/cm*
Salinity	Calibration check standard	Successful daily calibration	Readings	10%	NA	NA	Field instrument/ SM 2520 B	0.1 part per thousand

* - Sensitivity value listed for field parameters (Temp., Cond., Salinity) - instrument must be capable of reporting to nearest incremental sensitivity value listed
P/A - method detects presence when bacteria is present in control (P) and method does not detect bacteria when absent in control (A).
NA - not applicable
RL - Reporting Limit
SM - Standard Methods of the Examination of Water and Wastewater, 22nd Edition

Laboratory Accuracy Objectives

Accuracy cannot be directly measured for bacterial samples. Accuracy will be assessed by the laboratory through the analysis of positive and negative controls and laboratory blanks and with field blanks in the field.

Dilution blank samples and method blank samples will be generated by the contract laboratory and used to assess contamination resulting from laboratory procedures. Duplicate analyses will be performed to check for sampling and analytical reproducibility.

Field Accuracy Objectives

Accuracy cannot be directly measured for bacterial samples. Accuracy will be assessed by the laboratory through the analysis of positive and negative controls in the laboratory and with field blanks in the field. In order for the accuracy assessment to be relevant, all appropriate protocols concerning sample collection, handling, preservation, and hold times must be maintained. Field blanks will be collected by each crew during each sampling event. A detailed discussion of these protocols is provided in the Water Quality Monitoring Plan.

Field blanks will be used to determine if samples collected have been contaminated. Equipment that is used to collect samples for analysis may become contaminated through the normal course of monitoring. If not properly cleaned and rinsed, samples may be contaminated during sampling from previous locations or in the laboratory between sample analyses. Field blanks consisting of reagent grade distilled water will be submitted to the analytical laboratory to assess the quality of the data resulting from the field monitoring program. Field blanks will be used to assess cross-contamination of samples by the equipment or sampling techniques. Field blanks will also be analyzed to check for procedural contamination at the laboratory that may cause sample contamination.

Field measurement accuracy will be assessed through pre- and post-monitoring checks to calibration standards. Probe performance within the specifications of the parameter will be used as confirmation of accuracy. Probe performance outside the specifications of the parameter will be qualified using the data validation protocols described in Section 5.

2.4.1.2 Precision

Precision is a measure of agreement between two or more measurements. Duplicates and replicates samples will be taken for a portion of the samples. Table 2-6 provides a summary of the data precision objectives for field and laboratory measurements. Table 2-6 applies if the average result of the duplicate/replicate samples is greater than five times the analysis detection limit. If the average result of the duplicate/replicate samples is less than five times the analysis detection limit, the precision test will not be utilized.

Laboratory Precision Objectives

The precision of the laboratory analysis is assessed by the comparison of laboratory replicate analyses. The RPD is calculated as follows:

$$RPD = \frac{|C_1 - C_2|}{0.5(C_1 + C_2)} \times 100$$

Where: C_1 = measured concentration of the first sample replicate
C_2 = measured concentration of the second sample replicate

Note that the average concentration of C_1 and C_2 must be at least five times greater than the reporting limit (Table 2-6) for the analyte to be in sufficient quantity to provide a reasonable measure of precision.

Field Precision Objectives

Field precision tests are conducted for grab samples and physical parameter readings. The precision of grab samples is assessed by the comparison of field duplicates. The relative percent difference (RPD) between the analyte levels measured in the field duplicates will be calculated as follows:

$$RPD = \frac{|C_A - C_B|}{0.5(C_A + C_B)} \times 100$$

Where: C_A = measured concentration of sample
C_B = measured concentration of duplicate sample

The precision of physical parameter readings is assessed by the comparison of each instrument's calibration readings versus the post check readings. The RPD between the readings will be calculated as follows:

$$RPD = \frac{|R_X - R_Y|}{0.5(R_X + R_Y)} \times 100$$

Where: R_X = calibration reading
R_Y = post check reading

2.4.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from the monitoring program compared to the amount of data that were expected. Events that may contribute to reduction in

measurement completeness include sample container breakage, inaccessibility to proposed sampling locations, automatic sampler failure, and laboratory equipment failures.

The percent completeness (%C) is determined as follows:

$$\%C = \frac{(M_V)}{(M_P)} \times 100$$

Where: M_V = number of valid measurements
M_P = number of planned measurements

If the completeness objectives are not achieved for any particular category of data, the Field Manager will provide documentation why the objective was not met and how the lower percentage impacts the overall study objectives. If the objectives of the study are compromised, re-sampling or re-measurement may be necessary.

Field Completeness Objective

Field completeness is determined by the number of measurements collected versus the number of measurements planned for collection. The details concerning the actual number of field measurements and samples to be collected are discussed in the Water Quality Monitoring Work Plan. The number of measurements collected is validated by the Field Manager. The completeness criterion for all measurements and sample collection is 90 percent, but will be influenced by environmental situations that may alter monitoring schedules.

Laboratory Completeness Objective

Laboratory completeness is a measure of the amount of valid measurements obtained from all samples submitted for each sampling activity. The Laboratory Manager validates the numbers of valid measurements. The completeness criterion for all measurements is 95 percent.

2.4.1.4 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representative data of dry weather and wet weather conditions are required to support the evaluation and modeling efforts.

For sample collection, representativeness will be assured by following the Water Quality Monitoring Work Plan and applying proper collection techniques including the proper sample sizes and volumes, sampling times, and sampling locations. The volumes of the samples depend on the analytical methods and should allow for QC sample analysis and reanalysis, if required. In the laboratory, representativeness will be ensured by using the appropriate sample preparation

techniques, by following appropriate analytical procedures, and by meeting the recommended sample holding times.

2.4.1.5 Comparability

The objective for data comparability is to generate data for each parameter that related water quality conditions between sampling locations and over time. Data comparability will be promoted by:

1. Using standard U.S. EPA approved methods, where possible.
2. Consistently following the sampling methods detailed in the SAP.
3. Consistently following the analytical methods detailed in the QAPP.
4. Achieving the required detection limits detailed in the QAPP.

All sample collection and analytical methods will be specified, and any deviations from the methods will be documented. All results will be reported in the standard units shown in Table 2-6. All field and laboratory calibrations will be performed using standards traceable to National Institute of Science and Technology (NIST) or other U.S. EPA approved sources.

2.4.1.6 Required Detection Limits

The required detection limits (RL) and methodology for the study is provided in Table 2-6. For the analytes specified for this study, all the RLs are at levels required for calibration of the water quality models to be developed.

Refer to Table 2-7 for the specification limits of the field measurement instruments.

Table 2-7: Specification Limits of Field Measurement Instruments

Parameter	Instrument	Range	Accuracy	Resolution
Temperature	YSI	-5 to 45°C	±0.15°C	0.01°C
Conductivity	YSI	0 to 100 mS/cm	±1% of range	4 digits
Salinity	YSI	0 – 70 ppt	±0.1 ppt	0.01 ppt

2.4.2 Water Quality Modeling

Model development for the DELCORA LTCP consists of four tasks leading to a calibrated and validated EFDC model for use in evaluating CSO control applications in the local waterways of the DELCORA service area. These tasks are addressed in this QAPP and are listed below.

- Model Input Development
- Model Calibration and Validation

- Model Scenario Application
- Documentation and Reporting of Results

Each of these model development tasks is described below.

2.4.2.1 Criteria for Model Inputs/Output

This task includes the processing of the necessary background, input, and calibration datasets for model development. Model development of the hydrodynamic (EFDC) and water quality (RCA) components of the EFDC-RCA model for the DELCORA waterways will occur sequentially, with EFDC development occurring first, followed by development of the RCA model. Model development for each component is discussed below.

EFDC-RCA Water Quality Model

Initial EFDC model development efforts will focus on development of a model grid, followed by processing of data to specify external hydraulic and water quality forcing functions (i.e., flows, loads) into a format that can be input to the model.

The major components of the model development process include the following items:

Grid development – Available bathymetric data will be assembled and used as the basis for development of a model grid with adequate resolution to capture the significant characteristics of the system for purposes of this project. At present, a one-dimensional grid is planned for the tributaries and three dimensional grid for the Delaware River portion of the model domain. The model grid will be an orthogonal grid within a curved perimeter suitable for numerical modeling. Where bathymetric data are not available, previously developed flood models will be obtained and the model bathymetry will be used to fill bathymetric gaps. Additionally, bathymetry surveys as described in Section 2.3.1 will be conducted in the tributaries. If reaches exist where no bathymetric data or hydraulic models exist, bathymetry will be extrapolated from upstream and downstream information.

Input development – Model upstream and tributary flows will be derived from available flow data at USGS gaging stations. CSO flows will be derived from the calibrated and validated hydrologic and hydraulic (H&H) model. Stormwater flows will be derived from a SWMM watershed model. Model upstream and tributary water quality will be based on the data collected during the WQMP. CSO and stormwater quality will be input using event mean concentrations (EMCs) derived from the CSO sampling program data collected during the WQMP.

Available water quality data to support model development and calibration have been compiled and reviewed to develop the WQMP. Available data have been incorporated into a project-specific database that will be used to generate model inputs and included in the pre- and post-processor for the model to facilitate comparisons of model results to observed data during calibration, as appropriate.

SWMM Stormwater Watershed Model

The main attributes of the proposed watershed model are that it will be able to predict dry and wet weather flows and associated bacteria loads. The watershed model will provide necessary spatial resolution to account for different subcatchment physical characteristics such as slope, imperviousness, length and width, and soils. Additional, it will be able to predict variations in timing, peak flows, and flow volumes.

Catchment Development – SWMM simulates surface runoff from catchments that represent physical areas in the watershed. For the DELCORA modeling framework, catchment areas will be developed for the areas outside of the combined sewer system collection system adjacent to the spatial domain of the Water Quality Model. Catchment areas will be defined similarly to the areas shown in Figure 1-3 and will be informed by the physical characteristics of the area, including slope, soils, imperviousness, and topographical or other defined watershed boundaries (e.g. roads).

Input Development – SWMM model inputs include catchment characteristics, such as area, width, imperviousness, and slope. Other characteristics affecting the hydrologic simulation include roughness, depression storage, and soil infiltration rates. Rainfall and temperature are temporal inputs. Runoff water quality will be input using EMCs derived from the stormwater sampling program data collected during the WQMP.

Available water quality data to support model development and calibration have been compiled and reviewed to develop the WQMP. Available data have been incorporated into a project-specific database that will be used to generate model inputs and included in the pre- and post-processor for the model to facilitate comparisons of model results to observed data during calibration, as appropriate.

2.4.2.2 Calibration and Validation

Once each EFDC model component is configured to the DELCORA watershed, the next step in the model development process is model calibration. During the calibration process, model inputs will be adjusted to allow the model to best fit the described observed data. The focus of calibration is the adjustment of model coefficients within an acceptable range (dictated by the field data and laboratory literature values) to achieve the best agreement between model and data within the constraints of both model and data. The model calibration approach will be consistent with the well-accepted methods presented in the EPA guidance manual for development, evaluation, and application of regulatory environmental models (EPA, 2009). Model coefficients will be calibrated independently to the extent possible, with calibrated coefficients left fixed while other coefficients are adjusted. For example, all hydraulic parameters will be calibrated prior to conducting any water quality calibration. Calibration of each model component is discussed further below.

EFDC Model Hydraulic Calibration and Corroboration

The hydraulic calibration will be informed by data from NOAA gages in the Delaware River, as

listed below:

- Water level gages: #8540433 (Philadelphia, PA), #8546252 (Bridesburg, PA), #8539094 (Burlington, NJ), and #8548989 (Newbold, PA)
- Current velocity meter: Station dB0301 (Philadelphia, PA)

Hydraulic calibration will primarily focus on reproducing observed water levels and current velocities in the Delaware River. This approach provides a robust calibration by focusing on the hydraulic attributes that are the primary dependent variables of the hydrodynamic model. Calibration goodness will be determined by qualitative visual comparison of model and data time series, one-to-one plots, and cumulative frequency distributions (CFDs). Calibration will involve adjustment of the roughness height to values that best replicate water level and velocities at NOAA stations.

After satisfactory calibration is achieved, the EFDC hydrodynamic model will be validated by applying the model for a different time period than the calibration. The roughness height used in the calibration will be used for the validation run.

EFDC Model Water Quality Calibration and Validation

Water quality calibration will rely primarily on the dry and wet weather data to be collected in the WQMP in Chester Creek, Ridley Creek and the Delaware River. The model coefficients determined in the calibration process will be independently corroborated (a process that has historically been called validation) via application of the model to a data set independent of that used for model calibration. The LimnoTech standard approach for selecting periods for calibration and validation is to divide the available data into periods of relatively equal duration and to use the most robust (or otherwise most representative) period as the calibration data set. Using this approach, the dry weather data and two of the sampled wet weather events will serve as the calibration dataset and the remaining third sampled wet weather event will serve as the validation data set.

Calibration will involve adjustment of model coefficients within an acceptable range (dictated by the field data and laboratory literature values) until the difference between model computations and measured state variables is within acceptable tolerance. The key calibration parameter for indicator bacteria in EFDC is the loss rate. The loss rate represents the net effect of bacteria settling, die-off and other physical and chemical processes as a first order loss rate.

Calibration will include the use of qualitative (graphical) comparisons of model results to data, such as:

- Time series
- 1:1 plots
- Cumulative frequency distributions

Quantitative comparisons of model to data will also be used to judge the calibration, with the objective of minimizing differences between model and data. For comparisons of simulated vs. observed parameters, these may include:

- Mean absolute error and/or mean relative % difference
- PBIAS (percent bias)

Diagnostic analyses (e.g., sensitivity analyses, mass balance checks, and comparison of results to simple models) will be conducted during the water quality calibration process. LimnoTech experience has shown that conducting these diagnostic analyses helps to:

- Confirm that inputs are being provided to the model in the required format,
- Troubleshoot unstable and unexpected behavior exhibited by model simulations,
- Assess the relative importance of different input parameters and systems simulated within the modeling framework, and
- Provide insights into system behavior based on predictions of the calibrated model.

Model validation will involve running the EFDC water quality model for the validation time period and calculating the same model-data comparison statistics as were used for model calibration.

Quality Objectives and Criteria for Model Inputs/Outputs

LimnoTech will develop and apply the calibrated and corroborated EFDC water quality model to evaluate management option scenarios as described Section 2.2.2 of this QAPP. The two overall modeling objectives for this QAPP follow and are described further below.

- to ensure the performance of the model; and
- to ensure the quality of the model inputs, model outputs, and conclusions made in support of CSO control alternatives evaluation.

Model Performance

During the application of the model, performance will be evaluated after each model run. The output will be compared against previous model runs to ensure that the outcome was expected, and within reasonable ranges. A reasonable range is defined as being within known ranges of possible outcomes. The range of possible outcomes is determined from previous model runs and user experience with the parameters being modified for the current run. For example, if the model is run to steady state with 50% of the annual load, then the steady-state water column concentration is expected to be 50% of the original value. In this example, model results that are not 50% of the original value (for this model run) would be subject to further review.

Model Input Data

Model inputs will be comprised of existing secondary data (i.e., previously collected, reported,

modeled or synthesized data) and will be used for the purposes of receiving water characterization and modeling efforts. Work under this QAPP will not generate any direct environmental data measurements. The data quality objectives (DQO) and associated criteria for the secondary data used for this project are listed below.

- Data are from a known and reliable source. The data sources will be documented. Data will be compiled primarily from reliable local, state, federal and peer-reviewed sources.
- Data are of known quality. The quality of secondary data will be reviewed prior to use for this project.
- Data are appropriate for the intended use as indicated by the following criteria:
    - data satisfy project objectives;
    - data satisfy evaluation and modeling requirements;
    - data exhibit appropriate characteristics (e.g., quality, quantity, temporal, spatial); and,
    - data were generated using appropriate methods.

Data sets to be used in the project will be reviewed for completeness, quality and conformance with the DQOs and associated criteria listed above. Data will be accepted for use if they conform to the DQO and criteria, and all accepted data will be cited appropriately including:

- Type of data and collection dates;
- Originating organization;
- Report title, author and date; and,
- Data format (electronic, hardcopy) and database names.

Identified data limitations will be documented, where applicable, and these datasets will be accepted for use on a case-by-case basis. Data of unknown/non-verifiable quality will be considered suspect and documented accordingly. To ensure transparency and defensibility in the decision making process, related project reports and/or existing data that were not used for this project will be clearly documented.

Model inputs will be carefully reviewed by the technical staff prior to each model run to ensure that the inputs are consistent with the modeling approach and scenario objectives. Any model inputs that are questionable or not fully documented will not be used to generate final results. All modifications to the model inputs will be documented in a separate file that lists the date, run ID, and inputs that were modified. All model inputs will be stored in the same folder as the corresponding model output to keep a complete record of each simulation used for each management scenario.

Model Outputs and Conclusions

Processing of model results will be accomplished through an automated post-processor that ensures the consistent treatment of model output for each model run. Model results will be reviewed by the technical staff as a final quality check to ensure that the model results are within reasonable ranges. Processed model outputs will always be stored in a folder with the run ID and the unprocessed model output.

2.4.2.3 Application

The calibrated EFDC water quality model is intended to be used to evaluate CSO control alternatives wherein indicator bacteria POC loads are reduced by specified amounts to evaluate impact on water quality in the Delaware River and the tributaries adjacent to the DELCORA service area. The list of model scenarios representing the CSO control alternatives to be evaluated will be developed in collaboration with DELCORA and Greeley and Hansen.

A baseline scenario will be developed, against which all load reduction scenarios will be compared. This baseline scenario will be developed in collaboration with DELCORA and Greeley and Hansen and will include:

- A representative time period to capture the range of river conditions including dry, wet and average conditions.
- A representation of current CSO discharge flows and quality.

Once scenarios have been defined, inputs to the calibrated model will be adjusted for each scenario to fit the specific change that the management option is considering. Model results for each scenario will be compared to the baseline scenario for a specific set of water quality response variables, including, but not necessarily limited to:

- Compliance with applicable water quality standards
- Reductions in levels of POCs

Compliance with applicable water quality standards will be evaluated assuming contributions from CSO and non-CSO sources and from CSO sources alone. If non-CSO (e.g. background) sources prevent compliance of water quality standards, the scenarios simulated will be configured assuming that background pollutant levels are reduced such that in-stream concentrations upstream of the CSO outfalls are no more than 75% of the applicable water quality standard.

2.5 Special Training/Certification (A.8)

Special training/certification needed for project, field, laboratory, and modeling staff to successfully complete project work is discussed in this section.

2.5.1 Project Staff

Greeley and Hansen, LimnoTech, Weston Solutions, and Eurofins QC professional staff will be involved in this monitoring program and water quality model development. Project staff will be assigned duties based on their qualifications to accomplish the task. The Field Manager will determine the appropriateness of individuals on their staff to undertake a task.

2.5.2 Field Staff

Training sessions will be carried out for all field staff on proper sampling, sample handling and submission and general field procedures prior to conducting the first sampling event. Specific emphasis will be placed on QA/QC issues as well as on health and safety. Field Safety Instructions will be prepared to outline the safety issues of concern.

Field crews will also receive training involving the operation, maintenance and calibration of field equipment including multi-parameter probes, velocity meters, and all other on-site equipment used throughout the field program.

Standard Operating Procedures (SOPs) for program elements will be distributed to staff and available at all times. The field Standard Operating Procedures (SOPs) and the Sampling Analysis Plan (SAP) referenced in the following sections of this report are provided in Appendix C.

2.5.3 Laboratory Staff

The Laboratory Manager or delegate will be the main point of contact for coordinating all sample drop-offs, pick-ups, etc. The Laboratory Manager or delegate will be assisted by the laboratory QA/QC Manager in performing review and validation of all data generated to assure all data quality objectives have been met. The Laboratory Manager or QA/QC Manager will contact the Field Manager immediately with any problems with samples noted during log in or with analysis. Prior to conducting the first sampling event, the Monitoring Task Manager and Field Manager will meet with the laboratory manager to review details of the planned progression of sampling events.

The laboratory staff will include chemists and technicians with specific experience in receiving water and source sampling analysis. The laboratory staff will be on call 24 hours a day and 7 days a week for wet weather events, including weekends.

All laboratory personnel receive training and have proven proficiency in their designated analytical procedures. Laboratory personnel have been provided copies of the appropriate Standard Analytical Procedures (SAPs), which will be available at all times and are provided in Appendix B.

2.5.4 Model Staff

Staff engineers and scientists comprising the modeling team are trained professionals with advanced technical degrees and skills necessary to successfully develop and apply water quality models for the system. All modeling activities will be overseen by the project's Water Quality

Model Task Manager who has extensive experience in applying water quality models to support CSO LTCP development.

2.6 Documentation and Records (A.9)

The Project Manager is responsible for ensuring that the most current approved version of the QAPP is distributed. The approved QAPP and any approved updates will be distributed to the list of project personnel identified in the Distribution List at the beginning of this document. These personnel are responsible for distributing copies of the QAPP to relevant personnel within their organization.

2.6.1 Monitoring Data

The Project Manager is responsible for initiating project files and for overseeing maintenance of the files during the course of the project. All project files will be properly identified by client, project name, project number, file description, and file number for all appropriate correspondence, memoranda, calculations, technical work products, and other project-related data. In addition, a quality assurance file will be maintained by LimnoTech containing all QA/QC related information. A back up of all computer files containing important project information will also be maintained.

Documents to be generated by field activities include staff notes, field logs, equipment logs, field on-site measurement data sheets, field audit reports, chain of custody forms. Documents to be generated by laboratory activities include QA/QC reports, laboratory bench sheets, laboratory results, and laboratory audit reports. These documents will be included in project reports.

At the conclusion of the project, relevant information from the project files and electronic files will be turned over to DELCORA to be archived.

2.6.2 Model Files

The development, calibration and corroboration of the Water Quality Model will be documented in a Water Quality Model Report. This report will be submitted to EPA and PADEP within 60 days after this Water Quality Model Work Plan is approved and fully implemented. The project report will include discussions of the data collected during the WQMP, additional data analyzed and used to support the modeling, model development and calibration processes and the calibration and corroboration. An initial draft of the report will be prepared for internal review. After this internal review is complete, the draft report will be edited accordingly and then delivered to the EPA and PADEP for their review. The final report will then be prepared.

A daily back up of all computer files containing important project information will also be maintained on LimnoTech's computer network. No files will be maintained on individual personal computers unless they are temporary working files. All data and work products will be saved to their respective network files daily.

Documents to be generated by this project include this modeling QAPP, technical memoranda, and the draft and final project reports.

Records that will be generated during this project include model inputs and output files, model post-processing files (e.g., those produced using Microsoft Excel, databases or other data analysis software programs), and the draft and final Water Quality Model reports. These records will be complete and detailed enough to allow the model to be re-loaded and re-run independently with the same data sets and producing the same results.

At the conclusion of the project, all relevant information from the project files and computer disks will be archived by LimnoTech, with data, deliverables and technical records retained for at least 10 years.

Section 3 Data Generation and Acquisition (Group B)

This section of the Quality Assurance Project Plan (QAPP) addresses quality assurance/quality control (QA/QC) elements related to the monitoring activities. The monitoring program QAPP was developed based on U.S. EPA requirements (EPA, 2001) following U.S. EPA guidance (EPA, 1998).

3.1 Sampling Process Design (B.1)

As described in the previous section, dry weather and wet weather monitoring will be conducted at six tributary in-stream locations, five Delaware River locations, and up to ten CSO and stormwater outfall locations. The sampling process design is discussed in the Water Quality Monitoring Work Plan portion of this Work Plan.

3.2 Sampling Methods (B.2)

SOPs will be employed to provide consistency and reproducibility to the sampling methods used by field personnel. The following sections present or reference the detailed methods for performing sampling activities, including related support procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments. Sample custody procedures are presented in the Sample Handling and Custody Section of this QAPP. For all sampling related procedures, personnel will use personal protective equipment as required by the Field Safety Instructions for the WQMP.

3.2.1 Surface Water Sample Collection

Surface water and outfall grab samples will be collected as specified in the WQMP Work Plan and/or according to the SOP.

3.2.2 Field Water Quality Measurements and Monitoring

Instantaneous water quality measurements (such as temperature, conductivity, and salinity) and depth data using field instruments will be collected as specified in the WQMP Work Plan and according to the standard operation procedures. All data generated is recorded for transfer to the project files.

3.3 Sample Handling and Custody (B.3)

Sample handling will be performed to collect, store, submit to the laboratory and obtain representative samples using methods as specified in the work plans and according to the SOPs. Sample containers, volumes, preservatives and holding times are summarized in Table 2-6. Proper sample handling and custody procedures will be employed as discussed in the following subsections of this QAPP.

3.3.1 Field Sample Custody

The objective of field sample custody is to ensure that samples are traceable and are not tampered with between sample collection and receipt by the analytical laboratory. A person will have custody of a sample when:

- The person is one of the authorized personnel;
- The sample is in their physical possession;
- The sample is in their view after being in their possession;
- The sample is in their personal possession and secured to prevent tampering; and
- The sample is in a restricted area accessible only to authorized personnel.

Field custody documentation will consist of both field log books and chain of custody forms.

Chain-of-Custody Forms

Completed chain-of-custody forms will be required for all samples to be analyzed. Chain-of-custody forms will be filled-out by the field sampling crew during the sample collection events. The chain-of-custody form will contain the following information for each sample:

- Unique identification number;
- Sample date and time;
- Sample description;
- Sample type;
- Sample preservation (if any);
- Analyses required.

The original chain-of-custody form will accompany the samples to the laboratory. Copies of the chain-of-custody form will be made prior to shipment for separate field documentation. The chain-of-custody forms will remain with the samples at all times. The samples and signed chain-of-custody form will remain in the possession of the sampling crew until the samples are delivered to the courier or to the laboratory.

Sample Packing and Shipping Requirements

Sample packaging and shipping procedures are designed to ensure that the samples and the chain-of-custody forms will arrive at the laboratory intact and together. Samples will be properly packaged for shipment according to the SOPs and submitted to the appropriate laboratory for analysis. Shipping containers will be secured with strapping tape and custody seals, if required, for shipment to the laboratory. The cooler is strapped shut with strapping tape in at least two locations.

All shipments will be accompanied by the chain-of-custody form identifying the contents. It is preferred that a separate chain-of-custody form be completed for and placed in each shipping container. The original form will accompany the shipment and copies will be retained by the sampler for the sampling office records.

3.3.2 Laboratory Sample Custody

Laboratory sample custody will be performed in accordance with the laboratory's Quality Assurance Manual (QAM), consistent with the guidelines set forth in this section of the QAPP, and/or compliance with laboratory accreditation requirements specified in 25 Pa. Code Chapter 252 .

The laboratory must have written SOPs for sample custody to protect the integrity of the samples, including, but not limited to:

- Sample receipt and maintenance of custody;
- Sample storage; and
- Sample tracking.

Sample Receipt and Maintenance of Custody

The laboratory shall have written procedures that document receipt of all sample containers and maintain chain of custody. Although a designated sample custodian responsible for receipt of samples is preferable, it is not required provided the laboratory has procedures for handling environmental samples, including

- Procedures for checking and recording the thermal and/or chemical preservative and sample container(s);
- Use of a record-keeping system that documents receipt of all sample containers that includes pertinent sample and laboratory information describing each sample; and,
- A sample acceptance policy that clearly outlines the circumstances that samples can be accepted or rejected. Departures from acceptable circumstances will be noted to be discussed with the Field Manager.

Sample Storage

After samples are received, they are placed in secure storage in accordance with the individual method requirements referenced by U.S. EPA or Standard Methods (e.g., maintained at less-than-or-equal-to six (6) degrees Celsius).

Consistent with 25 Pa. Code Chapter 252 and/or the National Environmental Laboratory Accreditation Program (NELAP), the laboratory will have documented procedures describing storage areas for samples in the laboratory, and steps taken to prevent sample contamination.

3.4 Analytical Methods (B.4)

The following section details the aspects of the analytical requirements, ensuring that appropriate analytical methods are employed. Appendix A includes the laboratory Quality Assurance Program and Appendix B includes the Standard Operating Procedures (SOPs) of the laboratory subcontractor. Table 2-6 summarizes the analytical methods to be used by the laboratory.

3.4.1 Parameter Specific Information

Table 3-1 displays the required container type, sample volume, preservation, and hold time for each parameter according to the previously referenced methods. The contract laboratory will provide sample containers from a commercial supplier. Sample containers will be new and pre-cleaned by the supplier. In addition, the contract laboratory will provide sample labels for each bottle and add the required preservative for each parameter, if necessary.

Table 3-1: Guidelines for Sample Container Preparation and Preservation.

Parameter	Container	Volume	Preservative	Holding Time
E. coli	Plastic	100 ml	$Na_2S_2O_3$	8 hours[1]
Fecal coliform	Plastic	100 ml	$Na_2S_2O_3$	8 hours[1]
Enterococcus	Plastic	100 ml	$Na_2S_2O_3$	8 hours[1]

Notes:
[1] The desired hold time, 8 hours, is shown in Table 3-1. Laboratory Chain of Custody Procedures

3.4.2 Laboratory Chain of Custody Procedures

Use of the chain-of-custody form will terminate when laboratory personnel receive the samples and sign the form. The laboratory custodian will open the sample coolers and carefully check the contents for evidence of leakage and to verify that samples were kept on ice. The laboratory will then verify that all information on the sample container label is correct and consistent with the chain-of-custody form. Any discrepancy between the sample bottle and the chain-of-custody form, any leaking sample containers, or any other abnormal situation will be reported to the Laboratory Manager or his/her designee. The Laboratory Manager will inform the Field Manager of any such problem, and corrective actions will be discussed and implemented.

3.4.3 Analytical Records

The analytical data results and a case narrative will be submitted by the contract laboratory to the Water Quality Monitoring and Modeling Project Manager in an electronic format within a specified time frame from the completion of each sampling event (dry and wet weather). A summary of the laboratory QC results (see Table 2-6 for QC measures and Table 4-1 for QC frequency) generated during the analysis of the samples will be submitted to the Water Quality

Monitoring and Modeling Project Manager in an electronic format. This file will include the accuracy (method blank, presence/absence control results) and precision (replicate RPDs) quality control results (e.g. +/-,and RPDs). Also, the laboratory will maintain copies of all bench sheets generated during the processing of these samples and data sheets that include sample identification information that can be provided as requested by LimnoTech for every sample analyzed.

3.5 Quality Control (B.5)

Analytical quality control will be performed in accordance with the specified analytical methods and as discussed under the Quality Objectives and Criteria Section of this QAPP.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance (B.6)

Field analytical equipment that may be used in this project includes instruments for measuring depth, salinity, conductivity, and temperature, and instruments for collecting water samples. These may be handheld instruments or autosamplers. Testing, inspection and maintenance will be conducted in accordance with manufacturer instructions. Preventative maintenance will be conducted as needed according to the SOPs.

Laboratory instrumentation and equipment testing, inspection and maintenance will follow manufacturer instructions and/or accepted procedures associated with the selected analytical methods, the laboratory's QAM and SAPs.

3.7 Instrument/Equipment Calibration and Frequency (B.7)

Calibration procedures for field equipment will follow manufacturer instructions. To maintain field precision and accuracy, the water quality instruments will be calibrated to known standards.

Laboratory instrument calibration will follow manufacturer instructions and accepted procedures associated with the selected analytical methods, the laboratory's QAM and SAPs.

3.8 Inspection Acceptance of Supplies and Consumables (B.8)

All supplies and consumables for field and laboratory activities will be inspected for compliance with the acceptance criteria by the identified responsible party prior to use. Supplies or consumables not meeting the acceptance criteria upon inspection will not be used. Supplies and consumables will be stored in accordance with individual method requirements referenced by U.S. EPA or Standard Methods.

3.9 Data Acquisition Requirements (Non-direct Measurements) (B.9)

Non-direct measurements will not be used in implementation of the monitoring program.

As described in Section 2.4.2.3, LimnoTech will evaluate multiple CSO control alternatives using the EFDC Water Quality Model. These activities will involve the use of secondary data from

multiple sources, including federal and state databases, peer-reviewed papers, and modeling results. Many of the state and federal datasets have undergone rigorous QA/QC prior to being released for public use. Other data comes from peer-reviewed sources that have also undergone internal QA/QC checks. LimnoTech has extensive experience in dealing with these types of data sources and will review and document the data sources, quality, completeness and appropriateness for use of all data to be considered for this project prior to their use in developing the Water Quality Model.

As described in Section 2.4, the data to be used for this project will be judged acceptable for their intended use if they conform to the DQOs and criteria. Data will be:

- accepted if they pass the screening criteria;
- qualified if the data do not pass the initial screening but the discrepancy is within the range of uncertainty for a given analytical method; or
- rejected.

Limitations in non-direct measurements identified through application of the acceptance criteria will be addressed by either using the data while identifying the implications of its limitations on the study results or, for non-critical non-direct measurements that do not pass acceptance criteria, conducting the tasks or analyses without the use of those non-direct measurements. Any limitation to the use of data and subsequent interpretation of study results will be reported in the final project report.

3.10 Data Management (B.10)

Data generated through field and laboratory activities will be used for developing models and reports. Reporting formats will vary depending on the purpose for which the data has been assembled. The Water Quality Monitoring and Modeling Project Manager has the responsibility of maintaining documents and data associated with field programs. The Laboratory Manager has the same responsibility for laboratory data and information.

3.10.1 Field Data and Information Management

Field data reporting shall be conducted principally through the transmission of data sheets containing tabulated results of all measurements taken in the field, and documentation of all field calibration activities. Copies of the field logs will be turned over to the Field Manager following each monitored event. Following review by the Field Manager, the field logs will be transmitted to the Quality Assurance Officer (QAO) for review and inclusion in the project's data management system. The QAO will transmit the field sheets to the appropriate Project Manager for his/her keeping after their review. Specific QA/QC procedures, including data and records management and QA audits, will be conducted according to the SOPs.

3.10.1.1 Field Logs

The field logs will serve as a daily record of events, observations, and measurements during field activities. All information pertinent to sampling activities will be recorded in field logs. Personal computers may also be used to record field data. Field logs will be maintained by field staff at all times documenting activities and conditions. A copy of the field logs will be turned in by field staff following each monitored event. Copies of all field logs will be made following each monitored event and maintained in the QA/QC project file. Field logs will include the following:

- Names of field crew and specifically the author of the field log
- Date and time of the sample round beginning and ending
- Location of sampling activity
- Date and time of sample collection
- Sample identification numbers
- Field measurements
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, stream flow description, etc.)

3.10.1.2 Equipment Logs

As installation, calibration and maintenance functions are completed on equipment, equipment logs will be maintained and included in the QA/QC project file.

3.10.1.3 Field On-Site Measurements – Data Sheets

Field measurement information recorded in the field log book will be compiled and the information transferred into electronic format by office staff. The Field Manager will review the source document and the electronic version to verify the accurate transfer of information. Following this review, electronic field data will be transferred to the QAO for review, then to the appropriate Project Manager for his/her keeping. The original data sheets will be maintained in the QA/QC project file.

3.10.2 Laboratory Data and Information Management

The reporting of laboratory data will begin after the Laboratory Manager or designee has concluded the verification review. The contract laboratory will prepare and submit full analytical and QC reports to the Project Manager that will include the following, as appropriate.

- Case narrative, including a statement of the conditions that samples were received, description of any deviation from standard procedures, explanation of any data qualifiers used, and identification of any problems encountered during analysis.

- Computer-generated report form containing all sample results in the forms of
  - a hard copy version of the report, and
  - an electronic version of the report.
- Hard copy and electronic QC summary report for each parameter by batch including the results of replicates, matrix spikes, matrix spike duplicates, controls, dilution blanks, method blanks, verification tests, etc.
- Copies of all laboratory bench sheets (upon request).
- Copies of all chain-of-custody forms.

Following receipt of laboratory data by the Project Manager, the data will be reviewed and validated by the Quality Assurance Officer following the procedures outlined in Section 4.

3.10.3 Electronic Data Management

All data collected during the course of the study will be entered into a database by LimnoTech for use in the modeling tasks. LimnoTech will manage and maintain the database. All electronic files will be backed up on a regular basis. At the conclusion of the project, relevant information, project files and electronic data will be turned over to Greeley and Hansen. The files will be archived for a minimum of ten years.

3.10.4 Model File Management

Data used during the project will be maintained in electronic format in a centralized project database. Manipulation of the downloaded data is identified as one of the major preventable error sources in the project effort. User-induced error can be identified and corrected under an appropriate level of QA/QC. Multiple steps will be taken to ensure errors are minimized. Data formatting will be reviewed, including the data element type, format, allowable values and ranges, and other parameters. Any manually entered parameter values from paper sources will be evaluated by reviewing hard copy printouts. The review will include a comparison of the original data sources and paper documentation. Any record identified as having issues will be reviewed to determine whether corrected data can be acquired or the record omitted. The project database will be used as a central repository for the data that will be used in model development and calibration.

The management of model code, input files, and output will be handled electronically. All input files are either contained within a specified format in a text file, or contained in an Excel file that is used to keep track of key time series forcing functions. Each set of model runs (input/output files) will be contained within a unique folder identified by a run ID. A log of every model run will be documented and maintained by LimnoTech, and will be a part of the project records. The run log will identify the run and include a brief description of the specifics of the model run.

3.10.4.1 Hardware/Software Configuration

The EFDC Water Quality Model is available as a Windows platform compatible executable. The minimum requirements of the model are easily met by any modern desktop PC. The input files required to run the model are contained in simple text files that can be viewed or edited with any simple word processing software (e.g. Notepad or Wordpad). Pre- and post-processing capabilities are available through several Microsoft Excel files. Any recent Microsoft Excel software (Excel 2007 or later) is capable of viewing and editing the additional processing files. The pre- and post-processors facilitate the writing and reading of the input and output files. In this configuration two copies of the model inputs and results always exist (in the text file and in the Excel file).

LimnoTech use a Microsoft Outlook-based email server for secure electronic communications, and secure access to networked file storage devices is provided for remote employees through the use of Virtual Private Network (VPN) protocols. These means of electronic communications and connectivity (for file transfers and backup) are expected to be secure for the needs of this project. No additional security measures are planned at this time.

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Section 4 Assessment and Oversight (Group C)

The Group C Assessment and Oversight elements are addressed in this section.

4.1 Assessment and Response Actions (C.1)

Internal quality control checks are performed to ensure that the field and laboratory generated measurements meet the project quality assurance objectives. In addition, the quality control checks are intended to identify any need for corrective action.

The EFDC Water Quality Model will be specifically developed to investigate CSO control alternative scenarios for the waterways tributary to the DELCORA service area. The development, calibration, and validation of the EFDC Water Quality Model will be performed as part of this project, as described in the preceding sections of this QAPP.

If potential quality assurance issues are identified following model calibration and/or scenario application, corrective actions required to address these issues will be performed by the modeling team. The LimnoTech Water Quality Model Task Leader and Project Manager will be responsible for ensuring that identified corrective actions are implemented. The modeling team will document these activities as they occur, and the information will be maintained by the project team. This documentation will be included in the project records.

The LimnoTech Water Quality Model Task Leader and Project Manager will review the modeling work conducted for this project, including model results and documentation of the modeling effort to ensure that a scientifically credible product is produced. The modeling team will address technical issues identified from these reviews.

If the review results in detection of unacceptable conditions or data, the LimnoTech Water Quality Model Task Leader will be responsible for developing and initiating corrective action. Staff will be notified if the nonconformance relates to their work. Corrective response actions may include review or validation of data, performing additional model runs, or editing and modifying report deliverables. Determination of the appropriate corrective response will be coordinated by the LimnoTech Project Manager and Water Quality Model Task Leader. Decisions will be documented in the Water Quality Report. LimnoTech will meet all QA requirements prior to approval of the final deliverables.

4.1.1 Field Measurements

Field quality control checks will consist of QA/QC samples that will be collected or prepared by the field crews to be submitted for laboratory analysis. These samples will consist of duplicates/replicates, and field blanks. Each sampling crew will collect a field duplicate per sampling crew, and blanks will be collected at a frequency of one blank per sampling crew during each sampling event. The acceptable control limits are discussed in Section 2.4. Upon receipt of

the data from the monitored event, the Field Managers will assess the adequacy of the quality control checks and identify any problems.

Quality control checks will be conducted in advance of using multi-parameter meters. The checks will involve the review of the previous calibration sheets. Any problems with sensors will be addressed immediately. The result of each review will be recorded on the instrument's calibration sheet. At the conclusion of each monitored event, all calibration sheets will be reviewed by the Field Crew Manager and the Field Manager to assess the adequacy of the quality control checks and to review the instrument's performance to identify any problems.

The Field Manager will inform the Monitoring Task Manager and the Project Manager in writing of any quality control check issues and to discuss corrective actions. All quality control documents will be contained in a file for each monitored event.

4.1.2 Laboratory Measurements

The contract laboratory will perform quality control checks as described in this QAPP. These will include replicates, control samples, and method blanks as appropriate. Quality control procedures for analytical services will be conducted by the contract laboratory in accordance to their standard operation procedures and the individual method requirements referenced by U.S. EPA or Standard Methods. The acceptable control limits for this project are discussed in Section 2.4. The Laboratory Manager or designee will inform the QA/QC Manager immediately of any quality control check issues and to discuss corrective actions.

At the conclusion of each monitored event, the contract laboratory will provide a summary of all QA/QC results. The QA/QC summary will be reviewed by the Laboratory Manager or designee and the QA/QC Manager to assess the adequacy of the quality control checks and to identify any potential problems. Table 4-1 summarizes the laboratory quality control check frequencies.

Table 4-1: Laboratory Quality Control Check Frequencies.

Parameter	QC Check	Frequency
E. coli	Positive/Negative Controls[1]	See footnote 1
	Replicate[3]	20 samples[3]
	Method Blank[2]	See footnote 2
Fecal coliform	Positive/Negative Controls[1]	See footnote 1
	Replicate[3]	20 samples[3]
	Method Blank[2]	See footnote 2
Enterococcus	Positive/Negative Controls[1]	See footnote 1
	Replicate[3]	20 samples[3]
	Method Blank[2]	See footnote 2

Notes:

[1] The frequency for analysis of the bacteria controls can be done at the option that occurs most often: 1) new media lot; 2) one set per event; 3) one set per month.

[2] Method blank frequency depends on the analytical method but the recommendations include, to the extent applicable: 1) check of dilution water; 2) when a low concentration sample (e.g. Delaware River) is analyzed using the same filter apparatus after a high concentration sample (e.g. CSO or SW sample); 3) at the start of a new batch of samples.

[3] When sample volume allows, the replicate should be a DELCORA sample.

4.1.3 System Audits and Technical Reviews

All project team members are committed to providing quality services. The primary responsibility for the quality of work products rests with the individuals doing the work and with their immediate supervisors.

For certain project components an independent technical reviewer will audit or review the work products. This reviewer may be the Monitoring Task Manager or a consultant team member not directly involved with the work being audited. The independent technical reviewer will perform a critical, written evaluation of the work product, and the independent technical audit or review will be incorporated in the project record.

The Monitoring Task Manager is responsible for identifying the work products to be audited/reviewed and the scope of the audit/review, for scheduling independent technical audits/reviews, for assigning competent, qualified independent technical auditors/reviewers, and for making sure that appropriate follow-up actions are taken to correct reported deficiencies.

4.1.3.1 Field System Audits

Field system audits will be completed to ensure that the actual field procedures conform to those documented in the SAP and associated SOPs. The Project Manager or designee will perform the

field system audits. The audit will include a check of all field records and a review of all activities to document if procedures were conducted in compliance with the specified documentation.

4.1.4 Corrective Action

Corrective actions will be implemented as required to rectify problems identified during the course of normal field and laboratory operations. Possible problems requiring corrective action include:

- Equipment malfunctions;
- Analytical methodology errors; or
- Non-compliance with quality control systems.

Equipment and analytical problems that require corrective action may occur during sampling and sample handling, sample preparation, and laboratory analysis.

For non-compliance problems, steps for corrective action will be developed and implemented at the time the problem is identified. The individual who identifies the problem is responsible for immediately notifying the Field Manager.

Any non-conformance with the established quality control procedures outlined in the QAPP will be identified and corrected. The Field Manager will issue a Corrective Action Memorandum for each non-conformance condition. All non-conformance memoranda will be discussed in the final report submitted to the Project Manager.

4.1.4.1 Field Measurements and Sample Collection

Project staff will be responsible for reporting any suspected QA non-conformance or deficiencies to the Field Manager. The Field Manager will be responsible for assessing the suspected problems in consultation with the Monitoring Task Manager to review the sampling protocols and provide additional training if necessary. If it is determined that the situation warrants a corrective action, then a Corrective Action Memorandum will be issued by the Field Manager.

The Field Manager will be responsible for ensuring that the corrective action for non-conformance takes place by:

- Evaluating all reported incidences of non-conformance;
- Controlling additional work on nonconforming items;
- Determining what corrective action is needed;
- Maintaining a log of non-conformance issues;
- Reviewing responses to corrective action memoranda;
- Ensuring that copies of corrective action memoranda and responses are included in the project files

No additional work will be performed until appropriate corrective action has been implemented and documented in response to the corrective action memoranda.

4.1.4.2 Laboratory Analyses

Corrective actions are required whenever laboratory conditions, instrument malfunction or personnel situations have led or could potentially lead to errors in the analytical data. The corrective action taken will be dependent on the analysis and the event.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the acceptable range for precision and accuracy as identified in Section 2 ;
- Blanks contain target analyses above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- Excessive interference is noted; or
- Deficiencies are detected by the QA staff during laboratory system audits as described in Section 4.1.3.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, and instrument sensitivity, etc.

Corrective action taken within the laboratory is the responsibility of the Laboratory Manager who informs the Monitoring Task Manager when a problem occurs and of the steps taken to resolve the problem. All non-conformance memoranda initiated by the contract laboratory will be discussed in the case narrative or included in the laboratory reports.

4.2 Reports to Management (C.2)

The Monitoring Task Manager and Laboratory Manager provide independent reporting to the Project Manager on an as needed basis. This communication is facilitated through the use of electronic mail, which provides ready access. In addition, the team leaders will provide written reports to the Project Manager on quality assurance issues as described in the QAPP.

Field and laboratory system audits will be performed as described in Section 3.1.3 and the results will be provided to the Project Manager. The results of all audits will be summarized in written reports, with copies retained in the Project Files. The audit reports will be completed for field and laboratory system audits according to the general outline described below.

All audit reports will include the following sections:

- Introduction – provides background of the project, laboratory, or program element, description of personnel and affiliation of all staff involved, the name of the auditor, the time and date of the audit, and a description of the activities audited.

- Audit Findings – describes the results of the audit including a deficiency report identifying all instances where the procedures in the SAP, QAPP, or laboratory QAM were not followed.
- Conclusions – summarizes the results of the audit and includes recommended actions to address any noted deficiencies.

The delivered documents and associated data will be accurate, complete, and traceable. The LimnoTech Water Quality Model Technical Leader and Project Manager will also provide independent reporting via emails on quality assurance issues to Greeley and Hansen and DELCORA on an as needed basis. Communication will be initiated concerning any of the following:

- Adherence to project schedule and budget;
- Any deviations from the QAPP;
- Potential uncertainties in decisions based on model predictions and data; or
- Data quality assessment findings regarding input data and model outputs.

Monthly project status reports will be prepared and delivered with monthly invoices. The status reports will describe (by task) activities during the previous month, and upcoming anticipated activities. The Water Quality Model report will document all aspects of the project.

Section 5 Data Validation and Usability (Group D)

The Group D Data Validation and Usability elements are addressed in this section. The purpose of these elements is to determine if the data meet the project's Data Quality Objectives (DQOs) (validation) and to evaluate the data against the method, procedural and/or contractual requirements (verification). Data validation, verification, and usability assessment will be conducted as outlined in this QAPP.

The data generated from the sampling program will be subjected to a multi-tiered review process described below. This process includes:

- A review of the data at the bench and field levels;
- A secondary review of field records by the Field Managers and analytical results within the laboratory by the QA/QC Manager to verify the data against method and SOP requirements;
- A screening level review of the verified data by the Monitoring Task Manager for reasonableness and to identify obvious data anomalies;
- A validation by an objective third party; and finally,
- An assessment of the data by project team members for its usability in the project as described in Section 5.1 of this QAPP.

5.1 Data Review, Verification and Validation (D.1)

All environmental measurement data collected by project staff will be subjected to quality control checks before being utilized in the interpretive reporting. A data generation system that incorporates reviews at several steps in the process is designed to protect the integrity of the data and reduce the number of data that do not meet the DQOs or the project goals. This section describes the requirements of each review step that will be used in this project.

5.1.1 Data Verification Requirements

The definition of data verification, as described in the EPA's "Guidance on Environmental Data Verification and Data Validation" (EPA QA/G-8) is:

> "…the process of evaluating the completeness, correctness, and conformance/compliance of a specific dataset against the method, procedural or contractual requirements."

Data verification will occur at the field and laboratory level as described in Section 2.4. This section describes the requirements of the data verification.

5.1.1.1 Field Activities Data Verification

The Field Manager will be responsible for ensuring that the samples are collected and handled according to the procedures specified in the Water Quality Monitoring Work Plan. Sample collection verification will include confirming that the samples were collected with the proper equipment at the appropriate locations with the appropriate frequency. Sample handling verification will include confirming that the samples were stored in the appropriate containers (see Table 3-1) with the correct preservative, that the samples were stored at the proper temperature during transport from the field to the laboratory, and that all of the appropriate information is logged on the chain-of-custody records.

5.1.1.2 Lab Activities Data Verification

The laboratory QA/QC Manager will be responsible for verification of laboratory-generated data, although the laboratory SAPs for each method require some components of the verification to also be conducted at the bench level. Laboratory verification will include assessing that the procedures used to generate the data are consistent with the method requirements as specified in the laboratory's SOPs and that the QA/QC requirements for each method are met. Examples of method requirements include verifying the calibration and data reduction procedures. However, these requirements vary by analyte and are presented in more detail in the laboratory's QAM and SOPs (Appendices A and B, respectively). Once the data have been verified and approved by the laboratory, they will be released to the Monitoring Task Manager.

5.1.2 Data Review Requirements

The Field Manager will perform data reviews consisting of screening the field and laboratory data sheets according to established criteria listed in this section. If the established screening criteria are violated, an additional review of the quality control checks and any relevant laboratory bench sheets will be conducted. The investigation of the issue will be documented and the data will be discarded or flagged appropriately, identifying the limitations of the data. This is an additional step of review that is designed to provide an early assessment of the data's use in meeting the project goals by evaluating it within the context of well-understood constituent relationships.

5.1.2.1 Field Data Sheet Reviews

The following criteria will be used to screen the recorded physical parameter measurements:

1. Salinity readings – do values seem reasonable?
2. Temperature readings – do values seem reasonable?
3. Conductivity readings – do concentrations seem reasonable?

5.1.2.2 Laboratory Data Sheet Reviews

The following criteria will be used to screen the analytical measurements performed by the contract laboratory:

1. Equipment blanks – are values less than detection limits?
2. Method blanks – are values less than detection limits?
3. Field blanks – are values less than detection limits?
4. Review of all values – do concentrations/densities seem reasonable?

5.1.3 Data Validation Requirements

The purpose of data validation, as described in the EPA's "Guidance on Environmental Data Verification and Data Validation" (EPA QA/G-8) is:

> "…an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance to determine the analytical quality of a specific data set."

According to U.S. EPA guidance, the data validation is typically performed by someone independent of the project activity and not associated with the organization responsible for producing the dataset. However, the data validator needs to be familiar with both the data validation requirements and the project objectives. The identified QAO from LimnoTech will conduct the data validation.

The first requirement in this project's data validation is to inspect the data verification and review records to ensure that no oversights were made during that process. The second requirement of the data validation is to evaluate the data against the project's DQOs, which are presented in Section 2.4. If data do not meet one or more of the DQOs, the data validation process will include an investigation into causes and an assessment of the impact of the noncompliant data on project objectives. The third requirement of the data validation is to evaluate the data in the context of the project's overall objectives, which are described in Section 2.1. The fourth requirement of the data validation is to communicate the data validation results to the rest of the project team.

5.2 Verification and Validation Methods (D.2)

All environmental measurement data and samples collected by project staff will be subjected to quality control prior to being entered into the project database. This is a multi-step process where the laboratory QA/QC Manager will have primary responsibility for verifying the data and a third party, who is not involved in the data collection or analysis, conducts the data validation. These steps are described in more detail in the following sections.

5.2.1 Data Verification

This section describes the procedures that will be utilized in this project for verifying the data against method, procedural and/or contractual requirements.

5.2.1.1 Field Activities Data Verification

Individual crew leaders will verify the completion of their field data sheets and chain-of-custody forms. In addition, crew leaders will also verify the proper calibration and operation of their multi-parameter instruments. At the completion of each monitored event, the Field Manager will review all field data sheets, calibration sheets, and chain-of-custody forms for accuracy and completeness. The Field Manager will also verify that monitoring QA objectives for all accuracy, precision, completeness, and adherence to the required collection techniques are being met.

5.2.1.2 Laboratory Analytical Results Verification

Individual analysts will verify the completion of the appropriate analytical test and required bench sheets. The Laboratory Manager or designee will review calculations and inspect laboratory bench sheets and log books daily to verify their accuracy, completeness, and adherence to the specified analytical method protocols. Calibration and QC data will be examined daily by the individual analyst. The Laboratory Manager or designee will verify that all instrument systems are under control and that QA objectives for accuracy, precision, completeness, and adherence to the required detection limits are being met.

A summary of all QA/QC results and any non-conformance issues will be included in the laboratory deliverable to the Field Manager.

5.2.2 Data Validation

This section describes the process that will be used to validate the data generated for this project. The first requirement in this project's data validation is to inspect the data, verification and review records to ensure that no oversights were made during that process. A complete set of field and laboratory information will be provided to the data validator for this task. The data management components described in Section 3.10 will be sufficient for this purpose.

The primary objective of the data validation in this project is to evaluate the data against the DQOs presented in Section 2.4. These DQOs include criteria for accuracy, precision, completeness, representativeness, comparability and compliance with required detection limits. The data management components described in Section 3.10 will provide the necessary information to make this evaluation. The following must be checked as part of the measurement data and analytical data validation activities.

1. field measurements data collection
2. field sample collection

3. sample custody
4. laboratory analytical results and case narrative
5. data reviews
6. quality control data

The QAO will conduct a systematic review of the data for compliance with the established quality control criteria based on duplicate, replicate, spiked, control, and blank data results provided by the laboratory. In addition, quality assurance evaluations of data accuracy, precision, and completeness will be performed on the field measurement data and the laboratory analytical results for each monitored event. The data validation qualifiers listed in Table 5-1 will be used when validating the data:

Table 5-1: Data Validation Qualifiers

Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.
J	The associated value is an estimated quantity.
R	The data are unusable (note: analyte may or may not be present)
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

If quality control checks or objectives were not met, an investigation of the non-conformance will be initiated by the QAO with the project team personnel, including the Field Manager, the laboratory QA/QC Manager, and the Project Manager. The non-conformance will be documented and the affected data set will be flagged appropriately, identifying any limitations.

Another objective of the data validation is to evaluate the data within the context of the project goals. As described in Section 2, these goals include providing datasets that can be used to develop model inputs, to calibrate and validate the models, and to ensure consistency among different sources of data. Suitable datasets for the modeling portion of this project will be based on the data quality assessment described above as well as an assessment of the spatial and temporal extent of the sample collection. Comparability with other sources of data will be evaluated by comparing and, if necessary, plotting the data with previously collected data to identify outliers or anomalous values.

The data validation results will be communicated to the project team in the form of a summary table that lists the validation tasks performed and the associated results and conclusions. If the validated dataset includes non-compliant data, this data will be addressed in a memo that accompanies the summary table. Data qualifiers assigned to the data during validation will be maintained in the project database to ensure communication of validation results with current and future data users.

5.3 Departures from Validation Criteria

This section describes the process to assess the usability of model results. All interim and final model results will be evaluated by the LimnoTech Principal Investigator.

Criteria will be established to decide whether to accept, reject, or qualify the data collected for the project and generated by the model. This work is done by adopting validation and verification criteria. Validation criteria specifies whether data satisfy user requirements, and verification criteria determine if data are sufficient for drawing data quality conclusions and project objectives. For all data, sufficient metadata must be available to allow persons unfamiliar with the data to make intelligent use of them. All data will be reviewed for usability, general quality, and consistency with other available data sources, prior to use in the modeling activities. Limitations in the data sets will be acknowledged and included in discussions of their use. All data entered manually or electronically will be confirmed by checking the source data.

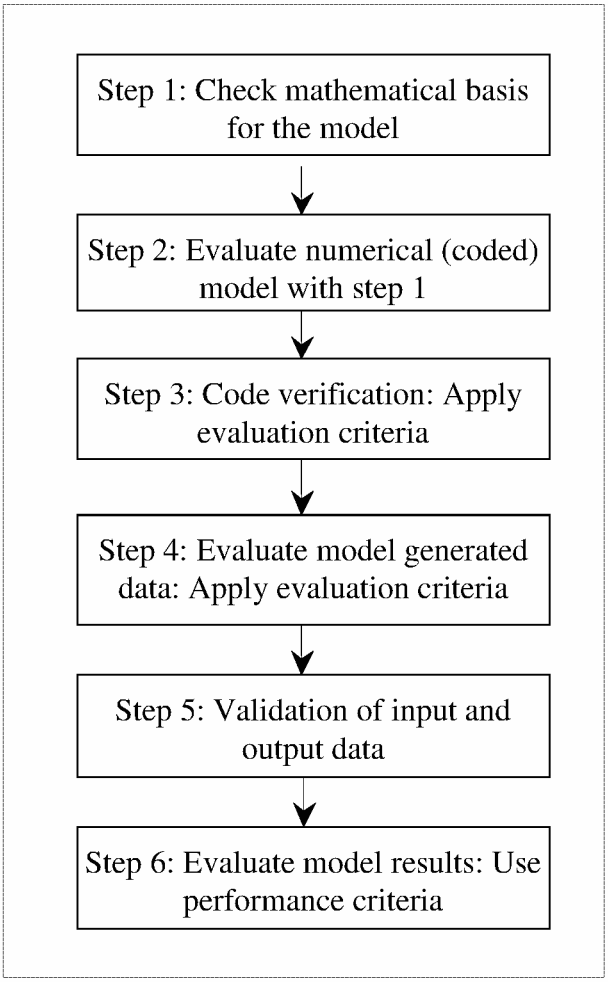
Qualified data will be examined on a case by case basis relative to including it in calculations. The decision to include qualified data will depend on a sensitivity analysis of the effect of uncertainty in the data on the calculation outcome. The data review and compilation task will be performed by experienced personnel.

With regard to the use of data in the modeling, each data set will be categorized according to validation criteria into different groups by its usability, as described in Section 3.2. The categories will include:

- Accepted (results can be used without any restrictions);
- Qualified (acceptable under certain conditions) – the team will specify conditions and provide the validation and usability of the results to satisfy the project objectives; and
- Rejected (cannot be used; will identify the problems and reasons for unsuitability).

The acceptance criteria for the modeling process includes evaluation of the model at various stages of the process as described in Figure 5-1. Model simulations will be compared with an independent data set that was not used for model development and model calibration purposes. Evaluations will be done by comparing plots of data and model predictions. These plots will not only provide the quantitative estimates, but will also provide qualitative assessments. As information is passed from one step of the modeling process to another, different assessments will be planned to determine if they are acceptable to pass on to the next phase. The individual assessments of the steps identified in Figure 5-1 will provide the basis of the overall assessment. The modeling team will discuss all issues identified pertaining to these criteria, alert the LimnoTech Project Manager and Water Quality Model Technical Leader about any identified issues, and will document any procedures used to resolve them. In general, judgments on the accuracy of the model results will be made by comparing the simulated results with previous results that have been peer reviewed, and with observed trends in the data. If the model results do not compare well, the inputs will be reexamined and the model will be run with adjusted inputs if needed.

Figure 5-1: Criteria for Various Stages of Modeling Process



All project deliverables will undergo in-house review and validation by project staff, review by the Field Manager Task Leader, Water Quality Model Task Leader and the Project Manager, and review by Greeley and Hansen.

5.3.1 Validation Methods

The model input data and model results will undergo extensive review for quality control by the project staff, Principal Investigator and Project Manager. As described in Section 4.1, model runs that are used to generate final results will be compared against model results from previous scenario runs to ensure consistent results. Any deviations from previous model runs will be noted and investigated to ensure that the model predictions are accurate and reasonable.

Data used for inputs will be evaluated for adequacy in terms of the common data quality indicators, such as precision, accuracy, comparability, representativeness, and completeness. Judgments on the accuracy of the data will be checked by comparing the data trends and by comparing data with any historical data available. Each data set will be categorized in different groups by its usability, as described in Section 2.4.

The project team is responsible for establishing and maintaining the QA/QC processes outlined in this QAPP to ensure the quality of the project data. The modeling team will discuss all the issues identified pertaining to available data, alert the LimnoTech Project Manager, Water Quality Monitoring and Modeling Task Leaders and Quality Assurance Manager about any identified issues, and will document in the final report the procedures used to resolve them.

5.3.2 Reconciliation with User Requirements (D.3)

Once all field measurements and analytical data have been reviewed, quality control measures assessed, and any problems addressed, the measurement and analytical data will be assessed.

The assessment of the information generated from the monitoring program will be initiated by entering all analytical data and field measurement data into the project database. In addition, precipitation, flow data, velocity data, stage data, field notes, and information on any sampling anomalies will be appended. All of these data will be evaluated and any relationships or correlations will be noted. The compilation of all information surrounding a sampling and/or monitoring event will be available to facilitate reconciliation with user requirements. Ultimately, these data will be used in the development of the watershed and water quality models.

The modeling staff, which includes the LimnoTech Project Manager, Water Quality Model Task Leader and Quality Assurance Manager, will review the model results, incorporating the uncertainty in model predictions, and will check model predictions for reasonableness and relevance based on observed data. The model development and testing are intended to ensure that if the step to develop the cause-effect relationship meets its own internal quality standards, the output of this step (i.e., the output of modeling framework) will meet the requirement for the entire project. Therefore, if the model outputs meet the internal criteria for establishing the cause-effect relationships, as described in this plan, requirements for the overall modeling framework will be met.

Section 6 References

United States Environmental Protection Agency (USEPA), 1998. EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5. Washington, DC.

United States Environmental Protection Agency (USEPA), 2001. EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5. Washington, DC.

United States Environmental Protection Agency (USEPA), 2002a. Guidance on Environmental Verification and Data Validation. EPA QA/G-8. Washington, DC.

United States Environmental Protection Agency (USEPA), December 2002b. Guidance for Quality Assurance Project Plans for Modeling. Office of Environmental Information. Washington, DC. EPA QA/G-5M. EPA/240/R-02/007.

United States Environmental Protection Agency (USEPA), 2009. Council for Regulatory Environmental Modeling (CREM), 2009. Guidance on the Development, Evaluation, and Application of Environmental Models. EPA/100/K-09/003. March 2009. United States Environmental Protection Agency, Office of the Science Advisor, Washington D.C. URL: http://www.epa.gov/crem/library/cred_guidance_0309.pdf

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APPENDIX A

EuroFins QC Laboratory Quality Assurance Program

Eurofins QC, Inc. UNCONTROLLED DOCUMENT
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QUALITY SYSTEMS MANUAL

Environmental Division

REVISION 26

November 2015

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NELAP ACCREDITED TNI LABORATORY

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1.0 APPROVAL OF IMPLEMENTATION

1.1 The personnel listed on Page 1 of this document authorize the implementation of the management of this Quality Systems Manual (QSM).

2.0 TABLE OF CONTENTS

2.1 Refer to Page 2.

3.0 INTRODUCTION AND SCOPE

3.1 Introduction

3.1.1 On May 1, 2015, QC Inc. was acquired by Eurofins Scientific, a global laboratory company based in Europe, and the Company became Eurofins QC, Inc. (EQC), a solely-owned subsidiary of EQC Holdings, Inc., incorporated in the State of Delaware.

3.1.2 EQC was originally founded in 1943 as a dairy testing lab, and since that time, the Company has evolved into a full-service environmental laboratory. The Company has also expanded its product offerings to include food and pharmaceutical testing. Food, dairy, and pharmaceutical operations (collectively referred to as Life Sciences) are now located at the laboratory facility in Horsham, PA. Operations at the Southampton facility consist primarily of environmental laboratory testing and associated support functions. EQC provides analytical services to support testing under the Clean Water Act (CWA) through the National Pollution Discharge Elimination System (NPDES) and the Safe Drinking Water Act (SDWA). EQC supports homeowners and public water suppliers through the analysis of potable water governed by the National Primary and Secondary Drinking Water Regulations (SDWA), the Private Well Testing Act (PWTA) of New Jersey, and other state regulations. Laboratory testing also supports site assessments, hazardous waste determinations, remedial investigations, and other characterizations regulated by Resource Conservation and Recovery Act (RCRA), Toxic Substance Control Act (TSCA), and other state, Federal, or private programs. Accreditations held by EQC are listed in Table 1. The foremost goal of the laboratory is to provide analytical data of the highest quality that are complete, accurate, legally-defensible, and produced in an ethical and timely manner.

3.1.3 EQC also operates satellite facilities in Horsham, PA; East Rutherford, NJ; Vineland, NJ; Wind Gap, PA; Reading, PA; and New Castle, DE.

3.2 Scope

3.2.1 The QSM, previously titled Quality Assurance Program Plan (QAPP), describes measures taken to ensure that laboratory data of known and acceptable quality are provided in compliance with all regulatory requirements. More detailed procedures are contained in the laboratory's Standard Operating Procedures (SOPs), which include operation, maintenance, and quality control procedures practiced routinely in the laboratory. The QSM and SOPs function together to assure laboratory analysis of the highest quality.

3.2.2 Satellite facilities are maintained in strategically-located areas (see Section 3.1.2) and serve primarily as intermediate transfer points for samples en route to the Southampton laboratory. Samples are transferred from satellite facilities to the testing laboratories according to procedures described in SOP QC0432 (Sample Transfers between EQC's Satellite Offices and the Southampton Laboratory) and SOP QC0889 (Sample Handling Details: Addressing Sample Movement from the Field or Deliveries to the Satellite). Satellite facilities also maintain accreditation for a limited number of microbiological and field testing parameters. The EQC-Delaware satellite location is accredited for microbiological and general chemistry parameters.

3.2.3 The QSM, SOPs and other documents referenced in this manual apply to the Environmental Division laboratory operations at EQC-Southampton and its satellite facilities. A separate QSM covers Life Sciences operations at EQC-Horsham.

3.3 References

3.3.1 TNI Standard, adopted by NELAP Board on September 8, 2009.

3.3.2 Environmental Laboratory Accreditation, PA Chapter 252, April 2010.

3.3.3 Regulations governing the certification of laboratories and environmental measurements, NJ AC 7:18, November 2006.

3.3.4 *Manual for the Certification of Laboratories Analyzing Drinking Water*, Criteria *and Procedures Quality Assurance*, January 2005, EPA 815-R-05-004 (CLADW); and *Supplement 1 to the Fifth Edition of the Manual for the Certification of Laboratories Analyzing Drinking Water*, June 2008, EPA 815-F-08-006.

3.4 Glossary and Acronyms

AA	Accrediting Authority
ANSI	American National Standards Institute
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
°C	degrees Celsius
CAS	Chemical Abstract Service
CCV	Continuing calibration verification
COC	Chain of custody
DO	Dissolved oxygen
DOC	Demonstration of Capability
IDOC	Initial Demonstration of Capability
EPA	Environmental Protection Agency
g/L	grams per liter
GC/MS	Gas Chromatography/Mass Spectrometry
ICP-OES	Inductively Coupled Plasma Optical Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
ICV	Initial calibration verification

ISO/IEC	International Organization for Standardization/International Electrochemical Commission
lb/in2	pound per square inch
LRB	Laboratory Reagent Blank
LCS	Laboratory control sample
LFB	Laboratory fortified blank
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MDL	Method detection limit
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
MS	Matrix spike
MSD	Matrix spike duplicate
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
PT	Proficiency Test(ing)
PTOB	Proficiency Testing Oversight Body
PTPA	Proficiency Testing Provider Accreditor
QA	Quality Assurance
QC	Quality Control
QSM	Quality Systems Manual
QAM	Quality Assurance Manager
r	Correlation coefficient
RL	Reporting level
RPD	Relative percent difference
RSD	Relative standard deviation
SOPs	Standard operating procedures
TNI	The NELAC institute
µg/L	micrograms per liter
UV	Ultraviolet
VOC	Volatile organic compound
WET	Whole effluent toxicity

4.0 ORGANIZATION

4.1 Laboratory Organizational Structure

4.1.1 EQC's organization chart structure is shown in Figure 1. Floor plans of EQC's major laboratory facilities are shown as follows: Figures 2A and 2B (EQC-Southampton, PA facility), Figure 2C (EQC-Horsham, PA facility), and Figure 2D (EQC-Delaware, New Castle facility).

4.2 Responsibility and Authority

4.2.1 Support for the overall system is provided by management through the allocation of material and human resources as needed. Implementation of the quality systems described in this manual is an operational responsibility for all employees. Laboratory managers and analytical personnel are trained in the

applicable procedures and decision-making processes for which they are responsible. General oversight of the program rests with the Quality Assurance Director who reports directly to the President. Responsibilities of key personnel are described in Section 20.0 (Personnel).

5.0 MANAGEMENT

5.1 Introduction

5.1.1 The laboratory's quality management system includes documentation of policies and procedures necessary to assure the quality of the test results.

5.2 Quality Policy

5.2.1 EQC is committed and dedicated to providing analytical data of the highest quality to its clients. Data produced and reported must meet the requirements of its clients and also comply with the letter and spirit of regulations and guidelines promulgated by various municipal, state, and federal agencies. Protocols and procedures are based on approved documents developed primarily from methods and regulations issued by various federal or state agencies, e.g. the United States Environmental Protection Agency (USEPA), Pennsylvania Department of Environmental Protection (PADEP), and the New Jersey Department of Environmental Protection (NJDEP), for the analysis of multimedia samples for a broad range of inorganic, organic, microbiological, and biological constituents. EQC's quality program encompasses the requirements for producing and reporting data of known and documented quality to its clients. It is understood that data are to be used by clients to make rational, confident, cost-effective decisions regarding assessment and resolution of their environmental compliance requirements.

5.2.2 It is the policy of EQC to incorporate the highest standard of quality into all analytical programs by adhering to the following practices:

5.2.2.1 EQC will only offer environmental analyses for which it can consistently demonstrate compliance with high-quality, traceable, and legally-defensible performance standards.

5.2.2.2 All EQC personnel are committed to good professional practice and honesty in the production and reporting of data.

5.2.2.3 EQC personnel are employed by or under contract to EQC. All personnel are qualified, supervised, and trained as required by the company's quality system.

5.2.2.4 Staff who become aware of misrepresentation of facts or manipulation of data are required to immediately inform the Quality Assurance Director, Laboratory Director, or Laboratory President.

5.2.3 EQC is operated under an *Open Door Policy* that enables every employee to have free access to senior management. This *Open Door Policy* is intended to foster two-way communication, encourage ethical behavior, and identify inappropriate data production and reporting practices. It is clearly understood that such information is treated confidentially. Any undue pressures to report

non-compliant data, either financial or commercial, from corporate owners, supervisors, employees, or clients, are to be immediately reported to management.

5.2.3.1 The Quality Assurance Department provides oversight that is independent of laboratory operations to ensure that unbiased judgment and integrity are maintained at all times.

5.2.4 Objectives of the Quality Systems Manual

5.2.4.1 The QSM describes the procedures used in the laboratory to ensure that data generated meet the requirements of the relevant standards including: TNI Standards, PA Chapter 252, EPA's *Manual for the Certification of Laboratories Analyzing Drinking Water*, other applicable federal, state and municipal regulations, and the quality objectives of all clients and regulatory programs.

5.2.4.2 The QSM describes procedures for routine data review that facilitate early recognition and remediation of problems which might affect the reliability and reproducibility of the analytical results.

5.2.4.3 The QSM establishes and maintains procedures to ensure the traceability of activities associated with sample analysis beginning with sample collection and continuing through reporting and storage of all associated records, including the following: sample chain of custody; sample preparation and analytical records; methods used and documentation of any deviations from the method; pertinent calibration and continuing calibration verification data, including preparation and traceability of standards; associated quality control data including, but not limited to, matrix spikes, duplicates, laboratory control samples, method blanks, surrogates, and internal standards; records of routine and non-routine equipment maintenance; and analyst training records demonstrating competence in tests performed.

5.2.4.4 The QSM establishes a program to minimize the possibility of loss or damage through administrative SOPs which address data retention, including, but not limited to, archival and storage of data files, computer media, and hard-copy laboratory data.

5.2.4.5 The QSM establishes a program to minimize data integrity issues or tampering with data by administering an ethics training program which describes unethical, fraudulent, and improper laboratory practices. This includes proper manual integration techniques to identify inappropriate instrument manipulation practices.

5.3 Quality Systems Manual Implementation

5.3.1 The Quality Assurance Director is responsible for updating, revising, and distributing the QSM for EQC. The QSM is a numbered, controlled document which enables each copy to be tracked and revisions to be distributed. The QSM is reviewed at least every twelve months and revised as necessary. All

previous versions are archived in compliance with relevant state and federal regulations. A copy of the QSM is maintained in each laboratory department and is available for review by the analysts and supervisors. The QSM is required reading for all laboratory staff during initial training.

5.3.2 The Quality Assurance Director, in cooperation with the Laboratory Director and Department Manager(s), is responsible for training laboratory personnel and implementation of the QSM.

5.3.3 Staff listed on the title page of this document represent the approved laboratory personnel and signatories responsible for the implementation and application of this QSM.

5.4 Ethics and Data Integrity Policies

5.4.1 EQC maintains a data integrity program which includes the following: data integrity and ethics training; an employee-signed ***Eurofins' Ethics Policy Statement*** (Figure 2); monitoring of data integrity using internal audits of laboratory methods and standard operating procedures; and signed documentation of these data integrity procedures by laboratory management.

5.4.2 The ***Ethics Policy Statement*** is signed at the time of hire or within two weeks of receipt of this policy. The agreement, signed by both the employee and a representative of the corporation, is a pledge by the employee that he/she understands the EQC ethics program. By signing the document, the employee commits to the ethical analysis and reporting of data. Any employee violating the agreement is subject to disciplinary action which could include termination of employment or legal action.

5.4.3 Data integrity and ethics training is provided within three months of employment for new employees and annually thereafter within 14 months of the anniversary of the previous training date for all employees. Training documents are issued, which includes the organizational mission, key integrity issues, procedures for reporting data integrity issues, examples of improper practices, and consequences of such practices. Training is mandatory and attendance is documented.

5.4.4 Data integrity procedures are reviewed annually and updated by management as required. Monitoring of data integrity is accomplished primarily through the quality assurance audits conducted by the Quality Assurance Department as described in Section 17.0 (Audits). Adherence to standard operating procedures and laboratory protocols is maintained to ensure data integrity.

5.4.5 Management is responsible for upholding the spirit and intent of the data integrity procedures by effectively implementing the specific requirements of the program. Management support for this program is acknowledged through their approval of implementation of this QSM as well as acceptance of the corrective actions proposed in the laboratory audits.

6.0 DOCUMENT CONTROL

6.1 Controlled Documents

6.1.1 All documents used as part of the quality system and issued to laboratory personnel are considered controlled documents.

6.1.2 Controlled documents are authorized by the Quality Assurance Director, or his/her designee, and Laboratory Director and may include SOPs, policy statements, and other documents required to support the quality system.

6.1.3 Additional information regarding controlled documents is contained in Section 16.0 (Control of Records).

6.2 Obsolete Documents

6.2.1 Invalid or out-of-date documents are removed from use by retrieving documents from the recorded recipients and/or issuing a revised document. The Quality Assurance Department provides the recorded recipient with a notice of expiration for the retired document when the document cannot be retrieved.

6.3 Standard Operating Procedures

6.3.1 Analytical SOPs are prepared to encompass the requirements of the regulatory methods and to document actual laboratory procedures, especially in cases where established methods specifically allow for method flexibility. EQC's analytical SOPs follow a standard format which includes the following:

6.3.1.1 Scope, application, and discussion of the method including applicable matrices, detection limits, and limitations of the method.

6.3.1.2 Definitions of acronyms and terminology.

6.3.1.3 Discussion of potential interferences.

6.3.1.4 Required safety measures.

6.3.1.5 Sample collection preservation, handling, and storage requirements.

6.3.1.6 Apparatus, instrumentation, reagents, and standards.

6.3.1.7 Quality control requirements including criteria and corrective action to be taken in the event of a quality control failure.

6.3.1.8 Step-by-step procedures including calculation and reporting.

6.3.1.9 Requirements of initial demonstration of capability to perform the procedure.

6.3.1.10 Method performance data, either derived from internal laboratory data or taken from the original reference method.

6.3.1.11 Contingencies for handling out-of-control or unacceptable data.

6.3.1.12 Pollution prevention measures and instructions on waste management and techniques to be employed for waste reduction.

6.3.1.13 Reference to the regulatory or reference method from which the laboratory procedure is derived.

6.3.1.14 Tables, diagrams, and flow-charts, when applicable.

6.3.1.15 Signatures of Quality Assurance Director (or designee) and Laboratory Director (or designee)

6.3.1.16 Effective date and records of dates of all previous revisions.

6.3.2 In addition to the laboratory analytical SOPs, EQC's administrative SOPs provide instructions on performing other routine company procedures, including preparation of SOPs and issuance of policy statements.

6.3.2.1 Policy statements are interim documents that are issued to immediately address or define an issue which may not be addressed in an SOP or the QSM.

6.3.2.2 Policy statements are reviewed annually and integrated into an SOP or the QSM as required.

6.3.2.3 Only approved SOPs may be used for laboratory analyses.

6.3.3 SOPs and the QSM are approved and signed by both the Quality Assurance Director and the Laboratory Director, or their designees. All SOPs and the QSM are handled according to EQC's controlled document policies. The Quality Assurance Department maintains and distributes all original copies of SOPs and the QSM.

6.3.3.1 Authorized copies are assigned unique copy numbers, and distribution is controlled and documented allowing the retrieval and replacement of outdated SOPs. When new SOPs are issued, the old version is collected and archived. Analysts performing analyses under the SOP are required to document their understanding as part of their training.

6.3.3.2 Copies of EQC's controlled documents are available for review by outside vendors at the laboratory. Authorization from the Quality Assurance Director must be obtained by any individual wishing to obtain copies of any controlled document(s).

6.3.3.3 Electronic copies (.PDF format) of current SOPs are maintained in a shared directory by the Quality Assurance Director or designee. SOPs may be reviewed but are protected from unauthorized modification. Analysts may not make uncontrolled copies of SOPs.

6.3.3.4 Paper copies or scanned copies (.PDF format) of SOPs are maintained for a period not less than five years following the last date of use.

6.3.4 A listing of EQC SOPs is provided in Table 3.

6.3.5 SOPs may be supplemented by reference documents which are considered part of the controlled SOP. Documents may include all or part of the reference method and manufacturer's operating manuals.

6.3.6 Copies of current SOPs are kept in each department and are easily accessible to all analysts.

6.3.7 Laboratory SOPs are reviewed at least every 12 months by a manager or other authorized staff member. Revisions are made as necessary.

6.4 Control of Quality Assurance Documents

6.4.1 Controlled documents generated by the Quality Assurance Department are uniquely identified and contain a date of issuance, a revision number, and departmental approval signatures.

6.4.2 Controlled documents may be paper copy or electronic media.

6.4.3 Current revisions of controlled documents are available in the general location of usage.

6.4.4 Documents are periodically reviewed and revised by the Quality Assurance Department to ensure suitability and compliance with the intended purpose.

6.4.5 Making copies of controlled documents is strictly prohibited. Confidential, uncontrolled documents may be issued to outside entities, e.g. regulatory authorities and clients, with approval and documentation of the Quality Assurance Department.

6.4.6 Uncontrolled documents are labeled with an expiration date to prevent extended use.

6.4.7 The laboratory uses reference documents from several external sources for a wide range of tests from a variety of method sources that have been nationally and internationally recognized for use in environmental analysis including the following:

- Methods for Chemical Analysis of Water and Wastes (USEPA)
- Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (USEPA)
- Methods for the Determination of Metals in Environmental Samples (USEPA)
- Methods for the Determination of Inorganic Substances in Environmental Samples (USEPA)
- Methods for the Determination of Organic Compounds in Drinking Water (USEPA)
- Standard Methods for the Examination of Water and Wastewater (APHA, AWWA.WEF)
- Test Methods for Evaluating Solid Waste, SW-846 (USEPA); and
- Technical Standards - American Society for Testing and Materials (ASTM)

7.0 REVIEW OF WORK REQUESTS, TENDERS, AND CONTRACTS

7.1 Procedure for the Review of Work Requests

7.1.1 All new work requests are reviewed to assure that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the needs of the customer. This process ensures that analytical data reported to the customer meet all applicable standards and project objectives.

7.1.2 Contracts for new work may consist of formal bids with signed documents, written or electronic quotes with or without client acknowledgement, or verbal quotes based on published price schedules.

7.1.3 The Laboratory Director or his/her designee shall review tenders, contracts and requests for analytical work in consultation with laboratory or client service staff and/or the Quality Assurance Director, as needed. The review includes, but is not limited to, laboratory accreditation status, analytical capability, laboratory workload, staff requirements, project-specific quality control requirements and/or reporting limits, turn-around time, and cost. EQC only accepts work for which it can meet project-specific objectives, regulatory requirements, and EQC's performance standards.

7.1.4 The Laboratory Director or his/her designee notifies the client of any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily.

7.1.5 Test method, target analyte list, project-specific reporting limits, project-specific quality control requirements, turnaround time, and requirements for data deliverables are specified in the contract documentation.

7.1.6 The client is informed of any deviation from the contract including the test method or sample handling processes. All differences between the request and the final contract are resolved and recorded before any work begins. It is necessary that the contract be acceptable to both the laboratory and the client.

7.1.7 The review process is repeated when there are amendments to the original contract by the client. Participating personnel are given copies of the amendments.

7.1.8 The laboratory notifies the customer when the method proposed by the customer is inappropriate or out of date.

7.1.9 Following contract acceptance, the laboratory notifies the customer when there is a change in laboratory accreditation, staffing, instrumentation, or any other area that affects its ability to meet the client's requirements.

7.2 Documentation of Review

7.2.1 Records are maintained for every contract or work request. This includes pertinent discussions relating to the client's requirements or the results of the work during the period of execution of the contract.

7.2.2 Records of all project-related communication with the client (including e-mails, fax or written correspondence, and telephone conversations) are kept on file.

8.0 SUBCONTRACTING

8.1 Samples may be received for analyses for which EQC does not hold accreditation or which exceed the laboratory's current capacity to complete the analysis in a timely manner. In such instances, EQC subcontracts these samples to another NELAP-accredited laboratory or to a laboratory that meets the applicable statutory and regulatory requirements, i.e. a state-certified laboratory for which the samples are

appropriate. EQC notifies the client, as required, of its intention to subcontract any portion of the testing. The Laboratory Director and the Manager of Environmental Laboratory Administration maintain a documented list of approved subcontract laboratories. Subcontractors also may be employed to perform other functions, e.g. sample collection.

8.2 EQC maintains responsibility to the client for the subcontractor's work, except in the case where the client or a regulatory authority specifies which subcontractor is to be used.

8.3 It is the responsibility of the sample custodian or designee to assure that all subcontracted samples are appropriately preserved and that sufficient volume is available to perform the analysis. If sufficient volume has not been provided by the client, the client will be immediately notified and options will be discussed, including but not limited to re-sampling, reporting increased detection limits, or using an alternative method of analysis.

8.4 Samples to be subcontracted are entered into the LIMS according to routine procedures, the containers are assigned unique identification numbers, and the samples are tracked based on their LIMS identification numbers.

8.5 Each subcontracted sample is accompanied by a completed chain of custody form (COC), which includes all information specified in SOP QC0302 (Chain of Custody Procedure). Samples are relinquished by the Sample Custody Department to a laboratory courier or other transportation service for delivery to the subcontract facility. All requirements for maintenance of sample chain of custody apply to subcontracted samples.

8.6 Any analysis performed by the subcontractor is clearly identified in the associated laboratory report.

9.0 PURCHASING SERVICES AND SUPPLIES

9.1 All purchases of supplies and services are made through reputable service providers. The laboratory evaluates the suppliers of critical consumables, supplies and services that will affect the quality of the analyses performed.

9.2 Purchased supplies, reagents, and consumable materials are not used until they have been inspected or otherwise verified as complying with SOP requirements.

9.3 Detailed information about purchasing of services and supplies that affect analytical procedures is available in SOP QC0478 (Purchasing of Services and Supplies).

10.0 SERVICE TO THE CLIENT

10.1 Client Confidentiality

10.1.1 All test reports, analytical data, and information produced by EQC are confidential and will be released by EQC to another party only upon receipt of a written statement of release from the client and acknowledged by laboratory management. Outside parties may not review proprietary client data without first obtaining written permission from both EQC management and the original data end user. A client is that person(s) or entity requesting EQC services who is the responsible party for remuneration of such services. All EQC employees

are required to sign a Confidentiality Agreement (Figure 3) upon employment with the company.

Exceptions to this procedure follow in Sections 10.1.1.1 and 10.1.1.2.

10.1.1.1 EQC will release data if information is requested by a regulating agency with statutory authority, e.g. Pennsylvania Department of Environmental Protection (PADEP), the United States Environmental Protection Agency (USEPA), or other regulatory entity. Information is released only upon the display of acceptable identification.

10.1.1.2 EQC will release data if information is subpoenaed by any entity for enforcement or litigation. In these cases, the client is notified that this information has been supplied, and all information, e.g. requesting entities or individuals, is provided to the client by EQC.

10.1.2 EQC considers all documents governed under the controlled document policy to be proprietary. Therefore, EQC's policy is to distribute them to vendors and clients only with authorization and if required by contract. All documents and data records are available for review at the laboratory by clients, regulatory auditors, or other authorized personnel.

10.1.3 The distribution of any information without authorization is strictly prohibited. This includes verbal communications, electronic communication by FAX, email, text, or other means, written correspondence, or distribution of information in any other manner pertaining to a EQC client. Information subject to confidentiality includes, but is not limited to, specific report results and/or data associated with those results, client projects or programs, and regulatory requirements. EQC's confidentiality policy also protects material such as customer name, address, phone numbers, as well as any information regarding data, sample containers, and disposal methods.

10.1.4 Access to the LIMS is restricted, and employees are allowed access only to programs or authorization levels applicable to their job description. Access is approved by the Laboratory Director.

10.1.5 All data entries in LIMS are traceable to the employee and to the time of entry to ensure data integrity.

10.1.6 Access to archived information at the Southampton facility is controlled and documented with an access log. Laboratory data generated at EQC-Delaware are scanned and archived electronically as password-protected .PDF files to the EQC server. All archived records are protected against fire, theft, loss and environmental deterioration as described in Section 16.0 (Control of Records).

10.2 Customer Feedback

10.2.1 EQC seeks customer feedback from its clients, and positive and negative feedback are evaluated to improve the analytical processes, management system, and customer service.

11.0 COMPLAINTS

11.1 Client inquiries and/or complaints are directed to the Client Services Department. The customer service representative documents all issues and their resolutions in the LIMS Account History File. These include, but are not limited to, client inquiries regarding previously-reported analytical results or possible modifications to test methods, preservation issues, temperature violations, and all other sample issues. Client requests for confirmation of results are documented in LIMS and tracked through the Data Review Request (DRR) Maintenance file. A LIMS procedure is used to track unresolved issues, and a daily report (the "Issues List") is assigned to specific employees for resolution. The "Issues List" report acts as a reminder to staff to address unresolved issues within a reasonable time period. If any reviews indicate that the data quality is suspect, the customer is notified immediately and all relevant information is documented. Additional information is provided in SOP QC0510 (Customer Complaints). The report is reviewed periodically by the Laboratory Director or his/her designee, and repeated issues are investigated by the QA Department and targeted for corrective or preventive actions where necessary.

11.2 Following review of the original data, as discussed in Section 11.1, samples may be reanalyzed for confirmation of questionable results at the laboratory's discretion.

11.3 All resolutions and any changes made to final laboratory reports are recorded in LIMS.

11.4 In the event that the laboratory transfers ownership or goes out of business, all active customers will be notified in writing of the event. Customers will be given ten (10) working days to request custody of their analytical records. Additional information is provided in SOP QC0460 (Archiving and Storage of Data Files and Computer Media).

11.5 As part of EQC's on-going efforts to improve customer satisfaction, a survey is sent periodically to clients. The feedback obtained from these surveys is evaluated to improve performance and customer satisfaction.

12.0 CONTROL OF NON-CONFORMING WORK

12.1 Analytical data that deviate from required standards are reviewed by the Laboratory Director and Quality Assurance Director before reporting to any client or regulatory agency. This process is initiated through the use of a formal Data Variance Request (DVR) which is documented in LIMS. Procedures for initiating, submitting, and approving DVRs are described in SOP QC0515 (Data Variance Requests).

12.2 The Data Variance Request (DVR) is used to document deviations from policies, procedures, or quality control criteria or when it is not possible to comply with required corrective action procedures described in the SOP. Depending on the nature of the deviation, sample analysis may be suspended.

12.3 A DVR may be initiated by the analyst or department supervisor following initial review of the laboratory data. The DVR is initiated before results are entered into LIMS and within 72 hours of the identification of the issue, and the time of analysis.

12.4 A DVR is prepared and tracked in LIMS using a unique tracking number assigned by the system.

12.5 The DVR includes a description of the issue, reasons why it is not possible to meet the required quality control criteria, and any supporting documentation (e.g. raw data or summarized quality control results).

12.6 The DVR also includes the resolution proposed by the laboratory and any corrective or preventive actions taken to prevent a recurrence of the problem.

12.7 The DVR and associated data documentation are initially reviewed by the Department Manager. At this time, the required action for the DVR is logged into LIMS, i.e. it is accepted for further review or rejected as unnecessary. Following entry into LIMS, the Laboratory Director, Quality Assurance Director, and analysts are notified of the status of the DVR.

12.8 The DVR and associated documentation are reviewed by the Department Manager or, if necessary, the Quality Assurance Director and the Laboratory Director, to determine whether results are reportable. Comments or data qualifiers are included in the final report to document deviations from accepted methods that could impact the final results.

12.9 Before releasing analytical results to clients, the Manager of Environmental Administration or designee is responsible to assure that all relevant comments and data qualifiers have been entered into the LIMS.

12.10 Suspended analyses can resume upon the approval by the Quality Assurance Director and Laboratory Director.

13.0 CORRECTIVE ACTIONS

13.1 Selection and Implementation of Corrective Actions

13.1.1 Corrective and preventive actions (CAPA) reports are initiated upon identification of non-conforming work or deviations from policies and procedures in the management system or technical operations. CAPA reports are initiated, reviewed, and approved in LIMS in a manner similar to that for DVRs as described in SOP QC0515.

13.1.2 Deviations may be identified by routine quality control data review, internal or external assessments, client complaints, client queries, management review or feedback from clients.

13.1.3 Corrective action starts with an investigation to determine the root cause(s) of the problem. Once a root cause is determined, correction actions are taken which typically include instrument repair or maintenance, revision of laboratory processes and SOPs, purchase of new reagents or standards, and/or analyst retraining.

13.1.4 Depending on the nature of the deviation, analytical work may be suspended during the investigation. In cases where analytical work has been suspended, analyses may resume after it is verified that the corrective actions have been effective and the CAPA report has been approved.

13.1.5 CAPA reports are reviewed by the Laboratory Director, Department Manager (s), and Quality Assurance Director. Other management staff may be consulted and copied on CAPA reports. Upon approval of the CAPA report, suspended analytical work may resume.

13.1.6 Clients are notified by comments or data qualifiers on the final report that document deviations from accepted methods that could impact the final results.

13.2 Monitoring of Corrective Actions

13.2.1 Corrective and preventive actions are tracked in LIMS using Corrective and Preventive Action (CAPA) reports or Data Variance Requests (DVRs).

13.2.2 DVR and CAPA procedures are described in SOP QC0515.

13.2.3 The effectiveness of corrective actions is monitored by review of procedures and/or follow-up audits.

13.3 Policy of Permitting Departures from Documented Policies and Procedures

13.3.1 See Section 12.0 of this QSM.

14.0 IMPROVEMENT

14.1 EQC continually strives to improve the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, data analysis, corrective and preventive actions, and management review.

14.2 A variety of audit, review, and survey reports are used to evaluate laboratory performance and implement changes for improvement. These include, but are not limited to, review of Proficiency Test (PT) study results, internal blind study results, internal and external audit reports, management review reports, and customer feedback surveys. For any unacceptable PT results, a root cause analysis is performed and documented, and required corrective and preventive actions are taken.

15.0 PREVENTIVE ACTIONS

15.1 Preventive action is a proactive process to identify opportunities for improvement, rather than a reaction to specific problems or complaints. Preventive actions may be taken as a result of trend analysis based on evaluation of quality control samples (e.g. LCS, surrogate, and MS/MSD recoveries), evaluation of proficiency testing results, internal blind study results, internal and external audit reports, management review reports, process changes based on recommendations from staff or clients, and customer feedback surveys.

15.2 Preventive actions typically include instrument repair or maintenance, revision of laboratory processes and SOPs, purchase of new reagents or standards, development of new methods, and/or analyst retraining.

16.0 CONTROL OF RECORDS

16.1 Procedures for archiving and storage of data are described in SOP QC0460. In general, EQC retains all original project records for a minimum of five years, unless otherwise agreed to with the client or required by regulation (e.g. lead/copper testing documentation is maintained for 12 years).

16.2 Laboratory records associated with the quality system include, but are not limited to, client communication records (e.g. letters, email communications, and phone logs), contracts, equipment maintenance and calibration records, employee training documentation, temperature tracking logs, standards and media records, and the applicable QSM and SOPs. Laboratory records are maintained for a period of five years unless otherwise agreed to with the client.

Project and laboratory records are maintained on site for an interim period depending on available storage space and frequency of use. Records are then transferred to a secured, offsite facility for the remainder of the five-year period.

16.3 Paper copies of project and laboratory records are indexed for later retrieval. Electronic files associated with LIMS and instrument workstations are backed up daily on QC Inc. servers.

16.4 Electronic data generated at EQC-Delaware are backed up to the EQC Server. Hard copy records (e.g. logbooks, spreadsheets, instrument printouts, and chain of custody records) are scanned in .PDF format and archived on the EQC server. Backup procedures are described in Section 16.1.

16.5 General records are considered to be company documents that are not related to data generation or data quality, e.g. health and safety records, general personnel files, accounting and financial documents. General records are archived according to guidelines applicable to the specific functional area as summarized below.

16.5.1 Safety-related documents, e.g. Laboratory Safety Procedure Manual, Material Data Safety Sheets (MSDS), Safety Data Sheets (SDS), are maintained indefinitely in hard copy at each facility and are also accessible online. A list of chemicals used by the laboratory is maintained for 30 years after last use.

16.5.2 Accounting, contract, and financial records are maintained for ten years.

16.5.3 Records related to general personnel files, payroll, and benefits plans are maintained in accordance with requirements of the EEOC (Equal Employment Opportunity Commission), ADEA (Age Discrimination in Employment Act), and FLSA (Fair Labor Standards Act). Personnel records are maintained for at least one year following the last date of employment. Payroll records are maintained for at least three years. Benefit plan information is maintained for at least one year following termination of the plan.

17.0 AUDITS

17.1 Internal Audits

17.1.1 The correct and complete implementation of the programs described in this QSM is confirmed periodically by federal and state auditors as well as outside clients. In addition, internal audits are conducted periodically of all analytical systems by the Quality Assurance Department. Findings and recommendations of each internal audit are documented and reported to the appropriate Department Manager(s), the Laboratory Director, and President. Internal audit procedures are documented in SOP QC0488 (Annual Review of Operations and Internal QA Assessments).

17.1.2 Laboratory management is responsible to respond to all audit findings and deficiencies. Corrective actions are monitored by the Quality Assurance Director as part of the audit follow-up process. Responses to audit findings are reviewed by the Quality Assurance Director. Clients are notified no later than the close of the following business day if audit findings affect data quality or will prevent reporting within the required time frame.

17.1.3 Internal audit procedures focus on the following areas:

17.1.3.1 Adherence to standard operating procedures and conformance to reference methods.

17.1.3.2 Evidence of required data reviews and approvals by technical and supervisory personnel.

17.1.3.3 Adequacy of document filing, storage, and retrieval systems.

17.1.3.4 Documentation of required quality summary reports (e.g., control charts, calibration curves) and CAR reports or DVRs documenting corrective actions for deviations and out-of-control analytical events.

17.1.3.5 Evidence of proper training of analysts (e.g. understanding of laboratory SOPs and troubleshooting procedures).

17.1.3.6 Documentation of proper maintenance of laboratory facilities and equipment.

17.1.4 Internal audits are conducted at least monthly to evaluate conformance to applicable regulatory standards. For each audit, one area of the laboratory operation is selected so that each area is audited twice by the end of a biennial cycle.

17.1.5 The Quality Assurance Department also conducts periodic reviews of randomly-selected projects.

17.2 External Audits

17.2.1 EQC cooperates with clients for vendor qualification inspections or any client-required, third-party audits.

17.3 Performance Audits

17.3.1 Review of Proficiency Test (PT) study data is a key element of performance audits. Corrective actions are implemented for non-conforming data and CAR reports are tracked in LIMS.

17.4 System Audits

17.4.1 The quality system is audited at least every year for conformance to applicable standards promulgated by TNI, EPA, or other regulatory authorities.

18.0 MANAGEMENT REVIEWS

18.1 An internal review of the overall quality systems is conducted annually by the Quality Assurance Director and Laboratory Director based on results of quality documentation for the previous 12 months. Documentation that is reviewed includes, PT performance results, customer complaint documentation, internal operational documentation, internal audit reports, reports from certification audits, field service records, DVR and CAR documentation, LIMS documentation, and data package error logs. Internal audit procedures are documented in SOP QC0488 (Annual Review of Operations and Internal QA Assessments). Issues resulting from the annual management review are identified and assigned to staff for action.

19.0 DATA INTEGRITY INVESTIGATIONS

19.1 Investigations resulting from data integrity issues are conducted in a confidential manner. These investigations are tracked and documented using tools including Data Review Request (DRR) forms, CAR reports, or DVR forms in LIMS as well as other internal documentation and memoranda. Clients are notified no later than the close of the following business day if investigation findings affect data quality or will prevent reporting within the required time frame.

20.0 PERSONNEL/JOB DESCRIPTIONS AND TRAINING

20.1 Job Descriptions

Job descriptions are issued to all employees. Each document outlines the employee's duties, responsibilities, education requirements, and minimum level of qualifications. Specific jobs may require additional training or education (e.g. supervisor positions or other specialized technical positions requiring knowledge of specific, complex methods). These requirements are identified in the individual SOPs. Training courses or workshops on specific equipment, analytical techniques, or laboratory procedures are documented in the employee training records.

Job descriptions for key positions are provided below.

20.1.1 Quality Assurance Director

20.1.1.1 Report directly to the President and has direct access to the Laboratory Director(s).

20.1.1.2 Serves as the focal point for implementation of the QSM and is responsible for oversight and review of quality control data.

20.1.1.3 Functions independently from laboratory operations.

20.1.1.4 Determines the effectiveness of the overall quality system within the laboratory and recommends appropriate corrective actions or modifications of laboratory procedures.

20.1.1.5 Monitors laboratory-training records, including but not limited to Initial Demonstrations of Capability, Annual Demonstrations of Proficiency, and documentation of Method Detection Limit (MDL) studies.

20.1.1.6 Serves as a quality resource and advisor for the Laboratory Director and Department Managers.

20.1.1.7 Coordinates laboratory participation in inter-laboratory accreditation and proficiency programs and analysis of internal "blind" quality control samples.

20.1.1.8 Arranges for periodic laboratory audits and the annual management review of technical operations.

20.1.1.9 Supervises all personnel in the Quality Assurance Department.

20.1.1.10 Reviews analytical deviations in cooperation with the Laboratory Director to determine potential effects on validity and reportability

of sample results. Recommends and monitors corrective actions when needed.

20.1.1.11 Has documented training and/or experience-with laboratory quality assurance and quality control procedures and is knowledgeable of the quality systems as defined under applicable EPA, TNI and independent state regulatory programs.

20.1.1.12 Has a general knowledge of the analytical tests for which data review is performed.

20.1.1.13 Is able to evaluate data objectively and perform independent assessments free from outside influence.

20.1.1.14 Has the education and training as outlined in the current EPA, TNI documents with the following minimum requirements: BA/BS/AA degree or greater from an accredited institution in a chemical, physical, biological, or environmental; at least 1-year experience in the chemical analysis of drinking water, water pollution, or solid/hazardous waste samples; and completion of a formal training course in quality assurance practices and NELAP requirements.

20.1.1.15 Is empowered with the authority from company management to execute the duties of the position as described in the EQC QSM.

20.1.1.16 Has the authority to release analytical results to clients.

20.1.2 Laboratory Director

20.1.2.1 Has responsibility of the day-to-day laboratory procedures and reporting of results.

20.1.2.2 Monitors standards of performance in quality control and quality assurance.

20.1.2.3 Monitors the validity of data generated in the laboratory. Interfaces with the Quality Assurance Department to maintain and improve the overall quality system.

20.1.2.4 Ensures that adequate qualified personnel are employed to supervise and perform the work of the laboratory.

20.1.2.5 Is responsible to oversee implementation of corrective actions outlined in the QSM.

20.1.2.6 Ensures availability of sufficient instrumentation, equipment, reagents, gases, and chemicals to perform procedures for which the laboratory is accredited.

20.1.2.7 Provides educational direction to laboratory staff.

20.1.2.8 Reviews analytical deviations in cooperation with Quality Assurance Director to determine the validity and reportability of sample results. Implements corrective action when needed.

20.1.2.9 Designates appropriate deputies to assume responsibilities in the event of a scheduled short-term absence.

20.1.2.10 Reviews quotes for new work as required to evaluate whether the laboratory has the required certifications, facilities and resources to complete the scope of work.

20.1.2.11 Issues periodic ~~a~~ memoranda as required outlining specific contract requirements for MDLs, matrix, frequency of testing, parameters to be tested, turnaround time, data package requirement, start date and any additional customer-specific information.

20.1.2.12 Has the education and training requirements as outlined in the current NELAP or other applicable regulatory documents.

20.1.1.13 Is empowered with the authority from company management to execute the duties of the position as described in the EQC QSM.

20.1.3 Department Manager (also referred to as Supervisor or Technical Director)

20.1.3.1 Reports directly to the Laboratory Director.

20.1.3.2 Take measures to assure that all results issued by ~~their~~ department meet data quality requirements of SOPs and conform to applicable regulatory and internal quality control standards. Approves final analytical results.

20.1.3.3 Provides oversight of daily activities of laboratory technical staff and all analytical operations within department.

20.1.3.4 Supervises quality control for routine analytical operations as required by SOPs and the QSM.

20.1.3.5 Identifies and resolves technical problems in cooperation with the Laboratory Director and Quality Assurance Director following requirements of the QSM.

20.1.3.6 Reviews all quality control to verify that the department is meeting established criteria.

20.1.3.7 Evaluates new analytical techniques, procedures, instrumentation, and quality control methods, and provides recommendations to the Laboratory Director and Quality Assurance Director as applicable.

20.1.3.8 Has the education and training requirements as outlined in the current NELAP or other applicable regulatory documents.

20.1.3.9 Is required to have an operational understanding of all aspects of departmental SOPs including methodology, instrumentation, and quality control requirements.

20.1.3.10 Is empowered with the authority from company management to execute the duties of the position as described in the EQC QSM.

20.1.4 Analyst/Technician

20.1.4.1 Reports directly to Department Manager.

20.1.4.2 Performs analytical procedures and data processing in accordance with company SOPs. Reviews data for acceptability according to quality control requirements of the SOP.

20.1.4.3 Is responsible for preparation and maintenance of standard curves and the analysis of duplicates, spikes, blanks, and other quality control samples as directed.

20.1.4.4 Is responsible for documentation of routine and non-routine instrument maintenance.

20.1.4.5 Demonstrates acceptable performance on Initial Demonstration of Capability (IDOC) and Method Detection Limit (MDL) studies, quality control samples required by SOPs (e.g. blanks, laboratory control samples, and matrix spikes), PT samples, or internal, blind quality control samples.

20.1.4.6 Immediately reports non-conformances to the Department Manager to ensure that corrective action is taken.

20.1.4.7 Meets the education and training requirements outlined in job description and/or specific SOP.

20.1.5 Sample Custodian

20.1.5.1 Reports directly to the Laboratory Director.

20.1.5.2 Signs chain of custody forms to document sample receipt.

20.1.5.3 Arranges for proper and secure sample storage and distribution to individual departments. Defers distribution of non-compliant samples (i.e. do not meet sample handling and preservation requirements) until receipt of confirmation from client to proceed or resample.

20.1.5.4 Maintains internal custody records of sample transfer to respective laboratory departments.

20.1.5.5 Inspects samples for tampering and proper preservation, including temperature, in accordance with EQC SOPs on sample handling, receipt, and rejection.

20.1.5.6 Is responsible for entry of each sample into the LIMS for tracking throughout analysis.

20.1.5.7 Is responsible to ensure that permanent labels with correct, unique sample identification numbers (assigned by the LIMS) are attached to each sample.

20.1.5.8 Has completed the education and training requirements as outlined in his/her job description.

20.1.5.9 Is empowered with the authority from company management to execute the duties of the position as described in the EQC's QSM.

20.1.6 Deputies

20.1.6.1 In the event of an absence of either the Laboratory Director or the Quality Assurance Director for a period exceeding 16 consecutive calendar days, official notification of the appointment of the deputy director is made through inter-laboratory memo. During the period of absence, the deputy assumes the day-to-day responsibilities of the absent director. Additionally, all primary state accrediting authorities are notified in the event that an absence of either director exceeds 30 consecutive calendar days.

20.1.7 Support Personnel (data reviewers, customer service, forms specialists, computer specialists, scheduling specialists, field staff, and all others)

20.1.7.1 Reports directly to the Department Manager.

20.1.7.2 Has completed the education and training requirements as outlined in the job description.

20.1.7.3 Performs duties in accordance with Company SOPs and QSM.

20.1.7.4 Reports any deviations from the Company's standard operating procedures to the Department Manager.

20.1.8 Manager of Environmental Laboratory Administration

20.1.8.1 Reports to the Laboratory Director.

20.1.8.2 Reviews laboratory data in the final format and approves data for client reports.

20.1.8.3 Manage sub contract data and state forms.

20.1.8.4 Reviews progress of re-analyses and client data challenges.

20.2 Training

20.2.1 Each Department Manager is responsible for training new employees including personnel transferring from other departments. Specific requirements for the initial demonstration of capability to perform the procedure are listed in each method SOP, SOP QC0499 (General Preparation and Evaluation of Demonstration of Capability), and SOP QC0495 (Method Detection Limits). Training documentation is maintained on standardized laboratory training forms along with supporting data as described in SOP QC0499. Summary training records for each analyst are centrally managed by the Quality Assurance Department. Training records are maintained for a minimum of five years following termination of employment.

20.2.2 All new employees are trained in general Company procedures and policies including the Company's quality policy, the QSM and procedures for laboratory data retention, sample collection and handling laboratory documentation, facility access, instrumentation, safety, and good laboratory practices. The Company provides specific training on policies and procedures for data integrity and ethics which is described in Section 5.4. This preliminary training is provided upon hiring and is completed within two weeks from date

of hire. Training for specific method SOPs is performed concurrently with general training.

21.0 ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

21.1 EQC facilities meet or exceed requirements for acceptable performance of analytical procedures performed by the Company.

21.2 The laboratory monitors, controls, and records environmental conditions as required by the relevant test methods and procedures. These conditions may include temperature, noise, biological stability, dust, radiation, humidity, or lighting.

21.3 Testing procedures are suspended when environmental conditions jeopardize data quality.

21.4 Adequate separation is maintained between neighboring areas in which incompatible activities are performed.

21.5 Access to EQC facility in Southampton is controlled through the use of key cards issued to each individual employee. Unescorted visitors are not allowed. Visitors, including contractors and janitorial staff, are made aware of safety and security guidelines. Unauthorized personnel are not permitted in laboratory areas. Other EQC satellite locations are locked unless the front door access is monitored by the EQC staff.

21.6 Laboratory facilities at all locations are kept free from mice, rodents, and other infestations by using authorized service providers to apply insecticides and/or pesticides that have been approved for use by laboratory management and will not negatively affect sample analyses.

22.0 ANALYTICAL METHODS AND VALIDATION

22.1 Analytical Method Implementation

Analytical methods used by EQC generally are dictated by the regulatory application of the sample data. Typically, analyses are based on client requests and the approved parameter list from the laboratory certification documents. Special requests for non-routine methods are handled on a case-by-case basis.

To implement a new analytical method, a method SOP is developed and approved by the Laboratory Director and Quality Assurance Director. The Laboratory Director then creates a product in LIMS incorporating the necessary information for sample analysis and reporting. Subsequently, addition, revision, and/or deletion of methods, SOPs, or analytes is centrally-managed by the Quality Assurance Department. The request contains a brief explanation for the revision and is approved by the Department Manager, Laboratory Director, and Quality Assurance Director. LIMS is updated accordingly.

22.2 Initial Method Performance Evaluation

The laboratory conducts initial method performance evaluations of each analytical method to demonstrate the ability to achieve acceptable results. These evaluations are conducted before the analysis of samples and following significant changes in hardware or analytical systems. Required elements of the initial method performance evaluation are described in the following sections.

22.2.1 Method Detection Limit (MDL) and Limit of Detection (LOD)

22.2.1.1 The Method Detection Limit (MDL) is determined as described in SOP QC0495. An MDL is determined by matrix for each test method and target analyte. MDLs are determined during the initial method validation and annually thereafter where required. When the same parameter is analyzed on multiple instruments, the highest MDL value is used for reporting purposes.

22.2.1.2 Procedures for determination of the appropriate concentration for the LOD quality control sample are described in SOP QC0684 (Determination of LOD and LOQ).

22. 2.1.3 An MDL study is not performed for any analysis for which spiking solutions or quality control samples are not available, e.g. temperature, or when MDLs are not applicable to the procedure (e.g. flash point).

22.2.2 Limit of Quantitation (LOQ)

22.2.2.1 When an MDL study has not been performed, a result may not be reported at a value below the LOQ (Limit of Quantitation) which is generally the lowest calibration standard. The LOQ is also referred to as the Reporting Limit (RL). The LOQ is determined according to procedures in SOP QC0684 (Determination of LOD and LOQ). The validity of the LOQ is confirmed by analysis of a quality control sample containing the analyte(s) of concern at a level of 1-2X the reported LOQ.

22.2.2.2 The analysis of the LOQ quality control samples is considered to be acceptable when the recovery of each analyte is within the established test method acceptance criteria or client data quality objectives for accuracy.

22.2.2.3 Analysis of the LOQ quality control sample is not required if the accuracy of the measurement system is evaluated at the LOQ.

22.2.2.4 For tests that do not utilize a calibration curve, e.g. settleable solids and residue tests, the RL is established at a value that is able to be measured with a defined level of accuracy during routine analysis. For settleable solids, the RL is set at 0.5 mL/L, and for residue tests, the RL is calculated using a minimum weight value, typically 1 mg, on an analytical balance.

22.2.3 Evaluation of Precision and Accuracy

22.2.3.1 Precision is defined as the closeness of a set of duplicate observations or measurements of the same property which are obtained under similar conditions. Accuracy is defined as the degree of closeness of a measurement to the actual true value. A typical example of measuring precision is to analyze a sample in duplicate and compare the results. Analysis of a laboratory control standard (LCS) with known concentration may be performed in duplicate for

this purpose. Precision results are reported as a percent difference of measurements, standard deviation, variance, or range. Analysis of a matrix spike (MS) and matrix spike duplicate (MSD) may also be used as a measure of precision of a given method in a specific sample matrix. Trip and Field Blanks are not used as MS/MSD samples. Analysis of an LCS or other sample with a known or certified value may be used to evaluate accuracy.

22.2.3.2 Specific criteria for assessment of precision and accuracy measurements are described in laboratory SOPs or project-specific documents. These procedures conform to the requirements of applicable regulatory programs, including but not limited to the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), and the Resource Recovery and Conservation Act (RCRA). Where not dictated by regulation, criteria for accuracy and precision of each test method are based on actual laboratory performance in the specific sample matrix. Criteria conform to the standards of TNI. Laboratory samples used as matrix spikes and spike duplicates are selected randomly and rotated between clients based on availability of required tests and sample volume.

22.2.3.3 Precision and accuracy criteria are specified in the various approved methods required by the SDWA (500-series methods), CWA (600-series methods), RCRA (SW-846 methods), or other reference documents, e.g. Standard Methods for the Examination of Water and Wastewater. Additional criteria may be specified in state and federal regulatory programs. Data quality objectives established by EQC meet or exceed the applicable criteria specified by the method or regulatory program. In cases where criteria are not established, quality control limits are calculated internally using historical data tabulated by test method and sample matrix.

Procedures for preparation of control charts and determination of quality control limits are described in SOP QC0916 (Laboratory Quality Control Limits). Upper and lower warning limits are calculated as the mean $\pm 2\sigma$, while upper and lower control limits as the mean $\pm 3\sigma$. Precision warning and control limits are calculated similarly at $+2\sigma$ and $+3\sigma$. Limits are updated periodically with the actual interval dependent upon the total number of samples tested by each method. General data trends and overall analytical system control are tracked through control charts as described in Section 13.0 of SOP QC0499 (General Preparation and Evaluation of Demonstrations of Capability) and SOP QC0916).

22.2.3.4 While overall trends and method performance are tracked through control charts, daily method performance is tracked based on data from individual run sequences. Required corrective actions to be taken in individual instances of data non-conformances are described in the analytical SOPs.

22.2.4 Estimation of Uncertainty

22.2.4.1 The total uncertainty of a measurement is based on many factors including but not limited to, contributions from human factors, environmental conditions, sampling, equipment, test method application, and calibration. Estimations of uncertainty are based on published method performance, previous experience, and specific data validation procedures. Procedures for determination of uncertainty are described in SOP QC0831 (Measurement of Uncertainty).

22.3 Initial Demonstration of Capability (IDOC)

22.3.1 All analysts complete an Initial Demonstration of Capability (IDOC) before independently performing a procedure. Procedures for performing the IDOC are described in SOP QC0499 (General Preparation and Evaluation of Demonstrations of Capability).

22.3.2 A new IDOC is performed whenever there is a change in instrumentation, method, or personnel.

22.4 Continuing or On-going Demonstration of Capability

22.4.1 Continuing or on-going demonstration of capability (DOC) is satisfied and documented as follows:

22.4.1.1 When the analyst successfully analyzes at least four consecutive laboratory control samples from a secondary source and precision and accuracy meet criteria.

22.4.1.2 When the analyst performs another Initial Demonstration of Capability (IDOC).

22.4.1.3 When the analyst performs an acceptable analysis of an internal, single blind sample.

22.4.1.4 When the analyst performs an acceptable analysis of an external, blind Proficiency Test (PT) sample using a similar test method with the same technology.

22.4.1.5 When the analyst completes required activities described in the SOP and a quantitative test is not available, e.g. settleable matter and TCLP extractions.

22.5 Manual Integrations

22.5.1 Eurofins QC, Inc. (EQC) uses software developed by instrument manufacturers or third party suppliers to reduce chromatography data from an analog signal to an accurate concentration present in the sample. Efforts are made during method development to include the best instrument parameters that allow for automatic integration of chromatographic peaks by the data system in most cases. However, instances occur when the automated software does not integrate a peak correctly. Manual integration is employed to correct an improper integration performed by the data system.

22.5.2 All peaks must be integrated consistently in standards, samples, and QC samples. Integration parameters, both automated and manual must adhere to valid scientific chromatographic principles. The reason for manual integration must always be documented. Under no circumstances should manual integration be performed solely for the purpose of meeting quality control criteria. In other words, peak shaving, peak enhancing, or manipulations of the baseline to achieve these ends must never occur as this results in an improper integration rather than correcting a data system

22.5.3 Policies and procedures for manual integrations are described in QC0559 (Proper Manual Integration Techniques for GC and GC/MS).

22.6 Validation of Laboratory-Developed, Non-Standard Methods

22.6.1 Policies and procedures for validation of non-standard methods are described in SOP QC0485 (Acceptance/Rejection Criteria for Unspecified Methods).

23.0 CALIBRATION REQUIREMENTS

23.1 General Equipment Requirements

23.1.1 Analytical Instrumentation and Laboratory Facilities

EQC's laboratory instrumentation and facilities meet or exceed the technical, quality, and capacity requirements of clients, applicable methods, and regulatory agencies. Floor plans of EQC's major laboratory facilities are shown as follows: Figures 2A and 2B (EQC-Southampton, PA facility), Figure 2C (EQC-Horsham, PA facility), and Figure 2D (EQC-Delaware, New Castle facility). A listing of the laboratory's environmental testing equipment is provided in Table 2.

23.1.2 The laboratory's current and anticipated analytical work-load is tracked through the scheduling features of the LIMS and periodically reviewed by laboratory management to assure that incoming projects will not exceed the laboratory's capacity.

23.1.3 The potential need to update and/or purchase new laboratory equipment is reviewed during the preparation of the annual budget.

23.2 Support Equipment

Support equipment includes all devices that are not directly used for laboratory measurements, but are needed to indirectly support laboratory operations. These include, but are not limited to, balances, ovens, refrigerators, incubators, hot blocks, digestion equipment, extraction devices, and volumetric dispensing devices. Procedures for support equipment maintenance and calibration, if applicable, are described in the analytical SOPs, equipment specific SOPs, or manufacturer's operating manuals. Procedures are summarized in the following sections.

23.2.1 Support Equipment Maintenance

23.2.1.1 All support equipment is maintained in proper working order according to the recommendations of the manufacturer or specific

SOP. Records of maintenance are kept in the department where the equipment is located.

23.2.1.2 When support equipment is relocated, the equipment is shut down following recommended procedures. Following shutdown, the equipment is required to meet recommended operating conditions prior to being put back into service.

23.2.2 Support Equipment Calibration

23.2.2.1 Performance of all support equipment is periodically verified and documented according to procedures in the analytical SOPs, equipment-specific SOPs, or manufacturer's operating manuals. In cases where equipment requires calibration, the equipment is calibrated at least annually using standards or calibration materials (e.g. thermometers or weight sets) that are traceable to a recognized entity, such as NIST. Calibration materials are selected to bracket the applicable range of use as required by methods, operating manuals, or regulatory criteria. Applicable acceptance criteria for the calibration of support equipment are described in individual SOPs. Calibration records for thermometers and balances generally are maintained centrally by the Quality Assurance Department, while other operating documentation (e.g. oven or refrigerator logs) are kept in the department where the equipment is located.

Key elements of support equipment calibration are described in the following sections.

23.2.2.2 Analytical balances and weights are serviced and calibrated annually by a certified technician. Class 1 or better weights are used.

23.2.2.3 Except for Class A glassware, the delivery volumes of mechanical volumetric dispensing devices are checked at least quarterly. The accuracy is required to be within 2.5% of the expected value. Volumetric devices that do not meet this criterion are refurbished or taken out of service.

23.2.2.4 Temperature measuring devices such, as liquid-in-glass thermometers, are calibrated at least annually using a NIST-traceable thermometer, which is graduated in at least 0.2 °C increments.

23.2.2.5 A working thermometer is not used if it has a Correction Factor (CF) of 1.0 °C or greater from the reference thermometer. If the calculated CF is less than the graduation increment of the working thermometer, the CF is not applied.

23.2.2.6 Thermometers are graduated in increments of 0.5 °C or less for all analyses except fecal coliform analysis. Thermometers used for fecal coliform analysis have graduations of 0.2 °C or less.

23.2.2.7 Electronic data loggers are calibrated at least annually against NIST thermometers. In addition to the electronic records, calibration records and summary data are maintained in logbooks.

23.2.2.8 Operating conditions of autoclaves are documented in logbooks according to schedules described in laboratory SOPs. Documentation includes demonstration of sterilization through use of biological indicators and verification of cycle temperature.

23.2.2.9 The temperature of each laboratory refrigerator and freezer is documented at least daily. Refrigerators for storing environmental microbiology samples are required to maintain a temperature of 1 to 5 °C. Other samples are stored in refrigerators with a temperature range from 0-6 °C. Freezer temperatures are less than 0 °C to -20 °C.

23.2.2.10 Temperatures of water baths and ovens are verified each day, before use. Temperatures of microbiological incubators and water baths are verified twice daily, and the measurements are taken at least 4 hours apart.

23.2.2.11 Calibration of electronic, dial-type, and other non-glass thermometers, including thermocouples and metal thermometers, is verified on a quarterly basis with a NIST-certified thermometer. Note: Dial-type thermometers for ice cream sampling is calibrated every 6 months as specified by PA Department of Agriculture dairy sampling forms.

23.2.2.12 Certified NIST thermometers are recalibrated at least once every two years by an authorized independent firm. The certificates documenting the traceability to NIST standards are kept on file by the Quality Assurance Department in Southampton. In cases where regulatory authorities require local access to the certification documents, a copy is provided to the individual remote facility.

23.2.2.13 Equipment that does not meet calibration criteria is taken out of service and clearly marked to prevent usage.

23.2.2.14 When equipment is taken out of service, calibration and test data from the analytical run immediately preceding the out-of-service date/time are evaluated. This evaluation ensures that the tests were satisfactory and data were not affected by the equipment malfunction.

23.3 Analytical Instruments

23.3.1 Maintenance for Analytical Instruments

23.3.1.1 When an instrument does not meet the specifications of the approved methods or manufacturer, operation is suspended and maintenance or repair is performed as necessary. Maintenance or repairs are performed by qualified personnel, either experienced EQC operators or outside service personnel. Outside service

personnel generally are representatives of the manufacturer or independent contractors who perform non-routine instrument maintenance and repairs, as well as any periodic maintenance required by manufacturer's service contracts. Potential analytical down-time is minimized through the availability of backup instruments and/or alternate methods. Following maintenance or repair and prior to initiation of sample analysis, instrument performance is verified for conformance to regulatory requirements.

23.3.1.2 Preventative maintenance schedules and procedures are detailed in the individual instrument operations manuals, analytical SOPs, or in specific preventative maintenance SOPs.

23.3.1.3 Records of all routine and non-routine maintenance are maintained in instrument maintenance logs kept in each department.

23.3.1.4 When instruments are taken out of service by moving or placing in storage, EQC follows the applicable manufacturer's instructions and/or applicable SOP to ensure proper functioning and to prevent contamination or deterioration. Following moving or storage, instrument performance is verified for conformance to regulatory requirements prior to initiation of sample analysis and return to service.

23.3.2 Initial Instrument Calibration

23.3.2.1 Intervals for calibration are, at a minimum, those recommended by the manufacturer or those required by the analytical method, whichever is shorter. Calibration standards are prepared and analyzed in concentrations bracketing the range of the samples to be analyzed. Results within the calibration range, but not bracketed by the initial calibration standards, may be reported with a qualifying flag or comment as described in the specific analytical SOP. In cases where calibration is performed with a single standard and calibration blank (e.g. ICP-OES and ICP-MS), a linear dynamic range (LDR) is determined according to the specified method, and results above the single point standard used for calibration, but within the LDR, may be reported.

23.3.2.2 Standards used for initial calibration are verified using a standard (however named) prepared from an independent, second-source material. The second-source standard is obtained from a different manufacturer or from a different lot from the same manufacturer.

23.3.2.3 All sample results are quantitated from the initial instrument calibration and not from any continuing instrument calibration verification.

23.3.2.4 Calibration response may be determined using linear regressions, quadratic fit, or an average calibration response factor (e.g. area response or peak height versus amount injected as is the case with

chromatographic analyses). The required number of calibration standards is described in each analytical SOP. Linear and quadratic calibration acceptability are defined by SOP-defined statistics that establish the minimum value that is acceptable relating to the goodness of fit of the calibration curve. Acceptability of calibrations utilizing calibration response factors is based on calculation of the relative standard deviation (RSD). Acceptance limits for RSDs are listed in each analytical method.

23.3.2.5 When initial calibration criteria are not met, one or more of the following actions are taken until acceptable calibration data are obtained. Corrective actions include, but are not limited to: a) mechanical or electronic adjustment of the instrument followed by reanalysis of the initial calibration standards; b) instrument maintenance followed by reanalysis of the initial calibration standards; c) preparation of new standards and a new initial calibration curve; d) evaluation of one or more components of the standard for abnormally high response, indicating contamination, followed by corrective action to eliminate the contamination and reanalysis of the initial calibration standards; or e) removal of the instrument from service for subsequent repair. Additional corrective actions may be described in each analytical method.

23.3.3 Continuing Instrument Calibration

23.3.3.1 Continuing calibration verification standards (CCV) are analyzed at the frequency specified by the analytical methods or regulatory program and when calibration is not performed on the day of analysis.

23.3.3.2 Continuing calibration verification standards have defined acceptance criteria and are listed in each specific standard operating procedure.

23.3.3.3 If the continuing instrument calibration verification results obtained are outside the established acceptance criteria and analysis of an immediate second consecutive calibration verification fails to produce results within acceptance criteria, corrective actions are performed. Corrective actions include, but are not limited to, instrument maintenance and evaluation of chromatographic performance, software integration and mathematical calculations, and standard stability. Following corrective action, calibration verification is demonstrated by analyzing two consecutive passing calibration verifications. Alternatively, a new initial instrument calibration can be performed. Sample analyses are not initiated until the analytical system is calibrated and the calibration is verified.

23.3.3.4 When samples are analyzed using a system on which calibration has not been verified, the following rules apply:

a. When the acceptance criteria for the CCV are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with a qualifying comment.

b. When the acceptance criteria for the CCV are exceeded low (i.e., low bias) and there are associated samples that have values exceeding a regulatory limit, those results may be reported with a qualifying comment.

c. In all other cases, the samples affected by the unacceptable calibration verification are re-analyzed after a new calibration curve has been established, evaluated, and accepted.

d. PA-regulated drinking water samples with qualified results must receive pre-approval from the state prior to reporting.

23.3.4 Other Method- or Instrument-Specific Calibration Requirements

Additional method- or instrument-specific procedures may be required and are specified in individual method SOPs. These include, but are not limited to, tuning of mass spectrometers and minimum RRF criteria (GC/MS and ICP/MS), PEM breakdown and retention time verification (pesticides), wavelength calibration of spectrophotometers (colorimetric determinations), and inter-element correction factor and linear dynamic range verification (ICP-OES and ICP/MS).

24.0 MEASUREMENT TRACEABILITY

24.1 Reference Standards and Reagents

24.1.1 EQC purchases analytical standards and reagents from established vendors. Suppliers are approved according to procedures described in EQC SOP QC0478 (Purchasing of Services and Supplies). Standards are prepared and analyzed according to the requirements of the analytical methods. Initial calibration standards are verified by analysis of second source standard prepared independently of the initial calibration standard.

24.1.2 Handling and documentation of standard materials and reagents is described in SOP QC0486 (Reagent/Reference Material Receipt, Labeling, Expiration, Storage and Disposal). Records document the traceability of working standards or reagents to the stock materials. Documentation also includes certificates of analysis or purity, receipt date, and information specific to the standard or reagent preparation (e.g. date of preparation, method of preparation, expiration date and preparer's initials). All prepared standards and reagents bear a unique identifier with expiration date and are traceable back to stock standards or reagents.

24.1.3 The sources of deionized water within the laboratory are tested periodically for the parameters listed in Table 24.1.3 (Deionized Water Monitoring Criteria). Additional parameters may be added as required by individual regulatory authorities or specific clients. Samples that are routinely monitored are

scheduled in the company LIMS for the following locations: EQC-Southampton, 2nd floor; EQC-Southampton, 1st Floor; and EQC-Delaware.

Samples of deionized water are collected from the discharge port of each DI water system after allowing water to run for at least one minute. Samples are collected according to procedures described in Section 10.11 of SOP QC0548 (General Field Sampling Procedures).

Samples are analyzed for the scheduled tests according to the appropriate SOP. Deionized water must meet all test requirements indicated in Table 24.1.3 to be suitable for use. Deionized water that does not meet these requirements must be re-sampled and re-tested. Management is notified if repeat analyses do not give acceptable results.

Table 24.1.3
Deionized Water Monitoring Criteria

Parameter	Requirements	Frequency
TOC NH3	<1 mg/L <0.1 mg/L	Monthly
Organic Nitrogen	<0.1 mg/L	Monthly
Conductivity	< 2.0 micromhos/cm or >0.5 MΩ resistance at 25 °C	Monthly
Residual Chlorine	<0.1 mg/L	Monthly
Heterotrophic Plate count	< 500 CFU/mL	Monthly
Suitability/Bacteriological Water Quality	Ratio: 0.8 - 3.0	Annually
Heavy and Trace Metals	≤ 0.05 mg/L per metal, ≤ 0.1 mg/L collectively	Annually
SiO_2	<0.1 mg/L	Annually

24.2 Reference Materials

24.2.1 Materials used for method validation or instrument calibration are, wherever possible, traceable to certified reference materials. See additional information in SOP QC0478 (Purchasing of Services and Supplies).

24. 3 Transport and Storage of Reference Standards and Materials

24.3.1 Handling and documentation of reference materials is described in SOP QC0486 (Reagent/Reference Material Receipt, Labeling, Expiration, Storage and Disposal).

24.3.2 Reference standards and materials are handled in a safe manner to protect their integrity and to prevent contamination or deterioration.

25.0 SAMPLE COLLECTION AND MANAGEMENT

25.1 Sample Collection

25.1.1 Sample collection by EQC personnel is performed in accordance with EQC SOPs or client-specified procedures. Sample collection procedures comply with applicable EPA and state regulations. Applicable field sampling SOPs are listed in Table 3.

25.2 Sample Containers

25.2.1 Selection of sample containers is based on the requirements specific to the analyte, matrix and analytical method. Acceptable sampling containers are described in SOP QC0346 (Policy for the Acceptance and Rejection of Environmental Samples).

25.3 Preservation and Holding Time

25.3.1 Samples preservation is verified and documented upon receipt in the laboratory. Each sample is evaluated to ensure that the holding time is met for all analytes. Preservation and holding time requirements are described in SOP QC0346.

25.4 Sample Receipt and Acceptance

25.4.1 Samples are checked in according to SOP QC0303 (Sample Log-in Procedure)

25.4.2 Policies and procedures for accepting samples at the laboratory are described in SOP QC0346 (Policy for the Acceptance and Rejection of Environmental Samples).The samples are checked for tampering, closure integrity, proper collection procedures, and proper preservation, including use of approved containers, temperature, pH, chlorine residual, or presence of other required chemical preservatives as described in SOP QC0346.

25.4.3 The COC form is reviewed for all relevant information. When required, EQC personnel follow established procedures to contact the client and obtain complete and accurate information for the sample submittal (see SOP QC0346). All COC issues are documented in the LIMS and the client is notified.

25.5 Chain of Custody

25.5.1 All samples received by the laboratory must be accompanied by a completed COC form available from the client services at EQC. The COC provides a record of sample handling history beginning with the date and time of sample collection and continuing through laboratory receipt and distribution to individual departments for analysis. EQC has the ability to provide a complete internal chain of custody record including handling by individual analysts through final analysis and disposition of the samples upon request. These procedures are described in SOP QC0302 and SOP QC0468 (Electronic Chain of Custody and Sample Transfer). Key elements of these procedures are summarized in the following sections.

25.5.2 Documentation of a sample chain of custody begins with proper completion of a COC which is initiated by the sampler at the time of sample collection. The field identification of each sample is recorded on the COC, and a durable label including the unique field identification is affixed to each sample container providing traceability of each sample to the COC record.

25.5.3 In addition to sample identification information and other project information associated with the terms of each individual contract, the COC also includes

specifics regarding required analyses, numbers of containers for each sample, field measurements, sample preservation and other client notes.

25.5.4 Each sample container is labeled in accordance with relevant health and safety requirements when preservation chemicals are added. This label also provides additional traceability to ensure the container and preservation are those specified for the analytical requirements indicated on the COC.

25.5.5 The sampler, project coordinator, or courier maintains custody prior to, during, and after sampling until the samples are relinquished to EQC laboratory personnel.

25.5.6 In the event that the laboratory receives an incomplete or incorrect chain of custody form, EQC personnel follow established procedures to contact the client and obtain accurate information for the samples. These procedures are described in SOP QC0346 (Policy for the Acceptance and Rejection of Environmental Samples).

25.6 Sample Identification and Login

25.6.1 All samples are assigned a unique identification number and are logged into the LIMS according to procedures described in SOP QC0303. When there are more than one bottle per sample, each sample container will be uniquely identified.

25.6.2 The sample number is printed on a permanent label which is attached to each sample container. Each label includes a sample/project number traceable to the LIMS as well as a second container identifier code unique to that individual container, also tracked in the LIMS. Sample identification information, the unique container identification, and preservatives added to the container are all encoded onto the sample container using bar code labels.

25.6.3 EQC prepares pre-printed forms ("pick sheets") for field service staff to use in order to identify samples requiring pickup. Pick sheets contain the unique sample identification that is used during sample login. Pick sheets use the letter "P" as a prefix to the sample identification. Upon sample login, the "P" is changed to an "L" which indicates the sample is available for analysis, and this designation, along with the unique sample identification, is maintained thereafter.

25.7 Sample Storage, Handling, and Transfer

25.7.1 Sample storage and handling procedures are described in SOP QC0308 (Sample Storage Procedure) and SOP QC0468. All samples are tracked and transferred using the unique identification number assigned by LIMS. All analysts responsible for department sample custody and sample custodians at EQC's main laboratory in Southampton are assigned a unique identification number and badge. Information including analyst's name and department is encoded onto the bar code included on the identification badge. The LIMS uses this information to maintain a record of all sample transfers. Additional safeguards have been encoded into the electronic system to prevent unauthorized personnel from receiving or relinquishing laboratory samples.

For EQC-Delaware, other satellite locations, or where electronic documentation is not possible, sample transfers are documented manually.

25.7.2 In cases where holding time or other constraints require sample transfer prior to bar coding, the transfer is tracked manually using a rush sample custody log. With the rush sample custody log, all signatures are obtained manually. Then, following analysis, the samples are returned to the sample custodian for entry into the LIMS and attachment of bar code labels.

25.7.3 Individual sample containers are relinquished to the appropriate departments for storage. During analysis, the samples are stored, tracked, and transferred thereafter by each department as required by applicable methods.

25.7.4 It is the responsibility of the Sample Custodian or designee to assure that all samples are logged into LIMS. Laboratory personnel are responsible for receiving and processing samples as described in Section 25.7.1.

25.7.5 Custody of samples and sample extracts/digestates transferred between various laboratory departments is maintained either electronically or manually through a transfer logbook.

25.7.6 Each sample digestate or extract is assigned a unique identifier that is traceable to the original sample container. Whenever possible, a bar code label is printed and affixed to the extract or digestate container and custody is tracked electronically as above. When it is not possible to affix a bar code label (i.e., due to the small size of an injection vial), custody of these samples is tracked using manual signatures in a department-specific sample transfer logbook. The sample digests or extract vial labels (e.g. for GC and GC/MS analyses) contain sample batch identification, unique sample identification, client name, and the analysis required or a cross-reference to this information.

25.8 Sample Disposal

25.8.1 Samples and sample preparation products, e.g. extracts, leachates, and digestates, are stored in the laboratory under required storage conditions. Procedures for disposal of these materials are described in SOP QC0479 (Laboratory Waste Disposal).

25.8.2 Original samples and sample preparation products are retained for a minimum 10 days following report generation, but not fewer than 15 days from sample receipt. The samples may be retained for a longer time if previously agreed with the clients.

26.0 QUALITY ASSURANCE FOR ANALYTICAL TESTING

26.1 Essential Quality Control Elements and Internal Procedures

The following quality control procedures or indicators are incorporated into applicable laboratory SOPs and the QSM. Specific procedures for data evaluation, corrective actions and data qualification are described in individual method SOPs and SOP QC0913 (Laboratory Data Review and Reporting).

26.1.1 **Demonstrations of Capability.** Each analyst is required to complete an Initial Demonstration of Capability (IDOC) and also perform an annual On-Going Demonstration of Capability (DOC). Additional details regarding the IDOC and the on-going DOC are contained in Sections 22.3 and 22.4 respectively.

26.1.2 **Method Detection Limit (MDL) Determinations**. MDL studies are performed at annually according to procedures in SOP QC0495.

26.1.3 **Blank Analysis**

26.1.3.1 **Laboratory Reagent Blanks**. The purpose is to evaluate contamination resulting from laboratory processes, reagents, or glassware. Laboratory reagent blanks are performed at a frequency of one per analytical batch of 20 or less.

26.1.3.2 **Method blanks.** EQC systematically prepares and analyzes method blanks with each batch of samples, to continuously evaluate analytical system interferences and background contamination. An aliquot of deionized (DI) water or other appropriate analyte-free matrix is submitted to the entire testing procedure. The presence of the analyte (s) of interest in the method blank render associated data suspect and requires corrective action. Method blanks are performed at a frequency of one per analytical batch of 20 or less.

26.1.3.3 **Field Blanks.** Field blanks are equipment rinsate blanks prepared in the field or samples of clean water sent to the sample site for transfer by the client into clean sample containers with subsequent shipment back to the laboratory with the field samples. Field blanks are analyzed according to client requests for all required analytes. Results provide valuable information regarding contamination introduced by the field sampling procedures which could affect sample data.

26.1.3.4 **Trip Blanks.** Trip blanks accompany associated samples requiring volatile organic analyses from the time of sample container preparation, shipment to and from the sampling site, and analysis by the laboratory. Trip blanks are analyzed to detect accidental or incidental contamination. Organic-free water is provided to the client by the laboratory in closed 40-mL vials or other appropriate containers. These containers are taken onsite, but not opened, and are subsequently shipped to the laboratory with associated field samples. The holding time for trip blanks begins at the time actual field samples are collected.

26.1.4 **Laboratory Fortified Blank (LFB) or Laboratory Control Sample (LCS)**

LFBs or LCSs are analyzed routinely to confirm proper method performance and to evaluate method accuracy. The LCS serves as the primary batch quality control check, and sample results may not be reported unless the LCS or LFB meet method-specified criteria. Laboratory control samples may be purchased as pre-prepared, whole-volume samples or in concentrate or dry reagent form

to be prepared by the laboratory for analysis. Laboratory control samples are obtained from a source different from that used to prepare the calibration standards. Analysis of laboratory control samples, in conjunction with matrix spikes and duplicates, allow delineation between matrix effects that may affect analysis of individual samples and overall method performance affecting analysis of all samples. Unless otherwise specified within the SOP, a LCS or LFB is analyzed with each batch of up to 20 samples per matrix per day.

26.1.5 Laboratory Spikes, Spike Duplicates, and Serial Dilutions

26.1.5.1 Matrix Spikes/Matrix Spike Duplicates (MS/MSD). These are also described as Laboratory Fortified Matrix (LFM) and LFM Duplicate. These samples are analyzed to assess matrix interference problems and method precision. At a minimum, an MS and MSD (or LFM and LFM Duplicate) are analyzed with each batch of 20 samples. The frequency of analysis of the MS/MSD could be greater if required by the analytical method or request for a specific project. The MS/MSD data are used to document the effect of matrix on analyte recovery and method precision. MS/MSD recoveries are evaluated based on quality control limits established by the method, or, if recovery criteria are not specified, using control limits established by the laboratory.

26.1.5.2 Post-Digestion Spikes

When MS/MSD recoveries for metals analyses (e.g. hexavalent chromium in solids, ICP-OES, and ICP-MS) do not meet acceptance criteria, post-digestion spikes may be required to evaluate whether recovery deviations are caused by instrumental interferences or problems with sample preparation. The sample digest is spiked at the level specified by the individual method SOP, and post-digestion spike recoveries are evaluated according to method acceptance criteria. Possible matrix interferences that are identified from evaluation of MS/MSD and post-digestion recovery data are documented.

26.1.5.3 Serial Dilution

Serial dilution is performed for ICP-OES and ICP-MS analyses to determine if significant chemical or physical interferences are caused by the sample matrix. Matrix interferences may be present if the diluted sample does not agree with the undiluted sample within the range specified by the method. Data not meeting the serial dilution criterion are reported with appropriate qualifiers.

26.1.6 Duplicates

26.1.6.1 Field Duplicates

Duplicates of field samples are collected at the time of sample collection. Field duplicate analyses are used to assess precision of

sampling processes. Field duplicates are collected as required by field sampling plans.

26.1.6.2 Laboratory Duplicates

The laboratory, or matrix, duplicate is a second aliquot of sample that is processed through the entire analytical procedure. Results of duplicate analyses are used to evaluate the precision of the analysis for that specific sample. However, usable precision data are produced only when the target analytes are present in the samples. Matrix spike duplicates (Section 26.1.5.1) are used in these cases to provide detectable levels of analytes to aid in evaluation of precision. Duplicates are analyzed at a minimum of one per analytical batch of 20 samples, or as required by method SOPs. The precision is evaluated by calculation of Relative Percent Difference (RPD) and comparison with acceptance criteria in the individual method SOP.

26.1.7 Internal Standards and Surrogate Spikes

Internal standards are used for GC and GC/MS analysis, when required by the methods, to compensate for chromatographic drift, establish relative retention time windows, and determine quantitation response factors for target analytes. Surrogate spikes, consisting of non-targeted compounds exhibiting responses similar to the targeted compounds, are added to each GC and GC/MS sample, extract, and standard. Surrogate spikes provide continuous evaluation of method performance and measurement of matrix effects on the recoveries of target analytes. Poor recoveries of surrogate spikes render associated sample data suspect. Corrective action is required and it may be necessary to reanalyze samples or qualify associated analytical results if it is not possible to obtain acceptable surrogate spike recoveries. Corrective actions are specified in individual method SOPs.

26.1.8 Initial and Continuing Calibration

Initial and continuing calibration of analytical instruments is performed as required by the applicable methods. Requirements for initial and continuing calibration are described in Section 23.3.2 and 23.3.3.

26.1.9 Control Charts

Control charts are used as described in Section 26.2.

26.1.10 Corrective and preventive action and root cause analysis

Policies and procedures for corrective and preventive action are described in Sections 13.0, 14.0, and 15.0.

26.1.11 Quality control acceptance criteria

EQC analytical SOPs contain acceptance criteria required by the approved analytical methods.

26.1.12 Definition of preparation and analytical batches

The frequency of analysis of quality control samples generally is dictated by the size of the analytical batch. Unless otherwise specified by the method or specific project, an analytical batch is a batch of 20 samples or less prepared within 48 hours from the beginning of the sample preparation process. Other requirements may be specified in the individual method SOPs.

26.1.13 Minimum frequency for conducting all quality control elements

Quality control elements are performed at defined frequencies according to procedures described in the individual analytical method SOPs.

26.1.14 Inhibitory Residue Test

Microbiological laboratories must perform the inhibitory residue test upon the first use of a dishwashing detergent or when the brand or type of detergent is changed. This test ensures that the glassware is free of toxic material. This test is not required if the certificate of analysis includes results of the inhibitory residue test.

26.2 Quality Control Limits

26.2.1 Quality control measures are assessed and evaluated on an on-going basis, and quality control acceptance criteria are established as specified in the approved methods. In the absence of method-specified limits, internally-generated or lab-defined control limits are used.

26.2.2 Control charts are prepared to create internally-generated control limits for both accuracy and precision as required by each analytical method or company standard operating procedure. Procedures for preparation of control charts are described in SOP QC0916.

26.2.3 Trend analysis: EQC uses control charts for monitoring data quality for specific contaminants of concern, based on data obtained from multiple instruments.

26.3 Marginal Exceedances

26.3.1 If a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This does not necessarily mean that the system is out of control, and therefore corrective action may not be required. Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary.

26.3.2 A marginal exceedance (ME) is defined as being beyond the LCS control limit (three standard deviations), but within the ME limits. ME limits are between three and four standard deviations around the mean. The number of allowable marginal exceedances is based on the number of analytes in the LCS. If more analytes exceed the LCS control limits than are permitted by the method, or if any one analyte exceeds the ME limits, the LCS fails and corrective action is necessary.

26.3.3 This marginal exceedance approach is relevant for methods with numerous analytes. It does not apply to target analyte lists with fewer than eleven

analytes. The number of allowable marginal exceedances is determined using Table 26.3.3.

Table 26.3.3
Determination of Allowable Marginal Exceedances

Number of analytes in LCS	Number allowed as marginal exceedance
> 90	5
71-90	4
51-70	3
31-50	2
11-30	1
<11	0

26.3.4 If the same analyte exceeds the LCS control limit on consecutive analyses, it is an indication of a systemic problem requiring corrective action and the ME allowance does not apply.

26.4 Proficiency Test (PT) Samples or Inter-laboratory Comparisons

26.4.1 Analytes and methods for which EQC is certified are evaluated through the analysis of certified Performance Evaluation (PE) samples obtained from NELAC- accredited Proficiency Test (PT) sample providers.

26.4.2 EQC participates annually in two single-blind, single-concentration PT studies for each analyte on the NELAP designated Field of Proficiency Testing. A minimum of one PT is analyzed per year for non-NELAP parameters. Additional PT samples are analyzed as required by specific projects or other programs for which EQC holds accreditation.

26.4.3 Additionally, EQC conducts three internal blind PT Studies each year. These studies are conducted by the Quality Assurance Department to evaluate on-going proficiency in the analysis of potable water (Water Supply-WS) and non-potable water (Water Pollution-WP).

26.4.4 Each PT sample is integrated into the normal workload and tracked through LIMS. PT samples are diluted according to instructions provided by PT provider, and the diluted PT sample is then considered to be the actual sample. All PT samples are managed, analyzed, and reported in the same manner as normal environmental samples utilizing the same staff, methods, and quality control practices dictated by EQC SOPs.

26.4.5 All associated quality assurance data is reviewed for compliance with applicable criteria as specified in EQC SOPs.

26.4.6 EQC has established the following practices regarding analysis and reporting of PT samples:

26.4.6.1 EQC does not send any PT sample, or a portion of a PT sample, to another laboratory for analysis, nor will EQC knowingly receive any PT sample, or a portion of a PT sample, from another laboratory for analysis.

26.4.6.2 All EQC personnel, including laboratory management, are prohibited from communicating with any individual at another laboratory concerning the PT sample. All EQC personnel, including laboratory management, are prohibited from attempting to obtain the assigned value of any PT sample from a PT provider.

26.4.6.3 Final reporting of PT results is coordinated by the Quality Assurance Director who assures that all results are reported to the proper accrediting authorities and PT sample providers.

26.4.6.4 The laboratory maintains copies of all written, printed, and electronic records resulting from the analysis of PT samples according to policies described in Section 16.0 of the QSM. The laboratory records are available to auditors during on site audits of the laboratory.

26.4.7 PT samples for the State of Delaware shall be completed during the first quarter of the calendar year.

26.5 Data Reduction and Review

26.5.1 Data reduction and review procedures are described in SOP QC0913 (Laboratory Data Review and Reporting of Analytical Results). Permanent records of essential information pertinent to the analysis are maintained as described in Section 16.0 (Control of Records).

26.6 Expanded Data Packages

26.6.1 EQC provides expanded data packages required by various state and federal regulatory programs or site-specific project plans. Several routine options are available to clients ranging from a basic quality control summary to a complete data package with raw data that is suitable for validation. Procedures for preparation of expanded data packages are described in SOP QC0913 (Laboratory Data Review and Reporting of Analytical Results).

27.0 REPORTING OF RESULTS

27.1 Result Entry to LIMS

27.1.1 Data from most laboratory instruments are automatically entered into LIMS by interfacing the instrument workstations directly to LIMS. The automated data entry system is used at Southampton for most organic, metals, and wet chemistry instruments. Analysts review all results for conformance with applicable quality control criteria prior to initiation of data transfer. Department managers or peer review analysts then verify the accuracy of the data transfer. Data entry procedures are described in SOP QC0913 (Laboratory Data Review and Reporting of Analytical Results).

27.1.2 Manual data entry to LIMS is required for non-instrumental methods or procedures for which automated data transfer is not available. In these cases, a dual data entry system is used in LIMS whereby results (e.g. numerical value, date of analysis, analyst, dilution factor) are entered twice by the same person. LIMS monitors agreement between the two entries and provides a hardcopy report of the verification. Any discrepancies are evaluated and resolved before

a result is accepted by LIMS. Analysts review all results for conformance with applicable quality control criteria prior to initiation of data entry. Data entry procedures are described in SOP QC0913 (Laboratory Data Review and Reporting of Analytical Results).

27.2 Release and Reporting of Results

27.2.1 Following entry of results into LIMS, all chemistry results are reviewed prior to release to clients by the Laboratory Director, Manager of Environmental Laboratory Administration, Quality Assurance Director, or their designee. Microbiology results are reviewed by the Department Manager, Technical Director, or their designee. Results are reviewed for compliance with applicable regulatory limits, relationship to historical data if available, permit exceedances, MCL exceedances for compliance samples which are reported as required to the applicable regulatory authority, and other general criteria. Procedures for review, approval, and release of results are described in SOP QC0913 (Laboratory Data Review and Reporting of Analytical Results). Reports are issued with serial numbers in the format specified by the client.

27.3 Environmental Testing Obtained from Subcontractors

27.3.1 Subcontracted analyses are reported either by entry into LIMS or by attaching a copy of report from the subcontract laboratory to the EQC final report. The report clearly indicates the name and the laboratory identification number of the laboratory performing the analysis.

27.4 Electronic Transmission of Results

27.4.1 Clients have the option to access analytical results online using a secure access code.

27.4.2 Online analytical reports cannot be modified by the client.

27.5 Amendments to Test Reports

27.5.1 Amended test reports are identified with a new serial number as described in Section 27.2.1. Amended reports indicate the serialized report that it replaces and the reason for issuance of the revised report.

28.0 HEALTH AND SAFETY

EQC has established a formal health and safety program, which is detailed in its Safety Procedure Manual. The program includes policies and procedures that are essential for the safe operation of the laboratory. Training is provided to all employees on the key elements of this program.

28.1 Policy: EQC provides a safe and healthy working environment for all its staff. The Company's safety program complies with the requirements of Occupational Health and Safety Administration (OSHA) and other applicable regulatory agencies. EQC's objective of the health and safety program is to promote safe work practices that prevents or minimizes injuries and accidents, by raising awareness, and through safety training.

28.2 **Elements of Health and Safety Program:**

28.2.1 New Employee Safety Orientation: Training is provided to all new employees upon hiring. This training includes hazard communication, safe handling of laboratory equipment, chemicals and reagents, and Right Know Training. Policies adhere to OSHA's Hazard Communication Standard, Title 29, Code of Federal Regulations 1910.1200. Safety Data Sheets (SDS), previously, Material Safety Data Sheets (MSDS) are available for employees to access at each laboratory location, or via EQC's Intranet site for SDS.

28.2.2 Chemical Hygiene Plan: This plan includes identification and operating procedures of safety equipment and personal protective equipment (PPE). Potential health hazards of hazardous chemicals and reagents, and safe handling procedures are covered in this plan. EQC maintains a hazardous Chemicals Inventory at every laboratory location, and this list is updated annually.

28.2.3 Chemical Spill Response Plan: This plan includes steps to prevent spills, and minimize exposure risks from chemical spill or accidental release of chemicals or gases in the laboratory.

28.2.4 Blood borne Pathogen Plan: Blood borne pathogens are infectious microorganisms present in blood that can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), the virus that causes AIDS. EQC has implemented a plan to prevent workers' exposure to blood borne pathogens that are at risk for serious or life-threatening illnesses.

28.2.5 Respiratory Protection Plan: This plan includes steps for protection from exposure to respiratory hazards, when engineering controls and safe practices are inadequate to control the hazards.

28.2.6 Permit-Required Confined Space Program: Identifies confines spaces in the building. It instructs who can, and how to enter the confined spaces.

28.2.7 Radiation Protection Program: Identifies radiation devices, storage, handling and leak-checking requirements and responsibilities.

28.2.8 Fire Prevention Program: Identifies storage location of flammables, potential ignition sources and handling.

28.2.9 Emergency Response and Evacuation Plan: Procedures to protect staff and visitors during emergencies are detailed in this plan. These emergencies could include accidental fire, explosion, gas leaks, hazardous material spills, natural disasters etc. The plan identifies emergency response team that should coordinate the response in times of emergencies.

28.2.10 Lockout/Tagout Plan: When repair or maintenance is required on laboratory equipment, it is critical to ensure that the equipment is safe/inoperable before any work is done by EQC staff or outside contractors. The Lockout/Tagout plan

details procedures to do maintenance on equipment that has the potential to start, energize, or release energy, and cause injury to personnel.

28.3 All employees must wear appropriate personal protective equipment and adhere to the safety guidelines specified in the Safety Procedure Manual of EQC.

28.4 Food, drinks and plants are prohibited in the laboratory work areas.

28.5 Employees should not report to work when their health conditions might negatively affect other personnel or laboratory analysis.

28.6 Safety Committee: The Safety Committee comprises representatives from different laboratories, administrative personnel and Management, and conforms to guidelines of the State of Pennsylvania. The Committee coordinates periodic safety inspections, addresses safety concerns, makes improvements, and tracks facility accidents. The Committee meets monthly to discuss safety issues.

29.0 SUPERSESSION

29.1 This QSM supersedes the previous versions of the EQC QSM. Name references and logos were revised to reflect Eurofins QC, Inc. (EQC). Minor editorial changes were made throughout the document.

The following changes were made to Figures and Tables:

Figure 1	Updated for a new EQC Organization Chart
Figure 2	Updated to reflect the Eurofins' Ethics Policy Statement
Figure 3	Updated to reflect the Eurofins' Confidentiality Agreement
Figure 4	Added to reflect the Eurofins' Quality Policy Statement

Removed floor plans (Figure 2)

Other revisions were as follows:

Section 6.4.7	Added reference to additional reference Methods.
Section 9.0	Updated section with purchasing guidelines
Section 20.1.8	Added Manager of Environmental Laboratory Administration
Section 22.2.2.4	Defined LOQ for tests with no calibration curve
Section 22.5	Deleted to avoid redundancy.
Section 22.5.1	Manual integration policy summary added.
Section 23.3.2.4	Removed term "correlation coefficient" to indicate more general statistical criteria for calibration curves
Section 23.3.3.4.d	Section added to describe reporting of drinking water compliance samples to the state of Pennsylvania
Section 25.6.3	Section added to describe use of "pick sheets"
Section 25.8.2	Updated policy for sample disposal
Section 26.4.7	Added DE state requirement for PTs.
Section 26.1.5.2	Added hexavalent chromium in solids to for post-digest spikes
Section 26.2.3	Trend analysis added.
Section 27.2.1	Added Microbiology Department Manager and Technical Director for approval of microbiology data
Section 28.0	Updated Section 28.0 with detailed information on Health and Safety.

APPENDICES

Figure 1. Eurofins QC, Inc. Organization Chart

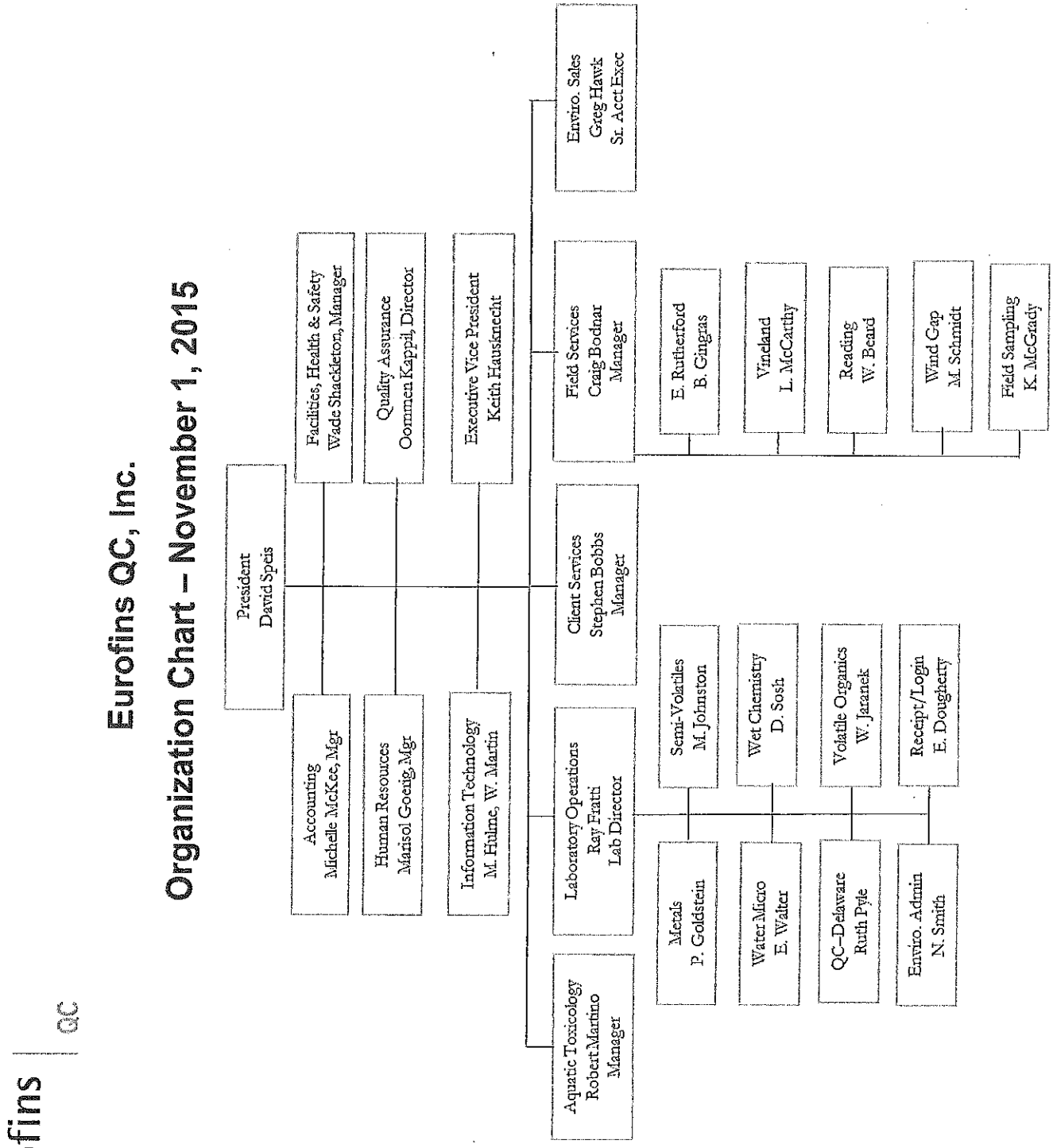

Figure 2

eurofins	Document Title: Eurofins Ethics Policy Statement		
	Eurofins Document Reference: N/A	Revision : 2	Historical Reference: N/A
	Effective date : 05/01/2015	Status: Effective	

Our Company was built on the foundation of high integrity and ethical laboratory practices. To preserve this standard we have a clear expectation that each of us take personal responsibility to do the right thing and uphold the highest level of ethics and quality in all of our dealings.

Here are the ethical responsibilities required of us:

Each and every one of us is expected to adhere to the highest professional and ethical standards. Each employee commits to honest and ethical practices in all daily actions.

- No one will intentionally improperly manipulate or falsify activities in any way.
- Ethical performance and data integrity MUST supersede any other objective of laboratory operations.
- Each employee bears ultimate responsibility for the validation and accuracy of his or her documentation. The analyst's signature signifies that the action taken to generate the data and the documentation are accurate and authentic, and confirm that all proper procedures were followed in the generation of the data in real time.
- Eurofins takes a zero tolerance stance for illegal, unethical, and improper practices affecting the testing process. Each employee is responsible for safeguarding the Lab's ethical practices. For this reason, each employee is responsible to report any situation that may be adversely affecting the quality and integrity of the data produced.
- It is vital that all employees take responsibility to preserve our ethical business practices. Employees who know of, or witness any violation of business, quality, or data integrity policy are required to report the activity to an Ethics Officer, Quality Director, or member of Senior Management. A timely and thorough investigation will occur to remedy any situation regarding these allegations.
- Any employee who knows of or witnesses any violation of business, quality, or data integrity policy, but fails to report it will be subject to disciplinary action.
- During a thorough investigation, the Ethics Officer, and/or Senior Management, will assess the situation and resolve the matter. Since data integrity is so vital to our business practices, any employee found willfully falsifying or manipulating data will be released from employment.
- The Ethics Officer, or Senior Management, in collaboration with appropriate staff, will complete a corrective action plan addressing the root causes. The action plan will be put in place and may include additional training or changes in policies and procedures. All those involved will receive confidential communication regarding corrective action steps taken to remedy the situation.

I understand and commit to these responsibilities. I understand the critical importance of data and business integrity compliance. I realize that any infractions of laboratory integrity procedures could lead to serious consequences including employment separation, debarment, or civil/criminal prosecution. I take personal responsibility to uphold the highest ethical business practices and report any concerns to help preserve Eurofins' integrity.

Name (Print)	Employee Number	Company Name
Signature	Date	

Figure 3

Eurofins QC, Inc.
CONFIDENTIALITY AGREEMENT

THIS AGREEMENT, made this _____ day of _____, 20__, between Eurofins QC, Inc.., a Pennsylvania corporation, hereinafter called "EQC" and _____, hereinafter called "Employee".

WHEREAS, EQC is engaged in the business of a professional testing laboratory, and

WHEREAS, EQC employs the Employee and the Employee desires to enter or continue in the employ of EQC on the terms, provisions and conditions specified herein as to confidentiality; and

WHEREAS, the employee in the course of his/her employment and as a necessary consequence thereof will receive information and acquire knowledge of the business and affairs of EQC and more particularly technical information which in character is private, peculiar and confidential in nature to EQC, and/or EQC's customers in their business; and,

WHEREAS, the business, success and profits of EQC depend in large part upon the maintenance of confidentiality as to such information and knowledge;

NOW, THEREFORE, in consideration of the mutual undertakings of the parties and the employment or continued employment of the Employee by EQC, incorporating the premises, intending to be legally bound, the parties agree as follows:

1. All technical information of a confidential nature encompassed within this agreement shall be made available to Employee on the basis that such technical information is necessary to Employee's proper performance of the work for which the Employee is responsible.
2. Employee agrees that he/she will not, while in the employ of EQC , or at any time thereafter, communicate or divulge either orally or in writing or otherwise, to anyone any knowledge or information that he/she may acquire or which may be imparted to him/her in the course of his/her employment, regarding the business or affairs of EQC or its customers and particularly, but not in limitation of the generality of the forgoing, knowledge or information regarding technical information of EQC or EQC's customers.
3. Other than as set forth herein, all terms and conditions of the employment of the Employee are as set forth from time to time in the Employee Handbook and any other document relevant to Employee or employees of EQC in general and this agreement shall not be constructed as granting to Employee any special rights or privileges not specifically granted in the said Handbook or other documents.

Staff Signature	Printed Name	Date
Corporate Signature	Printed Name	Date

Figure 4

QUALITY POLICY STATEMENT

eurofins	Document Title: Eurofins US Quality Policy Statement		
	Eurofins Document Reference: 1-P-QM-FOR-9007879	Revision: 6	Historical Reference: Form 2787
	Effective date: July 7, 2014	Status: Effective	

As an organization, all personnel are committed to high quality professional practice, testing and data, and service to our clients.

We strive to provide the highest quality data achievable by:

- Following all documentation requirements; describing clearly and accurately all activities performed; documenting "real time" as the task is carried out; understanding that it is never acceptable to "back date" entries and should additional information be required at a later date, the actual date and by whom the notation is made must be documented.
- Providing accountability and traceability for each sample analyzed through proper sample handling, labeling, preparation, instrument calibration/qualification/validation, analysis, and reporting; establishing an audit trail that identifies date, time, analyst, instrument used, instrument conditions, quality control samples (where appropriate and/or required by the method), and associated standard material.
- Emphasizing a total quality management process which provides accuracy, and strict compliance with agency regulations and client requirements, giving the highest degree of confidence; understanding that meeting the requirements of the next employee in the work flow process is just as important as meeting the needs of the external client.
- Providing thorough documentation and explanation to qualify reported data that may not meet all requirements and specifications, but is still of use to the client; understanding this occurs only after discussion with the client on the data limitations and acceptability of this approach.
- Responding immediately to indications of questionable data, out-of-specification occurrences, equipment malfunctions, and other types of laboratory problems, with investigation and applicable corrective action; documenting these activities completely, including the reasons for the decisions made.
- Providing a work environment that ensures accessibility to all levels of management and encourages questions and expression of concerns on quality issues to management.

We each take personal responsibility to provide this quality product while meeting the company's high standards of integrity and ethics, understanding that improprieties, such as failure to conduct the required test, manipulation of test procedures or data, or inaccurate documentation will not be tolerated. Intentional misrepresentation of the activities performed is considered fraud and is grounds for termination.

I understand the expectations and commit to implementation of all applicable policies and procedures and to providing quality data.

Name (printed) _____ Employee Number _____

Signature _____ Date _____

Table 1. List of Accreditations

Laboratory testing accreditations held by EQC are summarized below. Certified analyte lists are available upon request

State	EQC Department and Facility	Regulatory Authority	Programs	Certificate
International	Food Microbiology/Horsham PA	A-Class	ISO/IEC: 17025	72701
National	Pharmaceutical/Horsham PA	FDA	Pharmaceuticals/Personal Care Products	2515238
National	Food Chemistry/Horsham PA	USDA	Moisture, Protein, Salt, and Fat Contents	4260
Pennsylvania	Dairy/Horsham PA	Pennsylvania DOA	Raw Milk and Dairy Products	Approved
Pennsylvania	Food Chemistry/Horsham PA	Pennsylvania DOA	Meat and Poultry Products	NA
Delaware	Environmental/New Castle DE	Delaware DHSS/ODW	Microbiology/Potable Water	M13DE01102
Delaware	Environmental/New Castle DE	Delaware DHSS/ODW	Chemistry/Potable Water	C13DE01102
Connecticut	Environmental/Southampton PA	Connecticut DOH	Potable/Non-Potable Water Solid/Hazardous Waste	PH-0768
Maryland	Environmental/New Castle DE	Maryland DOE (MDE)	Potable Water	138
Maryland	Environmental/Southampton PA	Maryland DOE (MDE)	Potable Water	206
New Jersey	Environmental/East Rutherford NJ	New Jersey DEP	Potable/Non-Potable Water	2015
New Jersey	Environmental/Southampton PA	New Jersey DEP	Potable/Non-Potable Water Solid/Hazardous Waste	PA166
New Jersey	Environmental/Vineland NJ	New Jersey DEP	Potable/Non-Potable Water	06005
New Jersey	Environmental/Wind Gap PA	New Jersey DEP	Potable/Non-Potable Water	PA001
New York	Environmental/Southampton PA	New York DOH	Potable/Non-Potable Water Solid/Hazardous Waste	11223
Pennsylvania	Environmental/Reading PA	Pennsylvania DEP	Potable/Non-Potable Water	06-03543
Pennsylvania	Environmental/Southampton PA	Pennsylvania DEP	Potable/Non-Potable Water Solid/Hazardous Waste	09-00131
Pennsylvania	Environmental/Wind Gap PA	Pennsylvania DEP	Potable/Non-Potable Water	48-01334

Table 2. Equipment List

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Southampton			
Bioassay	2	pH Meter	Fisher Accumet Model 1002
Bioassay	1	pH Meter	Beckman Model 350
Bioassay	1	pH Meter	Fisher Accumet Model APS
Bioassay	2	Oxygen Meter	YSI Model 5000
Bioassay	2	Conductivity Meter	YSI Model 3100
Bioassay	9	Thermometer	Onset Model 2K Hobo
Bioassay	4	Thermometer	Onset Model HB
Bioassay	4	Mercury Thermometer	Fisher
Bioassay	1	Compound Microscope	Fisher Micromaster Model CK4
Bioassay	1	Dissecting Microscope	Cambridge
Bioassay	1	Analytical Balance	Mettler Model AE100
Bioassay	1	Analytical Balance	Mettler Model AE163
Bioassay	1	Drying Oven	Gallenkamp Model 300
Bioassay	3	Autoclave	Amsco Model 15
Bioassay	1	Sample Refrigerator	Bush 8 x 8 Walk-in
Bioassay	1	Sample Refrigerator	Magic Chef Model MCBR44W
Bioassay	1	Freezer	Gibson Chest
Bioassay	1	Environmental Chamber	VWR Model 2020
Bioassay	1	Environmental Chamber	VWR Model 2015
Bioassay	1	Mechanical Shaker	Lab Manufactured
Bioassay	1	Centrifuge	Fisher Model Marathon 10K
Bioassay	2	Water Bath	Precision Model 1100
Bioassay	1	Spectrophotometer	Hach Model DR100
Bioassay	1	Spectrophotometer	Milton Roy Model Spec 601
Bioassay	1	Fluorometer	Turner Model 450
Bioassay	1	Fume Hood	Fisher
Bioassay	4	Dessicator	Fisher
Bioassay	4	Light Box	Hall Productions
Bioassay	1	Photometer	SPER Model 840020
Bioassay	1	Water Purification System	U.S. Filter
Bioassay	36	15-gallon Breeder Tanks	Aquarium Supplier
Bioassay	9	5-gallon Batch Out Tanks	Aquarium Supplier
Bioassay	8	25-gallon Tanks	Fridgid
Bioassay	2	Chiller	Fridgid
Bioassay	1	150-gallon Tank for Reconstituted Water	Aquarium Supplier
Bioassay	1	350-gallon Polyethylene Tank For Saltwater	Aquarium Supplier
Bioassay	1	100-gallon Polyethylene Tank For Natural Fresh Water	Aquarium Supplier

Table 2. Equipment List (continued)

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Southampton			
Bioassay	3	Filter Systems	Rainbow
Bioassay	3	300-gallon Head Tanks	Aquarium Supplier
Bioassay	2	Dilutor	Specialized Environmental Equipment
Bioassay	2	Dilutor	ACE Glass
Bioassay	6	Peristaltic Pumps	Cole-Parmer
Bioassay	22	Water Baths	Various
Bioassay	1	Air Delivery System	Gas Regenerative Blower (1/2 HP)
Field Services	30	Compositor	ISCO Model 2910
Field Services	7	Submersible Pump	Grundfos Redi-Flow
Field Services	1	Low Flow Submersible Pump	ISCO
Field Services	6	Centrifugal Pump	Teel, 30 Ft. Capacity
Metals	1	ICAP with Autosampler	PE Optima 7300 DV/PE S10
Metals	1	ICAP with Autosampler	PE Optima 4300 DV/PE AS93 Plus
Metals	1	Graphite Furnace/Flame with	PE AANALYST 800/PE AS800
Metals	1	Mercury Analyzer	Leeman Hydra AA
Metals	1	Flame AA	PE AANALYST 300
Metals	1	ICP/MS with Autosampler	PE ELAN 9000/PE AS93 Plus
Metals	1	ICAP with Autosampler	Thermo 6500/CETAC ASX 500-Series
Metals	2	Digestion Block	Environmental Express SC100
Metals	1	Digestion Block	Environmental Express SC150
Metals	2	Digestion Block	Environmental Express SC154
Metals	1	Controller	Environmental Express/Hot Block Pro SC180
Metals	2	Digestion Block	Environmental Express/Hot Block Pro SC181
Metals	1	ICP/MS with Autosampler	Agilent 7500CX/CETAC ASX 500-Series
Metals	1	Microwave digestion system	CEM MARS5
Metals	1	DI water system	Thermo Nano Pure Water system
Metals	1	Turbidity Meter	Orbeco Hellige 965-10A
Organic Chemistry	2	GC (ECD/ECD)	HP5890 with injector and autosampler
Organic Chemistry	1	GC (FID)	HP5890 with purge and trap
Organic Chemistry	3	GC (ECD/ECD)	Agilent 6890 with injector and autosampler
Organic Chemistry	4	GC (FID/FID)	Agilent 6890 with injector and autosampler
Organic Chemistry	3	GC (ECD/ECD)	Agilent 7890 with injector and autosampler
Organic Chemistry	2	GC (FID/FID)	Agilent 7890 with injector and autosampler
Organic Chemistry	1	GC (FID)	Agilent 6890 with auotsampler (EST LGX50)
Organic Extractions	1	Concentrator	Zymark Turbovap II
Organic Extractions	2	ASE	Dionex ASE 200
Organic Extractions	2	Sonicator	Fisher 550
Organic Extractions	2	Sonicator	Fisher 500

Table 2. Equipment List (continued)

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Southampton			
Organic Extractions	1	Sonicator	Fisher 505
Organic Extractions	8	Automated Solid Phase Extraction Unit	Horizon Technology SPE-DEX 4790
Organic Extractions	1	Nitrogen Evaporator	Organomation Associates, Inc N-EVAP 112
Organic Extractions	2	Water bath	Organomation Associates, Inc S-EVAP-KD
Organic Extractions	1	TurboVap	Caliper Life Science
Sample Custody	1	Walk-in Cooler	Penn Refrigeration Service
Sample Custody	3	Walk-in Cooler	Bally Engineered Structures/Thermo Balance
Sample Custody	1	Walk-in Freezer	Bally Engineered Structures
Semivolatile Organics	2	GC/MS	Agilent 6890 GC/5973 MSD w/EPC
Semivolatile Organics	2	GC/MS	Agilent 7890 GC/5975 MSD w/EPC
Semivolatile Organics	2	Autosampler	Agilent 7683
Semivolatile Organics	2	Autosampler	Agilent 7693
Semivolatile Organics	4	Data Systems	HP Enviroquant Software
Volatile Organics	5	GC/MS	HP5890 GC/5971MSD w/EPC
Volatile Organics	4	GC/MS	HP5890 GC/5972 MSD w/EPC
Volatile Organics	1	GC/MS	HP6890/5973 MSD w/EPC
Volatile Organics	3	Purge and Trap	Evolution Dual Purge & Trap/Centurian
Volatile Organics	1	Purge and Trap	Encon Dual Purge & Trap/Centurian
Volatile Organics	1	Purge and Trap	Encon Dual Purge & Trap/Archon 2000
Volatile Organics	1	Purge and Trap	Encon Purge & Trap/Archon 2000
Volatile Organics	1	Purge and Trap	Tekmar 3000/Archon 2000
Volatile Organics	1	Purge and Trap	Tekmar LSC2000/ALS2016
Volatile Organics	8	Data Systems	HP Enviroquant Software
Water Microbiology	2	Autoclave	Consolidated – SR24C
Water Microbiology	1	Dishwasher National	Model NLW 441S
Water Microbiology	1	Dishwasher Fisher Jet Clean	Model 628
Water Microbiology	1	Dispenser	Filamatic
Water Microbiology	1	Incubator	Thermo-Fisher Model 815
Water Microbiology	1	Incubator	Thermo-Fisher Model 3721
Water Microbiology	1	Incubator	Thermo-Fisher Model 3720
Water Microbiology	1	Incubator	VWR Model 1545
Water Microbiology	1	Incubator	Precision Scientific
Water Microbiology	1	Incubator	Quincy Labs Model 10-180
Water Microbiology	1	Incubator	Fisher Model 525D
Water Microbiology	1	Walk-in Incubator	Hot Pack Model 462
Water Microbiology	1	Refrigerator/Freezer Combination	RCA Model MTX154CYXKRWH
Water Microbiology	1	Refrigerator	Woods Model RFA17NAD

Table 2. Equipment List (continued)

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Southampton			
Water Microbiology	1	Walk-in Refrigerator	Bally
Water Microbiology	1	Metal Bath	Thermo Scientific Model 2332
Water Microbiology	1	Water Bath	Precision Scientific Model 2868
Water Microbiology	1	Water Bath	Thermo Scientific Model 2862
Water Microbiology	1	Water Bath	Baxter W2975-22
Water Microbiology	1	Dark Field Colony Counter	Leica Model 3325
Wet Chemistry	2	TOC Analyzer	OI 1030 with 1088 auto sampler
Wet Chemistry	1	TOC Analyzer	Tekmar-Brinkman DC-190 with 183 solid sample
Wet Chemistry	1	Ion Chromatograph	Dionex ICS 1600 with AS-DV50 auto sampler
Wet Chemistry	1	Ion Chromatograph	Dionex DX-120 with AS50 auto sampler
Wet Chemistry	1	Ion Chromatograph	Dionex ICS 2000 with AS40 auto sampler
Wet Chemistry	1	Segmented Flow Analyzer	TrAAcs 800 with linear sampler
Wet Chemistry	1	Segmented Flow Analyzer	Alpkem RFA/2 with 301 auto sampler
Wet Chemistry	1	Discrete Auto-analyzer	Seal AQ2
Wet Chemistry	1	Infra-red Spectrophotometer	PE 710B
Wet Chemistry	1	Automated Titration / ISE with Conductivity Meter & xyz Sampler	Man-Tech, PC-Titrate Jenway, 4510 Conductivity meter Gilson 221 Liquid Handler
Wet Chemistry	1	Hexane Evaporation System	Horizon Technology Speed Vap II 9000
Wet Chemistry	1	Spectrophotometer	Hach DR/2400
Wet Chemistry	1	Spectrophotometer	Genesys 20
Wet Chemistry	3	pH Meter	Accumet AB-15
Wet Chemistry	1	pH/mV Meter	Orion EA920
Wet Chemistry	1	Conductivity Meter	YSI 3100
Wet Chemistry	1	Conductivity Meter	Mettler Toledo S230
Wet Chemistry	3	Automated BOD system	Man-Tech BOD Assay Plus
Wet Chemistry	2	Dissolved Oxygen Meter	YSI Model 52
Wet Chemistry	1	Dissolved Oxygen Meter	YSI Model 59
Wet Chemistry	2	Analytical Balance	Mettler AE240
Wet Chemistry	1	Analytical Balance	Mettler AE 160
Wet Chemistry	2	Cyanide Distillation System	Glastron Enviro Midi-Dist
Wet Chemistry	1	Phenol Distillation System	Midi-Dist 2210
Wet Chemistry	2	Ammonia Distillation System	Midi-Dist
Wet Chemistry	1	Incubator, 20^{0}C	Fisher 307C
Wet Chemistry	1	Walk-In Incubator, 20 ^{0}C	8' x 10' QC Manufactured
Wet Chemistry	3	Multi-position (6place) heating units with extraction glassware.	Lab-Line
Wet Chemistry	5	Top Load Balance	Various

Table 2. Equipment List (continued)

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Southampton			
Wet Chemistry	4	Drying Ovens	Various
Wet Chemistry	1	Muffle Furnace	Fisher Iso-Temp
Wet Chemistry	3	COD Reactors	HACH, 25-place
Wet Chemistry	2	Block Digesters	Technicon, BD40
Wet Chemistry	1	Pensky-Martens Flashpoint Tester	Boekel 152800
Wet Chemistry	1	Centrifuge	Whisperfuge, 12-place
Wet Chemistry	1	Sonicator	Branson 2510
Wet Chemistry	1	Ammonia Meter	Orion EA920
EQC-Delaware			
Field Services	12	Autosamplers	ISCO
Field Services	1	5-Station Battery Charger	ISCO
Field Services	1	M-Scope	Sample Pro 6000
Field Services	1	Conductivity Meter	Thermo Orion Model 135A
Field Services	3	Chlorine Meter	Hach DR-100
Water Microbiology	1	Autoclave	Market Forge Sterilmatic Model STM-E
Water Microbiology	1	Autoclave	Market Forge Sterilmatic Model STM-E
Water Microbiology	1	Colony Counter Denominator	Fisher Multiple Tally
Water Microbiology	1	pH Meter	Oakton Model 1100
Water Microbiology	1	Stirring Hot Plate	Thermo Fisher
Water Microbiology	1	Incubator	VWR Precision Model 1550 (#ACL-2D)
Water Microbiology	1	Incubator	VWR Precision Model 6M (#DEINC001)
Water Microbiology	1	Incubator	Quincy Labs Model 10-1450 (#L03602)
Water Microbiology		Membrane Filtration Equipment	Gelman , Millipore 3-place
Water Microbiology	1	Microscope	Fisher
Water Microbiology	1	Refrigerator	Danby DCR34W
Water Microbiology	1	UV Lamp 366nm, 6 W	Spectroline EA-160 (#1557885)
Water Microbiology	1	Water Bath (Coliform)	Precision (#66850)
Water Microbiology	1	Water Batch (Colilert)	Precision (#9308-426)
Water Microbiology	2	Quanti-Tray Sealer	IDEXX Model 2X
Wet Chemistry	1	Walk-in Cold Storage Box	Kysor/Needham
Wet Chemistry	2	Oxygen Meters	YSI Model 58/5906 BOD probe
Wet Chemistry	1	pH Meter	Cole-Parmer Mode 6209
Wet Chemistry	1	Analytical Balance	Denver Instruments TL-204
Wet Chemistry	1	Drying Oven #1	VWR Model 1320
Wet Chemistry	1	Drying Oven #2	Thelco Model 17
Wet Chemistry	1	Drying Oven #3	Fisher IsoTemp Model 6916
Wet Chemistry	1	Drying Oven #4	Thermo Precision Model 6958

Table 2. Equipment List (continued)

Department	Quantity	Equipment Description	Manufacturer/Model
EQC-Delaware			
Wet Chemistry	5	BOD Incubators	Fisher Model 507C
Wet Chemistry	1	Muffle Furnace	Lindberg Blue BF51766A
Wet Chemistry	1	Hot Water Bath	Fisher Scientific IsoTemp 120
Wet Chemistry	1	Heating Block	Fisher Scientific IsoTemp 145D
Wet Chemistry	1	Stir Plate	Cimarec 2 Thermolyne Model S46725
Wet Chemistry	1	Stir Plate	Fisher Vuemix Model 116
Wet Chemistry	1	Stir Plate	Fisher Scientific 11-06000-7S
Wet Chemistry	1	Stir Plate	Fisher Thermix Model 120S
Wet Chemistry	1	Stir Plate	Cimarec 3 Thermolyne Model S47035
Wet Chemistry	8	Dessicators	Boekel
Wet Chemistry	1	Dishwasher	Labconco Flask Scrubber
Wet Chemistry	1	Vacuum Pump	Marathon 5KH36KNA510X
Wet Chemistry	1	Turbidimeter	Hach Model 2100N
Wet Chemistry	1	Lachat Flow Injection Analyzer	QuikChem 8000, Lachate Omnion 2.0 Software Block Digestor Lachat Model BD-46
Wet Chemistry	1	Ion Chromatograph	Dionex ICS-1000, Autosampler Dionex AS-40 Software Dionex Chromeleon
Wet Chemistry	1	Ion Chromatograph	Dionex ICS-1600, Autosampler Dionex AS-40 Software Dionex Chromeleon
Wet Chemistry	2	COD Digestion Blocks	Hach 45600-00
Wet Chemistry	1	COD Temperature Probe	Hach 15-077-14
Wet Chemistry	1	Conductivity Meter	Orion (#9098)
Wet Chemistry	3	Stir Plates	VWR Mini-Stirrer Model 200
Wet Chemistry	1	UV-Vis Spectrophotometer	Hach DR-2500
Wet Chemistry	1	UV-Vis Spectrophotometer	Spectronic 20 Genesys
Wet Chemistry	1	Balance	Mettler Model PM-4600
Wet Chemistry	1	Hot Block	Environmental Express Model SC10
Wet Chemistry	1	Hot Block	Environmental Express Model SC100
Wet Chemistry	1	Refrigerator	Kenmore
Wet Chemistry	1	Refrigerator	Magic Chef
Wet Chemistry	1	TOC Analyzer	Teledyne Tekmar Phoenix 8000 Teledyne Tekmar Autosampler and Software
Wet Chemistry	1	Automatic Titrator	Metrohm Model 719S Titrino Autosampler Metrohm Model 730 Software Beckman Titrino Workcell V4.0

Table 3. List of Standard Operating Procedures

Department	Standard Operating Procedure Title	SOP Number
Bioassay	Quality Systems Manual for the Aquatic Toxicology Laboratory	QC0452
Bioassay	Dissolved Oxygen Measurement by Probe-Membrane Method (EPA 360.1)	QC0489
Bioassay	Test Methods and Protocols for Acute Testing Under the NPDES Program	QC0491
Bioassay	In Vitro Determination of Chlorophylls, a, b, $C_1 + C_2$ and Pheopigments in Marine and Freshwater Phytoplankton by Visible Spectrophotometry	QC0492
Bioassay	Sampling, Preparation and Handling of Dilution Waters and Effluent for Use in NPDES Testing	QC0493
Bioassay	Procedure for Cleaning Labware used in Aquatic Toxicity Testing	QC0496
Bioassay	Fathead Minnow, Pimehales Promelas, Larval Survival and Growth Test, EPA Method 1000.0	QC0503
Bioassay	Daphnid, Ceriodaphnia Dubia, Three Brood Survival and Reproduction Test, EPA Method 1002.0	QC0504
Bioassay	Mysid, Mysidopsis Bahia, Survival, Growth and Fecundity Test, EPA Test Method 1007.0	QC0507
Bioassay	Sheepshead Minnow, Cyprinodon Variegatus, Larval Survival and Growth Test, EPA Test Method 1004.0	QC0632
Bioassay	Atlantic Silverside, Menida Beryllina, Larval Survival, and Growth Test EPA Method 1006.0	QC0634
Bioassay	Standard Operating Procedure for Culturing the Green Algae Selenastrum for Testing and Use as Cladoceran Food	QC0635
Bioassay	Green Alga, Selenastrum Capricornutum, Growth Test Method 1003.0	QC0636
Bottle Preparation	Preparing a Bottle Order	QC0429
Bottle Preparation	Preparation and Storage of Pre-preserved Sample Bottles	QC0458
Bottle Preparation	Preparation of Containers for Soil Samples with Methanol	QC0842
Environmental Administration	Review of Routine Laboratory Results	QC0436
Environmental Administration	Review of Permitted Results	QC0436
Environmental Administration	Preparation of PADEP SDWA-Pb,Cu Forms	QC0451
Environmental Administration	Preparation of PADEP SDWA-1, TTHM, HAA, TOC, Alkalinity, PBCU, Bromide, Bromate, Coliform Check Samples, Chlorine Residual and HPC Forms	QC0453
Environmental Administration	Preparation of PADEP SDWA-4, Inorganic/Organic Chemical and Radiological Analysis Forms	QC0462
Environmental Administration	XMIT Program for Exxon	QC0517
Environmental Administration	Laboratory Information Management System (LIMS) Result Rollback Procedure	QC0571
Field Services	Groundwater Monitoring Well Sampling Procedures	QC0305
Field Services	Trip and Field Blank Preparation	QC0309
Field Services	DPD Chlorine and DPD Bromine Using a Taylor Slide Comparator	QC0317
Field Services	Field Measurement of Conductivity, Standard methods 2510B	QC0331

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Field Services	Field Temperature Measurement	QC0332
Field Services	Field pH Measurement	QC0333
Field Services	Procedure for Collection & Submittal of VOC Field Reagent Blanks for Drinking Water Samples	QC0374
Field Services	Field Sampling Procedure for Swimming Pools, Wading Pools, Hot Tubs, Spas and Bathing Beaches	QC0538
Field Services	Field pH using a Taylor Slide Comparator	QC0547
Field Services	General Field Sampling Procedures	QC0548
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – General Requirements	QC0591
Field Services	NJ Private Well Testing Act (PWTA)– Microbiological Sampling	QC0591A
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – Volatile Organics	QC0591B
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – Nutrients	QC0591C
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – Metals	QC0591D
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – Field pH Measurement	QC0591E
Field Services	NJ Private Well Testing Act (PWTA) Sampling Procedures – GPS Readings	QC0591F
Field Services	NJ PWTA Sampling Procedures – 24 Hour Gross Alpha	QC0591G
Field Services	Sampling of Ice Cream and Frozen Desserts	QC0620
Field Services	Documentation of Field Measurements	QC0637
Field Services	Measurement of Free & Total Chlorine using the Hach® Pocket Colorimeter II	QC0661
Field Services	Low Flow Groundwater Monitoring Well Sampling Procedure	QC0663
Field Services	Grab and Composite Sampling Procedure	QC0664
Field Services	Sampling Procedure for the DRBC PCB Project	QC0711
General	Thermometer Calibration, Maintenance, and Record keeping	QC0339
General	Documentation of Laboratory Data	QC0343
General	Routine and Non-routine Instrument Maintenance	QC0417
General	Laboratory Balance Calibration	QC0470
General	Calibration Verification of Air Displacement Pipetters and non-Class A Disposable or Reusable Pipets	QC0472
General	Calibration of Reagent Delivery Pumps	QC0473
General	Purchasing of Services and Supplies	QC0478
General	Waste Disposal in the Laboratory	QC0479
General	Reagent/Reference Material Receipt, Labeling, Expiration, Storage and Disposal	QC0486
General	Proper Manual Integration Techniques for GC and GC/MS Chromatography	QC0559
General	Review Guidance for Data Deliverables Generated by EISC Software	QC0640

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
General	Culture Transfers between EQC Satellite Offices and the Southampton Laboratory	QC0760
General	Media Transfers between Southampton Laboratory and the EQC Satellite Offices	QC0761
General	Pest Management	QC0797
General	Change Control	QC0838
Metals	Mercury-Manual Cold Vapor Technique, EPA 245.1	QC0263
Metals	Determination of Trace Metals by Graphite Furnace Atomic Absorption, SM 3113B-2011	QC0265
Metals	Glassware Cleaning Procedure for Metals Analyses	QC0272
Metals	Metals and Trace Metals by Inductively Coupled Plasma (ICP) in Aqueous samples by EPA 200.7	QC0280
Metals	Mercury-Manual Cold Vapor Technique Method 7470A	QC0354
Metals	Mercury-Manual Cold Vapor Technique, SW846 Method 7471A & 7471B	QC0355
Metals	Acid Digestion of Aqueous Samples and Extracts for Analysis by SW846 Method 6010 (ICP)	QC0356
Metals	Acid Digestion of Sediments, Sludges, and Soils by Method EPA 3050B for ICP-AES Metals Analysis by Method 6010	QC0371
Metals	Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by SW846 Method 6010 (ICP)	QC0373
Metals	Turbidity Testing for Metals Digestion (Nephelometric) EPA Method 180.1	QC0430
Metals	Nitric Acid Digestion of Aqueous Samples by SM3030 E- 2004	QC0589
Metals	Calibration Validation of Digestion Vials	QC0592
Metals	Metals and Trace Elements by Inductively Coupled-Plasma Mass Spectroscopy (ICP-MS) by EPA 200.8	QC0599
Metals	Sample Preparation Procedure for the Digestion of Aqueous Samples for Total Recoverable Elements by EPA Method 200.2 for Analysis by EPA Methods 200.7, 200.8 and 200.9	QC0618
Metals	Metals and Trace Elements in Environmental Samples By Inductively Coupled Plasma (ICP) SW-846 Method 6010C	QC0757
Metals	Microwave Assisted Acid Digestion of Sediments, Sludges and Oils Method 3051A	QC0810
Metals	Metals and Trace Elements in Environmental Samples by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) by SW-846 Method 6020A	QC0829
Metals	Metals and Trace Elements in Food and Nutritional Samples by Inductively Coupled Plasma (ICP) AOAC Method 990.08	QC0910
Organic Extractions	Pressurized Fluid Extraction (PFE) EPA method 3545A	QC0415
Organic Extractions	Labware Washing Procedure for the Organic Extraction Laboratory	QC0469
Organic Extractions	Solid Phase Extraction-Herbicides by Method EPA 3535A	QC0674
Organic Extractions	Florisil Cleanup EPA 3620C	QC0677

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Organic Chemistry	Diesel and Gasoline Range Organics by Gas Chromatography Based on USEPA SW-846 Method 8015B	QC0358
Organic Chemistry	Chlorinated Herbicides by Gas Chromatography based on EPA Method 8151A	QC0360
Organic Chemistry	1,2-Dibromomethane (EDB), 1,2-Dibromo-3-Chloropropane (DBCP), 1,2,3-Trichloropropane (1,2,3TCP) by Gas Chromatography based on EPA Methods 504.1 and 8011	QC0368
Organic Chemistry	Chlorinated Phenoxy Acid Herbicides by Gas Chromatography Based on Standard Methods 6640B	QC0412
Organic Chemistry	Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography based on USEPA Method 608	QC0425
Organic Chemistry	Determination of Haloacetic acids in Drinking Water based on EPA Method 552.2	QC0555
Organic Chemistry	Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) by Gas Chromatography based on SW846 Methods 8081 and 8082	QC0641
Organic Chemistry	Total Semivolatile Petroleum Hydrocarbons by Gas Chromatography Based on Method NJDEP OQA-QAM-025	QC0680
Organic Chemistry	The Determination of Extractable Petroleum Hydrocarbon Compounds by Flame Ionization Gas Chromatography Method NJ EPH 10/08	QC0756
Organic Chemistry	Determination of Chlorinated Pesticides in Drinking Water By Gas Chromatography with Electron Capture Detector (Method EPA 508 Revision 3.1)	QC0823
Organic Chemistry	Determination of Chlorinated Acids in Drinking Water by Liquid-Liquid Extraction, Derivatization and Gas Chromatography with Electron Capture Detection (EPA Method 515.3 Revision 1.0)	QC0824
Organic Chemistry	Determination of Ethylene Glycol, Propylene Glycol and Diethylene Glycol by Direct Aqueous Injection Using Gas Chromatography-Flame Ionization Detector	QC0825
Organic Chemistry	Analysis of Dissolved Gases in Water Using Headspace Autosampler and Flame Ionization Based on Method PA-DEOP 3686	QC0834
Quality Assurance	Content, Format, Preparation, Review, Approval, Distribution, Revision and Control of Standard Operating Procedures	QC0310
Quality Assurance	Content, Format, Preparation, Review, Approval, Distribution, Revision and Control of Administrative Standard Operating Procedures	QC0418
Quality Assurance	Archiving and Storage of Data Files and Computer Media	QC0460
Quality Assurance	Acceptance Criteria for Unspecified Methods	QC0485
Quality Assurance	Annual Review of Operations and Internal Quality Assurance Assessments	QC0488
Quality Assurance	Method Detection Limit Determination	QC0495
Quality Assurance	General Preparation and Evaluation of Demonstrations of Capability	QC0499
Quality Assurance	Customer Complaints	QC0510
Quality Assurance	Data Variance Requests	QC0515
Quality Assurance	Good Laboratory Practice	QC0673
Quality Assurance	Determination of LOD and LOQ	QC0684
Quality Assurance	Measurement of Uncertainty	QC0831
Sample Custody	Completing a Chain of Custody Form	QC0302
Sample Custody	Sample Log-in Procedure	QC0303
Sample Custody	Sample Storage Procedure	QC0308

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Sample Custody	Sample Compositing and Sub-sampling	QC0338
Sample Custody	Policy for the Acceptance and Rejection of Environmental Samples	QC0346
Sample Custody	Sample Transfers Between EQC, Satellite Offices and the Southampton Laboratory	QC0432
Sample Custody	Electronic Chain of Custody and Sample Transfer	QC0468
Sample Custody	Preparation of ID Cards for Electronic Sample Custody Transfer	QC0511
Sample Custody	Sample Handling: Details Addressing Sample Movement from the Field or Deliveries to the Satellite and Testing Labs	QC0889
Semivolatile Organics	Semivolatile Organic Compounds Analyzed by GC/MS: SW846-8270C	QC0321
Semivolatile Organics	Semivolatiles Analyzed by EPA Method 625	QC0322
Semivolatile Organics	Reporting of Tentatively Identified Compounds Determined from Mass Spectral Analysis	QC0583
Semivolatile Organics	Semivolatile Organic Compounds Analyzed by GC/MS: EPA 525.2	QC0676
Semivolatile Organics	Semivolatile Organic Compounds Analyzed by GC/MS: SW846-8270D	QC0682
Volatile Organics	Determination of Volatile Organic Compounds by GC/MS: EPA Method 8260B	QC0320
Volatile Organics	Determination of Volatile Organic Compounds by GC/MS: EPA Method 624	QC0329
Volatile Organics	Determination of Volatile Organic Compounds in Drinking Water by GC/MS-EPA Method 524.2	QC0340
Volatile Organics	Determination of Volatile Organic Compounds by EPA 8260C	QC0681
Water Microbiology	Heterotrophic Plate Count by Standard Methods, 9215B (2000)	QC0439
Water Microbiology	Membrane Filter Technique for Members of the Coliform Group (SM9222B-1997, SM21st Ed.)	QC0440
Water Microbiology	Membrane Filter (MF) Technique for Members of the Fecal Coliform Group (SM21st Ed. 9222D)	QC0441
Water Microbiology	Multiple Tube Fermentation (MPN) Technique for Members of the Coliform Group SM9221B,C,E,F-2006)	QC0442
Water Microbiology	Membrane Filter (MF) Technique for Members of the Fecal Streptococcus and Enterococcus Groups SM9230C-2007	QC0444
Water Microbiology	Chromogenic Substrate Technique for Total Coliform and E. Coli (Colilert®) SM9223B 21st Ed.	QC0446
Water Microbiology	Media and Broth Preparation (SM20th Ed., 9050)	QC0448
Water Microbiology	Environmental Monitoring of the Laboratory (Standard Methods 9020B-2005)	QC0477
Water Microbiology	Preparation of Bottles Used for Environmental Microbiological Testing (SM 20th Ed., 9030B, 9040)	QC0480
Water Microbiology	Entering and Verifying Environmental Microbiology Results	QC0481
Water Microbiology	Operation and Maintenance of the Consolidated SR-24C Autoclaves	QC0482
Water Microbiology	Preparation of Phosphate-Buffered Dilution and Rinse Water (Standard Methods, 21st Ed., 9050C)	QC0500
Water Microbiology	Salmonella (SM 9260D)-1997	QC0512

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Water Microbiology	Water, Waste water, Sludge and Compost Sampling for Microbiological Testing (SM 20th Ed., Methods 9060, 9213)	QC0519
Water Microbiology	Repeat Monitoring for Samples that are in Violation of the National Primary Drinking Water Regulations	QC0586
Water Microbiology	Membrane Filter (MF) Technique for Enterococci (EPA 1600)	QC0613
Water Microbiology	Membrane Filter (MF) Technique for E. Coli in Natural Bathing Beach Waters (SM 20th Ed., 9213D)	QC0617
Water Microbiology	Membrane Filter (MF) Technique for Pseudomonas aeruginosa (SM 20th Ed., 9213E)	QC0624
Water Microbiology	E. Coli in Water by Membrane Filtration using membrane-Thermotolerant Escherichia Coli, (mTEC) EPA1103.1	QC0642
Water Microbiology	*E. coli* in Water by Membrane Filtration using modified Membrane-Thermotolerant *Escherichia coli* Agar (Modified mTEC) (EPA 1603)	QC0665
Water Microbiology	Multiple Tube Fermentation (MPN) Technique for Members Fecal Coliform Group for Sewage Sludge (Biosolids)	QC0759
Water Microbiology	Water Microbiology Sample Receipt and Prioritization	QC0800
Water Microbiology	Documentation of Water Micro data in Logbooks	QC0811
Water Microbiology	Cleaning and Sanitizing Environmental Microbiology Laboratory	QC0818
Water Microbiology	Detection of Pseudomonas Aeruginosa in Recreation Waters (IDEXX Pseudalert Test Method)	QC0839
Water Microbiology	Chromogenic Substrate Technique for Total Coliform and Escherichia Coli by SM9223B (Colilert-18) 2004	QC0888
Water Microbiology	LIMS Report Comments: Water Microbiology Department	QC0901
Wet Chemistry	Specific Conductance Standard Methods 2510B and EPA SW-846 Method 9050	QC0094
Wet Chemistry	Determination of Dissolved Solids by Gravimetric Oven Drying Standard Methods 2540C-2011	QC0123
Wet Chemistry	EPA Method 1664B, n-Hexane Extractable Material and Silica Gel Treated n-Hexane Extractable Material by Solid Phase Extraction	QC0319
Wet Chemistry	Nitrite-Nitrogen: Colorimetric Standard Methods 4500NO_2-B	QC0347
Wet Chemistry	Paint Filter Liquids Test (SW846 9095B)	QC0379
Wet Chemistry	Soil and waste pH EPA 9045	QC0380
Wet Chemistry	pH, Electrometric Measurement (Method 9040)	QC0381
Wet Chemistry	Toxicity Characteristic Leaching Procedure (TCLP): SW846 Method 1311	QC0382
Wet Chemistry	Determination of Inorganic Ion by Ion Chromatography, SW846 Method 9056	QC0385
Wet Chemistry	Total Organic Halides by EPA 9020B and Standard Methods 5320B	QC0386
Wet Chemistry	Ignitability of Solids, SW-846 Method 1030	QC0387
Wet Chemistry	Pensky-Martens Closed-Cup Method for Flashpoint SW846 1010A and ASTM D93-80	QC0389
Wet Chemistry	Synthetic Procedure Leaching Procedure, Method 1312	QC0391

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Wet Chemistry	Chromium Hexavalent by EPA Method 7196A	QC0392
Wet Chemistry	Total and Amenable Cyanide Distillation, SW846 Method 9010C	QC0393
Wet Chemistry	Manual Spectrophotometric and Titrimetric Determinative Method for Cyanide Using SW846 Method 9014	QC0394
Wet Chemistry	Determination of Reactive Cyanide and Reactive Sulfide, SW846 Chapter 7	QC0396
Wet Chemistry	Titrimetric Procedure for Sulfide, SW-846 Method 9034	QC0397
Wet Chemistry	Alkalinity: All forms. Titration to a pre-determined pH Standard Methods 20th 2320B	QC0408
Wet Chemistry	Labware Washing Procedure For the General Chemistry and Water Microbiology Departments	QC0409
Wet Chemistry	Turbidity, (Nephelometric)	QC0410
Wet Chemistry	Determination of Inorganic Ions by Ion Chromatography, EPA Method 300.0	QC0411
Wet Chemistry	Total Recoverable Phenols: Method 420.1 and Method 9065 (Spectrophotometric, Manual 4-AAP with Distillation)	QC0422
Wet Chemistry	Chromium Hexavalent Standard Methods: Colorimetric Method 3500Cr-B, 2011	QC0424
Wet Chemistry	Nitrogen, Ammonia-Potentiometric, Ion Selective Electrode by Method SM4500NH3-D	QC0456
Wet Chemistry	n-Hexane Extractable Material (HEM) for Sludge, Sediment and Solid Samples, SW846 Method 9071B	QC0457
Wet Chemistry	Chemical Oxygen Demand, Reactor Digestion Method-Hach Procedure 8000	QC0464
Wet Chemistry	Nitrate plus Nitrite and Nitrite alone, Automated Cadmium Reduction, SM4500 NO3-F	QC0466
Wet Chemistry	pH, Electrometric Measurement	QC0467
Wet Chemistry	Alkaline Digestion for Hexavalent Chromium, SW846 Method 3060A	QC0471
Wet Chemistry	Total Cyanide and Cyanide Amenable to Chlorination Manual Distillation, Colorimetric, SM4500 CN-C, E and G	QC0475
Wet Chemistry	Total Carbon and Total Organic Carbon by Combustion SW846-9060	QC0487
Wet Chemistry	Color by Visual Comparison Method, Platinum-Cobalt, SM2120B Rev. 2011	QC0494
Wet Chemistry	Salinity-Electrical Conductivity Method Standard Methods 20th 2520B	QC0514
Wet Chemistry	Phosphorous, Colorimetric, Single Reagent, All forms of Phosphorous Standard Methods 4500-P,B.5, E	QC0535
Wet Chemistry	Total Solids, Dried at 103-105 °C Standard Method 2540B 2011	QC0536
Wet Chemistry	Total Suspended Solids (TSS), (Non-Filterable Residue), and Total Suspended Volatile Solids (TSSVS) Method SM2540D and 2540E APPROVED 1997, Editorial Revisions 2011	QC0537
Wet Chemistry	Total Solids in Solids and Semi-Solid Samples, Dried at 103-105 °C, Standard Methods 2540G	QC0542
Wet Chemistry	Volatile and Fixed Solids and Semi-Solid Samples, Ignited at 550 degree C, SM2540G	QC0543
Wet Chemistry	Volatile Residue (Solids) Following ignition at 550 °C Method: EPA 600, 160.4	QC0544
Wet Chemistry	Acidity, Titration to pH 8.3-Standard Methods 2310B	QC0545
Wet Chemistry	Nitrogen Ammonia-Preliminary Distillation Step SM 4500 NH3-B	QC0546

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Wet Chemistry	Nitrogen-Total Kjeldahl, Semi-Automated Colorimetry, EPA 351.2	QC0549
Wet Chemistry	Biochemical Oxygen Demand (BOD) and Carbonaceous BOD (cBOD) Standard Methods 5210B 2011	QC0550
Wet Chemistry	Dissolved Oxygen-Azide Modification Standard Methods, 22nd Ed 4500 O-C	QC0551
Wet Chemistry	Oxidation -Reduction Potential of Water, Method 2580B	QC0554
Wet Chemistry	Free and Total Chlorine Measurement in the Laboratory DPD Colorimetric Method SM4500 Cl-G	QC0556
Wet Chemistry	Ammonia as N, Distillation/Titration, Standard Methods 4500 NH3-B, C	QC0558
Wet Chemistry	Dissolved Oxygen-Modified Winkler Azide Method, HACH-Dissolved Oxygen Test Kit for Field Measurements	QC0567
Wet Chemistry	Sulfide: Colorimetric Methylene Blue Method:SM4500 S^2-D-2011	QC0569
Wet Chemistry	Chlorine: Free or Combined Forms DPD-FAS Titrimetric, Standard Methods: 4500-Cl2-F	QC0578
Wet Chemistry	Sulfite-Iodometric Titration	QC0580
Wet Chemistry	Settleable Solids-Imhoff Cone	QC0584
Wet Chemistry	Methylene Blue Active Substances-Anionic Surfactants as MBAS, Standard Methods 5540C	QC0585
Wet Chemistry	Total Organic Carbon Heated Persulfate Oxidation Method Standard Methods 5310C	QC0590
Wet Chemistry	Total Organic Carbon Method: USP 643 for Purified Water	QC0594
Wet Chemistry	UV Absorbing Organic Constituents, UV254	QC0595
Wet Chemistry	Chlorine Demand/Requirement Standard Methods 2350B	QC0598
Wet Chemistry	Threshold Odor Test Standard Methods: 2150B	QC0615
Wet Chemistry	Extractable Organic Halides (EOX) in Solids EPA Method: SW846- 9023	QC0616
Wet Chemistry	Multiple Extraction Procedure: Method 1320 (modified)	QC0621
Wet Chemistry	Organic and Volatile Acids, Distillation Method, Standard Methods 20th 5560C	QC0622
Wet Chemistry	Carbon Dioxide-Titrimetric Method, Standard Methods 4500CO2-C	QC0625
Wet Chemistry	Reserve Alkalinity for Solid Wastes	QC0626
Wet Chemistry	Total Organic Content by ASTM D2974	QC0628
Wet Chemistry	Total Chlorine (TX) in New and Used Petroleum Products EPA Method SW846 9076	QC0629
Wet Chemistry	Dissolved Oxygen-Membrane Electrode Method Standard Methods, 22nd Edition, 4500 O-G	QC0644
Wet Chemistry	Elutriate Preparation: Modified Elutriate Test	QC0649
Wet Chemistry	Shake Extraction of Solid Waste with Water by Method ASTM D3987-85	QC0686
Wet Chemistry	Perchlorate in Water via Ion Chromatography	QC0700
Wet Chemistry	Saturation Index (SI) Using SM2330B	QC0701
Wet Chemistry	Nitrite: Colorimetric Analysis Discrete Colorimetric Analyzer, Standard Methods 4500NO2 B Equivalent	QC0702

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Wet Chemistry	Acid Producing Soil: pH and Qualitative Sulfate Test	QC0713
Wet Chemistry	Specific Gravity and Density Standard Methods SM2710F	QC0772
Wet Chemistry	Bulk Density	QC0773
Wet Chemistry	Determination of Moisture Content in Cocoa Beans by Method ISO-2291	QC0774
Wet Chemistry	Moisture Content in Food AOAC Official Method 950.46, Modified	QC0781
Wet Chemistry	Ortho Phosphorous Automated Ascorbic Acid Reduction Standard Methods 4500 P-F Discrete Auto Analyzer	QC0783
Wet Chemistry	Sieve Analysis with Hydrometer ASTM D 422-85 and ASTM D 422-43	QC0784
EQC-Delaware*		
General	Determination of Temperature by Standard Methods-SM2550B (For use EQC-Delaware)	QC0862
General	Calibration of Eppendorf and Mechanical Volumetric Pipets (For use at EQC-Delaware)	QC0866
Water Microbiology	Total Coliform and Fecal Coliform by Membrane Filtration by SM9222B-1997 (For Use at EQC-Delaware)	QC0843
Water Microbiology	Heterotrophic Plate Count by SM9215B-2004 (For use at EQC-Delaware)	QC0844
Water Microbiology	E. Coli by Most Probable Number (MPN), 9221F (For EQC-Delaware)	QC0853
Water Microbiology	Glassware Washing and Testing in Microbiological Laboratory (For use at EQC-Delaware)	QC0856
Water Microbiology	Operation of Autoclaves in the Microbiology Laboratory (For use at EQC-Delaware)	QC0857
Water Microbiology	Testing of Sample Containers used for Collection of Microbiological Samples (For use at EQC-Delaware)	QC0858
Water Microbiology	Total Coliform by Most Probable Number (MPN) Standard Methods SM 9221B-2006 (For use at EQC-Delaware)	QC0859
Water Microbiology	Fecal Coliform by Membrane Filtration Standard Methods:9222D-2006 (For use at EQC-Delaware)	QC0860
Water Microbiology	Total Coliform and E. Coli by Chromogenic Substrate by Standard Methods; SM9223B-2004 (For use at EQC-Delaware)	QC0861
Water Microbiology	Fecal Streptococcus and Enterococcus by Most Probable Number (MPN) Standard Methods 9230B-2007 (For use at EQC-Delaware)	QC0863
Water Microbiology	Fecal Coliform by Most Probable Number (MPN) Standard Methods: 9221E-2006 (For use at EQC-Delaware)	QC0864
Wet Chemistry	Determination of Dissolved Solids by Gravimetric Oven Drying by Standard Methods 2540C-2011, (For use at EQC-Delaware)	QC0850
Wet Chemistry	Specific Conductance Standard Methods 2510B and SW-846 9050 (For Use at EQC-Delaware)	QC0852
Wet Chemistry	Methylene Blue Active Substances-Anionic Surfactants as MBAS Standard Methods 5540C (For EQC-Delaware)	QC0854

Table 3. List of Standard Operating Procedures (continued)

Department	Standard Operating Procedure Title	SOP Number
Wet Chemistry	Calibration of Eppendorf and Mechanical Volumetric Pipets (For use at EQC-Delaware)	QC0866
Wet Chemistry	pH and Alkalinity: All Forms by Titration to a Pre-Determined pH, SM 4500-H^+ and SM 2320B (For use at EQC-Delaware)	QC0867
Wet Chemistry	Threshold Odor Test by Standard Methods 2150B (For use at EQC-Delaware)	QC0868
Wet Chemistry	Ammonia, Flow injection Analysis Colorimetry Standard Methods 4500-NH3-G (For use at EQC-Delaware)	QC0869
Wet Chemistry	Biochemical Oxygen Demand (BOD) and Carbonaceous Biochemical Oxygen Demand (cBOD) by Standard Methods 5210B (For use at EQC-Delaware)	QC0870
Wet Chemistry	Hexavalent Chromium, Colorimetric, Diphenylcarbazide Standard Methods: SM3500 Cr-B (For use at EQC-Delaware)	QC0871
Wet Chemistry	Determination of Total Volatile Solids (TVS) EPA 160.4 (For use at EQC-Delaware)	QC0874
Wet Chemistry	Determination of Total Solids Standard Methods 2540B (For use at EQC-Delaware)	QC0875
Wet Chemistry	Determination of Settleable Solids Standard Methods: SM2540F (For use at EQC-Delaware)	QC0877
Wet Chemistry	Determination of Total Suspended Solids (TSS) and Total Suspended Volatile Solids Standard Methods: SM2540D and SM2540E (For use at EQC-Delaware)	QC0878
Wet Chemistry	Color by Visual Comparison Method, Platinum-Cobalt, SM 2120B Rev. 2011 (For use at EQC-Delaware)	QC0879
Wet Chemistry	Determination of Inorganic Ions by Ion Chromatography EPA 300.0 Rev. 2.1 (For use at EQC-Delaware)	QC0882
Wet Chemistry	Turbidity, (Nephelometric)-SM2130B (For use at EQC-Delaware)	QC0883
Wet Chemistry	Determination of ortho-Phosphorous in Aqueous Matrices Standard Methods 4500-P E (For use at EQC-Delaware)	QC0884
Wet Chemistry	Total Organic Carbon-Heated Persulfate Oxidation Method Standard Methods: 5310C (For use at EQC-Delaware)	QC0885

EQC-Delaware: These SOPs are applicable to EQC-Delaware only. Please contact the QA Department of EQC For a listing of General SOPs applicable to each department.*

Eurofins QC, Inc.
Quality Systems Manual – Interim Amendment 1

During the period of Q1 through Q3 2016, transitions are underway affecting the Eurofins QC, Inc. (EQC) operations of the Southampton PA laboratory location at 1205 Industrial Blvd and the Horsham PA location at 702 Electronic Drive. The laboratory operations currently performed at the Southampton lab are being moved and the location will ultimately be closed. Chemistry testing is being moved to Eurofins Lancaster Laboratories Environmental (ELLE) in Lancaster PA at 2425 New Holland Pike. Aquatic Toxicology and Microbiology testing currently performed in Southampton is being moved to Horsham. In addition, in February 2016, Oommen Kappil (QA Director of record in the manual) left Eurofins. QA responsibilities are being addressed through Eurofins Environment Testing US by ELLE QA Director, Dorothy Love, effective February 13, 2016.

As a result of the above listed transitions, the current EQC Quality Systems Manual (revision 26, effective 11/30/2015) contains some obsolete information. The manual will not be updated until after all transitions are complete and the Southampton operations cease. In the interim, this amendment serves to identify the sections of the manual that will need to be revised and what the changes will cover.

Section	Change
Cover	Change address to Horsham location
Approvers	List David Speis, Raphael Fratti, Erich Walter, Dorothy Love
Throughout	Change scope of service to be Aquatic Toxicology, Microbiology, and Pharmaceutical Product Testing
3.1.3	Remove Horsham as a satellite location as it will be the main laboratory location
Throughout	Remove all references to Southampton and simply make reference to the laboratory
4.1.1; 23.1.1; 24.1.3	Floor plans – note that these are available for review onsite but, due to security reasons, are not published in the quality manual or provided externally.
Throughout	Remove any sections detailing chemistry specific QC and calibration practices.
10.1.6; 16.3; 16.4	Refers to archives and server at Southampton – update location for these
Multiple	Discussions for client account history files and data review requests will need to be evaluated with the use of eLIMS-EP
12.1-9; 13.1.5; 17.1.2	Specifies CAPA and DVR reviews by the QA director. These may be handled by other QA staff. Add "or designee".
21.5	Describes building security access for Southampton. Revise to address Horsham.
24.1.3	DI water test plan, evaluate any changes that may be in place for Horsham.
25.7.1	Describe electronic sample tracking used at Southampton. Address with what will be used at Horsham.
Figure 1	Replace Oommen Kappil with Dorothy Love as the QA Director; update other positions when the transitions are complete.
Table 1 through 3	All will be revised for reduced scope of work at Horsham.

Interim Amendment Approvals:

David Speis, President
Technical Director, Organics

25 Mar 2016
Date

Raphael Fratti, Lab Director
Technical Director, Inorganics

3/28/2016
Date

Erich Walter
Technical Director, Microbiology

3/28/2016
Date

Dorothy Love
Quality Assurance Director

3/25/2016
Date

APPENDIX B

EuroFins QC Laboratory Standard Operating Procedures

Eurofins QC, Inc. UNCONTROLLED DOCUMENT
This document is valid only to the date shown below. Updates may be issued after this date which you will not receive. Use at your own discretion. This document is not for Eurofins QC, Inc. laboratory use.
PH / 10/13/16 (Initials / Issue Date)
Next Rev (Valid Thru)

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SOP Number QC0441
Membrane Filter (MF) Technique for Members of the Fecal Coliform Group (SM 9222D-2006, Standard Methods, 22nd Ed.)

CONFIDENTIAL

Revision: 00	Date: 02/01/00
Revision: 01	Date: 01/16/01
Revision: 02	Date: 01/07/03
Revision: 03	Date: 12/16/04
Revision: 04	Date: 01/05/05
Revision: 05	Date: 11/21/05
Revision: 06	Date: 03/03/06
Revision: 07	Date: 11/17/08
Revision: 08	Date: 04/01/10
Revision: 09	Date: 07/20/10
Revision: 10	Date: 10/27/11
Revision: 11	Date: 12/15/14
Revision: 12	Date: 07/29/15
Revision: 13	Date: 01/08/16
Revision: 14	Date: 05/31/16
Revision: 15	Date: 09/30/16

Prepared/Revised By	: Tamara Charnauski	Date:	09/30/2016
Reviewed By	: Raphael Fratti	Date:	10/04/2016
QA Approval	:	Date:	10/11/16
Management Approval	:	Date:	10/12/16
Effective Date	: 10/13/16		

1.0 Scope and Application

1.1 This Standard Operating Procedure (SOP) is used to determine the density of fecal coliform bacteria by the membrane filtration (MF) technique. The MF technique is highly reproducible, can be used to test relatively large sample volumes and yields results more rapidly than the multiple-tube procedure. The MF technique is extremely useful in monitoring the quality of a variety of natural and recreational waters (lakes, streams, pools, etc.) as well as wastewaters (chlorinated effluents) and may be used in the examination of saline waters.

1.2 This SOP is for use at all Eurofins QC, Inc. (EQC) microbiology departments. Note: the Delaware laboratory in New Castle DE, maintains a separate SOP for fecal coliform by membrane filtration.

2.0 Summary and Discussion of Procedure

2.1 The MF procedure uses an enriched lactose medium and incubation temperature of 44.5 ± 0.2 °C for selectivity and gives 93% accuracy in differentiating between coliforms found in the feces of warm-blooded animals and those from other environmental sources. The sample volume will be dependent on the site from which the sample was taken. Small sample volumes may be necessary for waters in which high turbidity and/or historically elevated levels of fecal coliforms have been

observed. Samples are filtered through a sterile 47 mm, 0.45 micron membrane filter and incubated on M-FC agar for 24 ± 2 hours in a water bath at 44.5 ± 0.2 °C. Colonies produced by fecal coliform on M-FC medium are various shades of blue. Non-fecal coliform colonies are gray to cream-colored.

3.0 Definitions

3.1 *Fecal coliform*: A subgroup of the total coliform group found in the intestinal tract of warm blooded animals distinguished by its ability to grow at elevated temperatures. The occurrence of these bacteria is considered a specific indicator of fecal contamination.

3.2 *Holding Time*. The maximum time a sample may be held prior to analysis. For Microbiology testing the holding time for a sample is determined from the time a sample is collected to the time the sample incubation begins.

4.0 Health and Safety Warnings

4.1 Personnel engaged in laboratory analyses at EQC must be familiar with and adhere to the policies set forth in the current version of the EQC Safety Procedure Manual.

5.0 Cautions

5.1 Start microbiological examination of a water sample promptly after collection to avoid unpredictable changes.

5.1.1 Any deviances in transport or analyzing holding times, missing sampling information, sample volume, or test performed must be communicated to the client representative and notes made in the sample login and history log.

6.0 Interferences

6.1 High levels of background (non-coliform) bacteria, (i.e. 10^4 or greater), may lead to false negative results.

6.2 The MF procedure has limitations, particularly when testing waters with high turbidity or non-coliform (background) bacteria. It cannot be used to assess the quality of wastewaters that have received only primary treatment followed by chlorination because of turbidity in high volume samples or wastewaters containing toxic metals or toxic organic compounds such as phenols.

7.0 Personnel Qualifications

7.1 Before performing this test independent of secondary supervision and review, each analyst must have an approved Demonstration of Capability Certification Statement (DOC) form (see SOP QC0499) on file in the Quality Assurance office.

8.0 Equipment, Apparatus and Materials

8.1 Erlenmeyer flask-clean borosilicate, pre-sterilized for mixing media.

8.2 Petri dishes-60x15 mm pre-sterilized, plastic petri dishes.

8.3 95% ethanol.

8.4 Water bath capable of maintaining a temperature of 44.5 ± 0.2 °C.

8.5 Incubator capable of maintaining a temperature of 35 ± 0.5 °C.

8.6 Dissecting microscope 10-15x with fluorescent light source.

8.7 Filter funnels-47 mm magnetic (Gelman or equivalent).

8.8 Membrane filters-47 mm/0.45 micron sterile membrane filters (Millipore or equivalent).

8.9 Forceps.

8.10 Water-proof plastic bags.

8.11 Rosolic acid. Mix 0.5g of Rosolic Acid with 50 mL of sterile water and 10 mL of 1 N NaOH. Store Rosolic solution in refrigerator until use. Expiration date is two weeks. Record all media preparation data in the Electronic Media Prep Validation logbook as directed in SOP QC0448.

8.12 Vacuum manifold and pump.

8.13 M-FC agar (Acumedia or equivalent): Used for the enumeration of fecal coliform by the MF method. Rehydrate 52 gm of product per 1 L of purified water. Mix with agitation and heat to near boiling to dissolve medium and then remove from hotplate. Do not boil. Add 10 mL of 1% of Rosolic acid dissolved in 0.2 N NaOH. Allow for cooling to below 50 °C. Do not sterilize in autoclave. Dispense 5-7 mL in each 15 x 60 mm petri dishes and let solidify. Final pH should be 7.4 ± 0.2. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container with the date prepared, batch ID, date EXP, Lot #, temperature for storage and method name. Refrigerate finished media in tightly sealed containers and give a two-week expiration date. Store all prepared plates at 2-8 °C. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for M-FC is *E. coli* and the negative is *E. aeruginosa*. Each new lot of medium must be tested against an acceptable previous lot. Let the water micro manager know when a new lot of media is being made.

8.14 EC broth (Acumedia or equivalent): Used for confirmation of fecal coliform at 44.5 °C. Add 37 grams of medium to 1 liter of purified water. Mix thoroughly. Dispense 10 mL portions into autoclavable, borosilicate glass tubes (with fermentation vials in them) of sufficient size to contain both the culture media and the sample without being three quarters full. Autoclave prepared media at 121 °C for 15 minutes. Final pH must be 6.9 ± 0.2. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Give media a two-week expiration date from prepared date for tubes with "pop" tops and three months for tubes with "screw" tops. Store in a cool, dry, location out of the way of direct light. Test for sterility and growth promotion properties as directed in SOP QC0448.

8.15 Lauryl Tryptose Broth (LTB) (Acumedia or equivalent): Used for the detection of coliform bacteria. Add 35.6 g of powder to 1 L of purified water. Mix thoroughly. Warm slightly to completely dissolve the powder. Dispense 10 mL portions into autoclavable, borosilicate glass tubes (with fermentation vials in them) of sufficient size to contain both the culture media and the sample without being three quarters full. Autoclave prepared media at 121 °C for 15 minutes. Cool the broth as quickly as

possible. Final pH after autoclaving must be 6.8 ± 0.2. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, media lot number, storage temp, method number and media name. Store in a cool, dry location out of the way of direct light. Give media a two-week expiration date from prepared date for tubes with "pop" tops and three months for tubes with "screw" tops. Test for sterility and growth promotion properties as directed in SOP QC0448.

8.16 Phosphate Buffered Dilution water: Prepare as directed in SOP QC0500. The amount of media prepared can be adjusted accordingly to the work load. Record prepared dilution water in the Electronic Media Prep Validation logbook as directed in SOP QC0448.

8.17 Sodium Thiosulfate – 100 mg/10 mg active tablets (Cargille Corp. or equivalent) or 10% solution.

8.18 Bottles-125 mL, polypropylene, autoclavable (Single use, sterilized coliform containers from a reputable manufacturer may be used).

8.19 Autoclave indicator tape.

8.20 Weights to keep samples submerged during incubation.

8.21 Computer capable of running live analysis time via the WM electronic logbook.

8.22 Positive control culture, *E. coli* ATTC 11775 or equivalent (BioBalls).

8.23 Negative control culture, *E. aeruginosa* ATTC 13048 or equivalent (BioBalls).

8.24 Autoclave bags for funnel sterilization.

8.25 Syringes- plastic, sterile (10 mL)

9.0 Calibration

9.1 Calibrate thermometers used to monitor the temperature of incubators and water baths against a NIST thermometer annually according to SOP QC0339.

9.2 Schedule annual calibration and maintenance of balances through the manufacturer or other qualified, contracted personnel.

9.3 Calibrate pH meters according to manufacturer's recommendations and SOP QC0467. Record daily calibrations in the Media Prep pH logbook.

9.4 Check incubator temperatures twice daily to ensure temperature requirements are being met. Record readings in the temperature logbooks.

10.0 Sample Preparation and Analysis

10.1 Collect samples as directed in SOP QC0519 Water, Wastewater, Sludge and Compost Sampling for Microbiological Testing. Maintain sample temperatures following collection and transport to the laboratory, on ice between 0 and 10 °C (do not freeze). When samples are stored at the testing laboratory, prior to analysis, store refrigerated between 0.5 °C and 6 °C.

10.2 The maximum holding time for fecal coliform testing is eight (8) hours from sample collection.

10.3 Sample size

10.3.1 Size of sample will be governed by the expected bacterial density and/or the degree of sample turbidity. An ideal sample volume will yield 20 to 60 fecal coliform colonies on a membrane filter surface. Where the bacterial density is expected to be high and/or turbidity situations exist, filter appropriate dilutions (i.e. 1:10, 1:100, etc.) prepared in phosphate buffered dilution water through a membrane. When analyzing a new site or the density of fecal coliform is unknown test using three dilutions (example: 100 mL, 10 mL, 1.0 mL) to obtain the best-expected density and reportable count.

10.4 Sterile filtration units

10.4.1 Begin each filtration series with a sterilized filter funnel. If more than 30 minutes elapses between sample filtrations during a filtration series, open and use a second sterilized filter funnel.

10.5 Filtration of sample

10.5.1 Using sterile forceps, place a sterile membrane filter (grid side up) over the porous plate of the filtration unit. Pour sample into filtration unit and filter under partial vacuum. With the membrane still in place, rinse the interior surface of the funnel 3 times with a 20-30 mL portion of sterile dilution water from a squeeze bottle to prevent carryover contamination. Upon completion of final rinse, and the filtration process, disengage vacuum, unlock and remove funnel, and immediately remove the membrane filter with sterile forceps, and place it on a M-FC agar dish which has been allowed to warm to room temperature with a rolling motion to avoid entrapment of air.

10.5.2 The first sample filtered on any sterile funnel is a "Sterility Blank". This serves as the 'Initial Sterility Blank'. Refer to section 11.3.

10.5.3 When more than one sample is processed on an individual funnel, the last sample filtered on a funnel is a "Final Sterility Blank". Refer to Section 11.3.

10.5.4 Analyze a Rinse Water check as a sample, one time, for each new bottle of sterile rinse water bottle opened. Rinse water counts as a sample in the filtration series. Refer to Section 11.3.

10.6 Filtration series

10.6.1 A filtration series is considered to be interrupted when an interval of 30 minutes or longer elapses between sample filtrations. After such interruption, treat any further sample filtration as a new filtration series and replace the filter funnels with new sterile filter funnels.

10.6.2 Do not process more than ten (10) filtrations on any funnel. That is, after ten filtrations, including samples, rinse water or sample dilutions, change-out the filter funnel to a second, sterile funnel.

10.6.3 During testing in the laboratory, multiple funnels may be used for less than 10 field sample filtrations in order to meet holding times or when, in the judgment of the analyst, a new funnel should be used following a sample with

a suspected high level of bacteria. Always complete any funnel use with a filter blank.

10.7 Place prepared samples in waterproof plastic bags, seal, invert and submerge in a water bath at 44.5 ± 0.2 °C for 24 ± 2 hours. Anchor dishes below water surface to maintain critical temperature requirements. Place all samples in the water bath within 30 minutes after filtration.

10.8 Counting fecal coliform colonies

10.8.1 Use a low power (10-15x) binocular wide-field dissecting microscope with a cool white fluorescent light source directed to provide optimal viewing.

10.8.2 Colonies produced by fecal coliform on M-FC medium are various shades of blue. Count colonies of any size including pinpoint blue colonies. Non-fecal coliform colonies are gray to cream-colored. Normally, few non-fecal coliform colonies will be observed on M-FC medium because of the selective action of the elevated temperature and addition of rosolic acid salt reagent.

10.8.3 Count and record in the Water Microbiology (WM) electronic logbook the number of fecal coliform colonies found on the membrane. Note: the ideal colony count for this test is a count or 20 to 60 CFU. Refer to section 12.0 for details.

10.9 Confirming fecal coliform colonies

10.9.1 Inoculate a tube of Lauryl Tryptose Broth (LTB) and EC Broth with a suspect fecal coliform colony directly from the membrane with an inoculating loop.

10.9.2 Incubate the LTB for 24 ± 2 hours in an incubator set at 35 ± 0.5 °C and examine for gas production with growth (turbidity). Incubate the EC Broth for 24 ± 2 hours in a circulating water bath at 44.5 ± 0.2 °C and examine for gas production with growth. If the confirmation does not verify the initial response, notify your supervisor. Test results will be qualified.

10.9.3 Gas production with growth in an EC broth culture within 24 ± 2 hours or less is considered a positive fecal coliform reaction. Failure to produce gas (with little or no growth) constitutes a negative reaction. If heavy growth occurs with no gas production, subject the culture to a fecal coliform or *E. coli* test using a different medium. Check with your supervisor if a different medium may be required.

11.0 Quality Control

11.1 Test all microbiological broth after preparation as directed in SOP QC0448 and record in the Water Microbiology Validation logbook.

11.2 Check each lot # of membrane filters for sterility by incubating in tryptic soy broth for 24 hours at 35 ± 0.5 °C and looking for growth. Reject any lot that is found to be non-sterile. Record results in the Water Microbiology Quality Control Logbook.

11.3 Perform the following checks when using autoclavable (multi-use) funnels.

11.3.1 Analyze an initial sterility blank, as the first sample for each sterile funnel used. Rinse each funnel with 20-30 mL of sterile water as performed in the

rinse step for a sample. Do not use additional rinses. Complete the analysis of the sterility blank as a regular sample.

11.3.2 Analyze a final sterility blank following all samples analyzed with any funnel, WHEN more than one sample is analyzed on a funnel. If only one sample is processed per funnel, a final sterility blank is not required.

11.3.3 For each autoclavable funnel, up to a maximum of ten (10) filtrations may be performed. A filtration include any: sample, sample dilution or rinse water check.

11.3.4 Results from the sterility blank or the rinse water check are reviewed for contamination. The data represent colonies per funnel or colonies per rinse. The criteria for these check is <1 cfu / funnel or < 1 cfu / rinse.

11.4 Disposable sterile funnels.

11.4.1 When using disposable sterile funnels, an initial sterility check or end procedural check is not required.

11.4.2 Disposable sterile funnels are lot checked for sterility when received at the laboratory.

11.5 Check each **batch** of rinse water for sterility by adding 50-mL water to 50- mL double strength tryptic soy broth, incubating at 35 ± 0.5 °C for 24 ± 2 hours and checking for growth. Reject any batch of rinse water that is found to be non-sterile. Record results in the electronic Media Prep logbook.

11.6 Check each newly opened rinse water bottle for sterility. Use 50 mL from the newly opened rinse water bottle and process by filtration as a sample.

11.7 Each lot of sample containers must be tested for sterility before use by adding approximately 100 mL of a non-selective broth (i.e. Tryptic Soy Broth), incubating for 24 ± 2 hours at 35 ± 0.5 °C and checking for growth (turbidity).

11.8 On a monthly basis, verify a minimum of 10 fecal coliform colonies (10 typical and 10 atypical) as directed in Section 10.9. Record results in the Water Microbiology Fecal Coliform Verification Logbook. The adjusted count may be REDUCED if the confirmation for any typical colony is negative. The adjusted count may be increased if the confirmation for any atypical colony is positive.

Example:

45 TOTAL Colonies

30 Typical Colonies, and 15 atypical colonies.

Reported Result = 30 colonies / 100 mL presumptive

Confirmation Phase: use percentage of colonies confirmed as below:

8 out of 10 typical show positive: adjust count DOWN to [(8/10) x 30] = 24

2 out of 10 atypical colonies show positive: adjust count UP by [(2/10) x 15] = 3

Actual count = 24 + 3 = 27 colonies / 100 mL

Edit and send the client a revised test report.

11.9 Compare old and new lots of MFC using dilution blanks inoculated with the appropriate ATC culture (Bio-Balls) to produce colony counts ranging from 20 - 60 CFU. Record results in the Electronic Water Microbiology log book.

11.10 Corrective actions are taken when nonconforming work or departures from policies and procedures in the management system or technical operations have been identified. Preventive action is a proactive process to identify opportunities for rather than a reaction to the identification of problems or complaints.

11.10.1 Analytical work may be stopped if necessary during the investigation, and analyses may resume after it is verified that the corrective actions taken have been effective.

11.10.2 Corrective actions may include, but not limited to instrument repair or maintenance, re-prep of media, resampling, reanalysis of samples, etc.

11.10.3 Preventive actions may include, but not limited to preventive maintenance, retraining of analysts, change in procedures etc.

11.10.4 Refer to EQC's Quality Systems Manual for more information.

12.0 Calculations and Record Keeping

12.1 Compute the count, using membrane filters with 20 to 60 fecal coliform colonies per membrane, by the following equation:

$$\text{Fecal coliform colonies/100 mL} = \frac{\text{Fecal coliform colonies counted} \times 100}{\text{mL sample filtered}}$$

(The 20 to 60 colony restriction is due to the larger colony size on M-FC medium.)

12.2 With water of good quality, the occurrence of fecal coliforms will be low. Therefore, count all fecal coliform colonies (disregarding the lower limit of 20 colonies cited in Section 12.1) and use the above formula given above to obtain fecal coliform density.

12.3 If the total number of fecal coliform colonies exceeds 60 per membrane, with one (1) dilution or if the colonies are not distinct enough for accurate counting, record the results as **>60** and compute and report the actual result by using the equation in the above equation.

12.4 For water other than drinking water quality

12.4.1 As with potable water samples, if no filter has a fecal count falling in the ideal range (20 to 60 CFU), total the fecal counts on all filters and report as the total number per 100 mL.

12.4.1.1 For example, if **duplicate 50-mL portions** were examined and the two membranes had 5 and 3 fecal coliforms, respectively, report the count as 8 fecal coliform colonies per 100 mL.

$$[(5 + 3) \times 100] / (50 + 50) = 8 \text{ CFU/100 mL}$$

12.4.2 Similarly, if 50-, 25-, and 10-mL **portions** were examined and the counts were 15, 6, and <1 fecal coliform colonies, respectively, then calculate **on the basis of the most nearly acceptable value** and report the fecal coliform count with a qualifying comment as "**estimated** 30 CFU/100mL":

[(15) X 100] / (50) = estimated 30 CFU/100 mL

12.4.3 On the other hand, if 10, 1.0, and 0.1-mL portions were examined with counts of **40**, 9, and <1 fecal coliform colonies, respectively, then select the 10-mL portion only for calculating the fecal coliform density because the filter had a fecal coliform count falling **in the acceptable range**, and report result as 400 CFU/100 mL:

(40 X 100) / 10 = 400 CFU/100 mL

12.4.4 If colony counts are **greater than the upper limit** then calculate on the basis of the most nearly acceptable value and report, with a qualifying comment.

An example: If 10, 1.0, and 0.1-mL portions were examined with counts of TNTC, 110, and 62 fecal coliform colonies, respectively, then calculate on the basis of the most nearly acceptable value and report, with a qualifying comment, as **estimated** 62,000 CFU/100 mL:

(62 X 100) / 0.1 = estimated 62,000 CFU/100 mL

12.4.5 If there is **more than one dilution having an acceptable range** of counts then sum the total coliform counts on the two filters and divide by the sum of their volume to obtain the final reported value:

An example: If 1.0, 0.3, 0.1, and 0.03 mL portions were examined with counts of TNTC, TNTC, 58, and 21 coliform colonies, respectively, then sum the total coliform counts on the two filters and divide by the sum of their volume to obtain the final reported value of 61 000 CFU/100 mL:

[(78 + 21) X 100] / (0.1 + 0.03) = 61 000 CFU/100 mL

12.4.6 If counts from all membranes are zero, calculate final result using the largest volume filtered.

12.4.7 If colony counts are both **above and below the upper and lower limits**, select the most nearly acceptable count.

12.4.8 For the sample in question (12.4.1.4) an error at the bench may have occurred investigate the issue, and report results with a qualifying comment or re-sample when possible.

12.5 Report confluent growth with or without discrete fecal coliform colonies as confluent growth per 100 mL with (or without) fecal coliforms and request a new sample via the field services department.

12.6 All results are required to be adjusted as per 11.8 if the sample was selected for colony confirmation.

12.7 If any sterility control sample, such as initial sterility blank, final sterility blank, or rinse water check, contains fecal coliform colonies, inform the supervisor

immediately. Qualify sample results on the test report and if possible, obtain a re-sample.

12.8 If a Laboratory accident, or cross-contamination is suspected, inform the supervisor immediately. For the sample(s) in question, investigate the issue and report with a qualifying comment and if possible, obtain a re-sample when possible.

12.9 Documentation of Laboratory work

12.9.1 Enter and initial the date and time sample was taken, received, run, and completed in designated areas on the EQC Chain of Custody form.

12.9.2 Document all laboratory data as outlined in SOP QC0343 Documentation of Laboratory Data.

12.9.3 Record all media preparation data in the Electronic Media Prep Validation logbook as directed in SOP QC0448.

13.0 Method Performance

13.1 Method performance is evaluated by the analysis of method blanks, positive and negative controls.

14.0 Pollution Prevention/Waste Management

14.1 Keep storage of chemicals in individual departments to a minimum, in order to minimize the potential for large spills and exposure to hazardous substances. Each laboratory manager or designee is required to inspect their department on a semi-annual basis for expired reagents and chemicals. Notify the Safety Director for disposal of expired reagents and chemicals.

14.2 Minimize the amount of waste generated by preparing only the minimum required amount of a reagent.

14.3 Expired hazardous chemicals, reagents, and samples requiring lab packing or other outside disposal/treatment are stored in a designated waste storage facility (such as the chemical shed) until final disposal. This is under the direction and supervision of the Safety Director. Individual analysts may not transfer chemicals or other substances to a waste storage facility without obtaining authorization from the Safety Director. All microbiological waste generated during the performance of this procedure (including used petri dishes) must be disposed of in accordance to the Laboratory Waste Disposal SOP, QC0479 and SOP QC0482 Operation and Maintenance of SR-24C Autoclaves. Additional details regarding specific disposal of chemical waste at EQC are given in the EQC Safety Procedure Manual, which is incorporated herein by reference.

15.0 References and Supplemental Documents

15.1 Standard Methods for the Examination of Water and Wastewater, SM 9222D-2006, Standard Methods, 22nd Edition.

15.2 EQC Quality Systems Manual, latest.

15.3 EQC Safety Procedure Manual, latest.

15.4 EQC SOP QC0339, Thermometer Calibration, Maintenance, and Record Keeping, latest.

15.5 EQC SOP QC0343, Documentation of Laboratory Data, latest.

15.6 EQC SOP QC0448, Media and Broth Preparation, latest.

15.7 EQC SOP QC0467, pH, Electronic measurement, latest.

15.8 EQC SOP QC0479, Waste Disposal in Laboratory.

15.9 EQC SOP QC0499, General Preparation and Evaluation of Demonstrations of Capability, latest.

15.10 EQC SOP QC0500, Preparation of Phosphate-Buffered Dilution and Rinse Water, latest.

15.11 EQC SOP QC0519, Water and Wastewater Sampling for Microbiological Testing, latest.

15.12 EQC SOP QC0848, Operation and Maintenance of Autoclaves Getinge Models 533LS and 733LS.

15.13 Microbiological Methods for Monitoring the Environment, EPA-600/8-78-017.

16.0 Supersession

16.1 Changes in this revision of QC0441 supersedes all previous revisions of SOP QC0441.

16.2 Revision 15: Details on color and size of CFU for counting added to Section 10.8.2; Section 10.9.2, added details when confirmation does not verify. Section 10.9.3; Verification by LTB and EC broth removed from Section 11.9; Section 12.4 revised and calculation examples added; Section 12.7 and 12.8 added; Reference to SOP QC0516 removed from SOP.

17.0 Tables and Figures

17.1 None.

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SOP Number QC0613
Membrane Filter (MF) Technique for Enterococci (EPA 1600)

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Revision: 02	Date: 03/15/06
Revision: 03	Date: 04/05/07
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CONFIDENTIAL

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QA Approval:	Pam Heller	Date: 12/1/16
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1.0 Scope and Application

1.1 The EPA has been increasingly concerned with the public health risks of infectious diseases caused by microbial organisms in a variety of waters including recreational fresh and marine waters. One such group of organisms under scrutiny is the Enterococci. Studies have indicated a direct relationship between the density of enterococci in recreational fresh and marine waters and the risk of gastrointestinal illness associated with swimming in the water.

1.2 This Standard Operating Procedure (SOP) applies to determination of microbial organisms in a variety of non-potable waters including recreational fresh and marine waters. The method outlined in this SOP describes a membrane filter (MF) procedure for the detection and enumeration of enterococci in water. Unlike the ME methods of 9213D and 1106.1 the enterococci 1600 method is a single step method which does not require a transfer of the filter to another medium. The modified medium of MEI has a reduced amount of triphenyltetrazolium chloride (TTC) and also includes indoxyl β-D-glucoside, a chromogenic cellbiose analog that is used in the place of esculin. The β-glucosidase, where positive enterococcus produces an indigo blue complex, diffuses into the MEI forming a blue halo around the colony. Enterococci are commonly found in the feces of humans and other warm-blooded animals. Although some strains are ubiquitous and not related to fecal pollution, the presence of enterococci in water is an indication of fecal pollution and the possible presence of enteric pathogens.

1.3 This SOP is to be performed by trained laboratory personnel anytime the enumeration of enterococci by membrane filtration in a water sample is required.

2.0 Summary and Discussion of Procedure

2.1 The MF method provides a direct count of bacteria in water based on the development of colonies on the surface of the membrane filter. A water sample is filtered through the membrane, which retains the bacteria. Following filtration, the membrane containing the bacterial cells is placed on mEI agar and incubated at 41 ± 0.5 °C for 24 ± 2 hours. All colonies greater than or equal to (≥) 0.5 mm in diameter (regardless of color) with a blue halo are recorded as enterococci colonies.

3.0 Definitions

3.1 Enterococcus – a subgroup of the fecal streptococci that includes *S. faecalis, S. faecium, S. gallinarum,* and *S. avium* differentiated from the fecal streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6 and at 10 and 45 °C. They are a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters.

In Method 1600, enterococci are those bacteria, which produce colonies greater than or equal to (≥) 0.5 mm in diameter with a blue halo after incubation on mEI agar. The blue halo should not be included in the colony diameter measurement.

3.2 Serial dilutions: This procedure is used to identify the number of viable micro-organisms in a fixed amount of a liquid. Serial dilution involves repeatedly mixing known amounts of sample with sterilized liquid. 1 mL added to 9 mL gives a 10-fold dilution; 1 mL added to 99 mL gives a 100-fold dilution. The first 10-fold dilution is termed the 10^{-1} dilution. The first 100-fold dilution is termed the 10^{-2} dilution. An undiluted sample is termed the 10^{0} dilution. The buffer used for dilution depends on the substance being diluted. When fixed amounts of this dilution series are plated and incubated, then different numbers of colonies will be obtained. By working back from an easily counted plate and using the appropriate dilution factor, the number of micro-organisms in the original source can be calculated.

3.3 Holding Time: The maximum time a sample may be held after collection until analysis. Results reporting for regulatory purposes must be from an analysis within the established holding time. For microbiology samples holding time is determined from the sample collection time to the time the sample is placed into incubation.

4.0 Health and Safety Warnings

4.1 Personnel engaged in laboratory analyses at Eurofins QC, Inc. (EQC) must be familiar with and adhere to the policies set forth in the current version of the EQC Safety Procedure Manual.

5.0 Cautions

5.1 Start microbiological examination of a water sample promptly after collection to avoid unpredictable changes.

5.2 Notify a client service representative when any chain of custody record is not clear such as missing sample time or sample ID information or requested test. Document the notification and reason in the company LIMS History Log.

6.0 Interferences

6.1 Water samples containing colloidal or suspended particulate materials can clog the membrane filter and prevent filtration, or cause spreading of bacterial colonies, which could interfere with the enumeration and identification of target colonies.

7.0 Personnel Qualifications

7.1 Before performing this test independent of secondary supervision and review, each analyst in a NELAC facility must have an approved Demonstration of Capability Certification Statement (DOC) form (see SOP QC0499) on file in the Quality Assurance Department.

8.0 Equipment, Apparatus and Materials

Equipment:

8.1 Autoclave capable to maintain a high pressure saturated steam at 121 C (249 F) for around 15-30 minutes depending on the size of the load and the contents.

8.2 Flame Burner, for flame-sterilizing forceps.

8.3 Carboy capable of holding 20 L.

8.4 Erlenmeyer flask, clean borosilicate, for mixing media.

8.5 Filtration funnel units: filter funnels 47-mm magnetic (Gelman or equivalent), graduated at 50 and 100 mL, in assembly with base, sterile, re-usable.

Note: As an alternative, disposable, sterile filtration funnel units can be used (Fisher, Catalog # 09-740-30D or equivalent).

8.6 A filter manifold to hold a filter bases. A vacuum filter manifold.

8.7 Forceps.

8.8 Hand tally.

8.9 Incubators, capable of maintaining temperatures of 41 ± 0.5 °C, 35 ± 0.5 °C and 45 ± 0.5 °C.

8.10 Refrigerators capable of maintaining a temperature of 0 - 6 °C and 2 - 8 °C.

8.11 Stereo microscope with fluorescent light source.

8.12 Test tubes, screw-cap, 20 x 125 mm, borosilicate glass or plastic.

8.13 UV light (6 watt, 365 nm).

8.14 Water bath capable of maintaining a temperature of 44.5 ± 0.2 °C.

Supplies:

8.15 Autoclave funnel wrap: aluminum foil or kraft paper.

8.16 Autoclave Indicator tape.

8.17 Alcohol: Reagent alcohol, purchased reagent grade chemical for forceps sterilization. Store in a flammable cabinet at room temperature.

8.18 Inoculating loops, plastic, sterile.

8.19 Membrane filters 47-mm/0.45 micron pore-size, sterile (Millipore or equivalent).

8.20 Petri dishes, 60 x 15 mm plastic, presterilized.

8.21 Sample containers, 125 mL, polypropylene, containing Sodium Thiosulfate tablet for chlorine neutralization.

Media and Reagents:

8.22 mEI agar (Difco or equivalent)

8.22.1 Suspend 72 g of the powder into 1 L of purified water. Mix thoroughly. Heat with frequent agitation and boil for 1 minute to completely dissolve the powder. Autoclave prepared media at 121 °C for 15 minutes and then cool media in a 50 °C water bath. Add nalidixic acid and TTC solutions to the medium as outlined in the Sections 8.22.2.1 and 8.22.2.2 below, and mix. Read pH. Final pH must be 7.1 ± 0.2.

8.22.1.1 Mix 0.24 g nalidixic acid in 5-mL reagent grade water. Add a few drops of 0.1N NaOH to dissolve. Add this solution to 1 L of the mEI medium.

8.22.1.2 Add 2 mL (0.02 g) of 1% solution triphenyl tetrazolium chloride (TTC) separately to 1 L the mEI medium and mix.

Note: If larger volume of mEI prepared, the amount of nalidixic acid and TTC solutions must be adjusted accordingly to the work load.

8.22.2 Dispense mEI agar in 4 to 6 mL quantities into 60 x 15 mm disposable petri dishes and allow to solidify. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container of media with date prepared, batch ID, date expired, lot #, temperature for storage and method name. The positive control for mEI is *E. faecalis* and the negative control is *E coli*. Test for sterility and growth promotion properties using positive and negative controls as directed in SOP QC0448. Store all prepared plates at 2 - 8 °C for up to 2 weeks. Record all media preparation data in the Media Electronic Logbook (Media Logbook) as directed in SOP QC0448.

8.23 Brain-heart infusion agar (BHIA) (BD BBL or equivalent).

Used in the verification of fecal streptococcus and enterococcus colonies.

8.23.1 Suspend 52 g of the powder in 1 L of purified water. Mix thoroughly. Heat with frequent agitation and boil for 1 to completely dissolve the powder. Autoclave at 121 °C for 15 minutes. Before use agitate gently to distribute the precipitate uniformly throughout the medium. Final pH must be 7.4 ± 0.2 after autoclaving.

8.23.2 Dispense 10 mL of agar into tubes for slants, or 15 – 20 mL into petri dishes, and allow to solidify. Prepared media will be slightly hazy and amber color. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container of media with date prepared, batch ID, date expired, lot #, temperature for storage and method name. The positive control for brain heart infusion agar is *E. faecalis* and the negative control is not needed. Test for sterility and growth promotion properties as directed in SOP QC0448. Store all prepared plates at 2 - 8 °C for up to 2 weeks and

tubes for up to 3 month. Store unprepared medium in a cool, dry, location out of the way of direct light. Record all media preparation data in the Media Logbook as directed in SOP QC0448.

8.24 Brain-heart infusion broth (BHIB) (Acumedia or equivalent)

8.24.1 Dissolve 37 g of medium into 1 L of purified water. Heat with frequent agitation to completely dissolve the medium. Autoclave for 15 minutes at 121 °C. Final pH must be 7.4 ± 0.2 after autoclaving.

8.24.2 Dispense 10 mL into autoclavable, borosilicate glass tubes of sufficient size to contain both the culture media and the sample without being three-quarters full. No inserts are needed in the culture tubes. Prepared media may have precipitate, will be a clear light to medium amber color. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container of media with date prepared, batch ID, date expired, lot #, temperature for storage and method name. The positive control for brain heart infusion broth is *E. faecalis* and the negative control is not needed. Test for sterility and growth promotion properties as directed in SOP QC0448. Store all prepared tubes at 2 - 8 °C for up to 3 month. Store unprepared medium in a cool, dry, location out of the way of direct light. Record all media preparation data in the Water Media Logbook as directed in SOP QC0448.

8.25 Brain-heart infusion broth with 6.5% NaCl (BHIB with 6.5% NaCl) (Acumedia or equivalent)

8.25.1 Dissolve 37 g of medium into 1 L of purified water. Heat with frequent agitation to completely dissolve the medium. Add 60 g of NaCl for every liter of broth made.

Note: BHIB with 6.5% NaCl is the same as BHIB above (Section 8.24), but with additional NaCl.

Add 60 g of NaCl to formula provided in Section 8.24 above and follow all preparation steps in Section 8.24.

8.25.2 The positive control for brain heart infusion broth with NaCl is *E. faecalis* and the negative control is not needed.

8.26 Bile esculin agar (Remel or equivalent)

8.26.1 Suspend 64 g of medium into 1 L of purified water. Heat to boiling with agitation to completely dissolve. Autoclave for 15 minutes at 121 °C. Final pH must be 6.8 ± 0.2 after autoclaving.

8.26.2 Dispense 10 mL into autoclavable, borosilicate glass tubes of sufficient size to contain both the culture media and the sample without being three-quarters full. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container of media with date prepared, batch ID, date expired, lot #, temperature for storage and method name. The positive control for esculin agar is *E. faecalis* and the negative control is *E. coli*. Test for sterility and growth promotion properties as directed in SOP QC0448. Store unprepared medium in a cool, dry location out of the way of

direct light. Store prepared medium at 2 - 8 °C. Record all media preparation data in the Media Logbook as directed in SOP QC0448.

8.27 Tryptic soy agar (BD BBL or equivalent)

8.27.1 Suspend 45.7 g of the powder into 1 L of purified water. Mix thoroughly. Heat with frequent agitation. Boil for 1 minute to completely dissolve the powder. Autoclave at 121 °C for 15 minutes. Final pH must be 7.3 ± 0.2 after autoclaving.

8.27.2 Dispense 15 to 20 mL into 15 x 100 mm sterile petri dishes and allow to solidify. The amount of media prepared can be adjusted accordingly to the work load. Label each batch and container of media with date prepared, batch ID, date expired, lot #, temperature for storage and method name. The positive control for TSA is *E. coli* and a negative control is not needed. Test for sterility and growth promotion properties as directed in SOP QC0448. Store in a cool, dry, location out of the way of direct light. Record all media preparation data in the Media Logbook as directed in SOP QC0448.

8.28 Nalidixic acid.

8.29 0.1N NaOH.

8.30 Phosphate Buffered Dilution water

8.30.1 Prepare as directed in SOP QC0500. The amount of media prepared can be adjusted accordingly to the work load. Record all media preparation data in the Media Logbook as directed in SOP QC0448.

8.31 Phosphate Buffered Saline (PBS)

8.31.1 Composition:

Sodium dihydrogen phosphate (NaH_2PO_4)	0.58 g
Disodium hydrogen phosphate (Na_2HPO_4)	2.5 g
Sodium Chloride (NaCl)	8.5 g
Reagent-grade water	1.0 L

8.31.2 Dissolve the reagents in 1 L of reagent-grade water and dispense in appropriate amounts for dilutions in screw cap bottles and/or into containers for use as rinse water. Autoclave at 121 °C for 15 minutes. Final pH must be 7.4 ± 0.2. Record all media preparation data in the Water Microbiology Validation book as directed in SOP QC0448.

8.32 Sodium chloride.

8.33 Triphenyl Tetrazolium Chloride dye (TTC), 1% solution.

Cultures:

8.34 Positive control culture *Enterococcus faecalis*, ATCC 19433 or equivalent (BioBalls, *Enterococcus faecalis,* NCTC 775).

8.35 Negative control culture *E. coli*, ATCC 11775 or equivalent (BioBalls, *E. coli,* NCTC 9001).

9.0 Calibration

9.1 Calibrate glass thermometers used to monitor the temperature of incubators and water baths against a NIST thermometer annually according to SOP QC0339. Calibrate all others (digital, infrared, etc.) quarterly.

9.2 Schedule annual calibration and maintenance of balances through the manufacturer or other contracted personnel. See SOP QC0470, Laboratory Balance Calibration.

9.3 Calibrate pH meters according to manufacturer's recommendations and SOP QC0467, pH Electrometric Measurement.

9.4 Check incubator temperatures twice daily, four hours apart to ensure temperature requirements are being met. Record readings in the temperature logbooks.

10.0 Sample Preparation and Analysis

10.1 Collect samples as directed in SOP QC0519 Water, Wastewater, Sludge and Compost Sampling for Microbiological Testing. Store collected samples from the field to the laboratory on ice at a temperature between 0 and 10 °C (do not freeze). When samples are stored at the testing laboratory, prior to analysis, store refrigerated between 0.5 and 5 °C (do not freeze). At no time shall the sample be frozen.

10.2 The maximum holding time for samples analyzed by this procedure is eight (8) hours.

10.3 Sample size

10.3.1 The size of the sample will be governed by the expected bacterial density based on the previous historical enterococci levels of the source. An ideal sample volume will yield 20 to 60 enterococcus colonies on a membrane filter surface. **A minimum of 3 dilutions must be used for any new sample source.** In instances where the bacterial density is expected to be high, turbidity situations exist, no known history of bacterial density or for legal cases, filter at least three appropriate dilutions from 1 to 100 mL using log interval (e.g. 100, 10, 1, 0.1, etc.) or half log intervals (e.g. 100, 30, 10, 3, 1 mL) prepared in phosphate buffered dilution water through a membrane.

10.3.2 For special projects, such as river project samples, where the bacterial density is expected to be high, use 10-fold or 100-fold dilution technique. Certain samples may require a 10^{-6} dilution.

10.4 Sterile filtration units

10.4.1 Use for filtration series

10.4.1.1 A filtration series is considered to be interrupted when an interval of 30 minutes or longer elapses between sample filtrations. After such interruption, treat any further sample filtration as a new filtration series and replace the filter funnels with new sterile filter funnels.

10.4.1.2 Do not process more than ten (10) filtrations on any funnel. That is, after ten filtrations, including samples, rinse water or sample dilutions, change-out the filter funnel to a second, sterile funnel.

10.4.1.3 During testing in the laboratory, multiple funnels may be used for less than 10 field sample filtrations in order to meet holding times or

when, in the judgment of the analyst, a new funnel should be used following a sample with a suspected high level of bacteria. Always complete any funnel use with a filter blank.

10.4.2 Use for serial diluted single sample (i.e., river samples, etc.)

10.4.2.1 Use separate sterile filtration unit for each sample to be tested. Start filtration from the highest dilution to lowest. Rinse the interior surface of the funnel 3 times with a 20-30 mL of the sterile dilution water after each filtration. Place filtration unit into the autoclave container when sample filtration is done, and place a new sterile funnel onto manifold for new sample use.

10.5 Enterococci procedure

10.5.1 Using sterile forceps, place a sterile membrane filter (grid side up) over the porous plate on the filter base and attach the funnel to the base so that the membrane filter is now held between the funnel and the base.

10.5.2 Shake the sample in an up and down motion for a minimum of 25 times. Measure the desired volume of sample or dilution into the funnel. Select sample volumes based on previous knowledge of the enterococci level, to produce 20 - 60 enterococci colonies on filter.

10.5.3 Smaller sample size or sample dilutions can be used to minimize the interference of turbidity or for high bacterial densities. Multiple volumes of the same sample or sample dilutions may be filtered.

Note: When analyzing smaller sample volumes (e.g., <20 mL), 20 – 30 mL of PBS or phosphate-buffered dilution water should be added to the funnel or an aliquot of sample should be dispensed into a dilution blank prior to filtration. This will allow even distribution of the sample on the membrane.

10.5.4 Filter the sample under partial vacuum. With the membrane still in place, rinse the interior surface of the funnel 3 times with a 20 - 30 mL portion of sterile dilution water from a squeeze bottle to prevent carryover contamination. Upon completion of final rinse, and the filtration process, disengage vacuum, unlock and remove funnel, and immediately remove the membrane filter with sterile forceps, and place it on a mEI agar dish which has been allowed to warm to room temperature with a rolling motion to avoid entrapment of air.

10.5.5 Invert culture plates and incubate at 41 ± 0.5 °C for 24 ± 2 hours.

10.5.6 After incubation, count and record colonies on those membrane filters containing, if practical, 20 - 60 colonies with any blue halo that are 0.5 mm or larger (not including blue halo) regardless of colony color as an enterococci colony (see Figure 1). Count enterococcus colonies using a measuring magnifier and a low power binocular wide-field, stereo microscope with a cool white fluorescent light source to give maximum visibility of colonies.

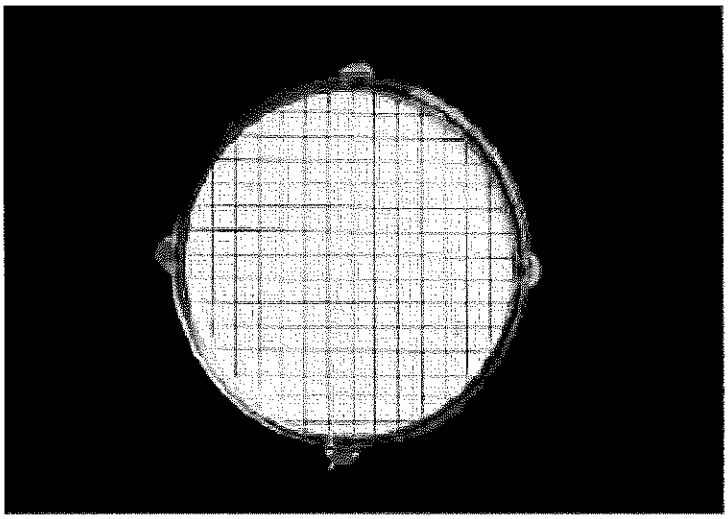

Figure 1. Enterococci colonies on mEI produce blue halos.

10.6 Verification Procedures

10.6.1 Frequency Tracking

The main lab and satellites offices must track the number of samples that contain typical and atypical colonies. Verification tests are performed at the main lab.

10.6.1.1 Following plate counting, use the Sample Tracking file for this method (EPA 1600) and bar-code each sample that has either typical or atypical colonies into the file for tracking frequency.

10.6.1.2 For satellites offices, take a picture of the plate. Send the plate and photo to the main lab for verification. Notify the main lab staff when plates are being sent.

Note: The main lab will use the picture as a reference for confirmation of original count of typical and atypical colonies.

10.6.1.3 After receiving plates from a Satellite office, initiate the verification the same day or at a minimum by the following day to ensure the quality of data.

10.6.1.4 Verification must be performed each month based on the following frequency: Verify a minimum of 10 typical (positive) and 10 atypical (negative) enterococci colonies or 1 typical and 1 atypical colony from 10% of all plates showing growth, whichever is more frequent.

10.6.1.5 When routine samples do not provide at least 10 typical and at least 10 atypical colonies, a source known to satisfy this requirement must be analyzed and verified. Such sources can include samples from local pounds or streams.

10.6.1.5.1 Collect a sample from local pound or stream and analyzed as a regular sample.

10.6.2 Verification tests performing

10.6.2.1 Using a sterile inoculating loop, transfer cells from the centers of at least 10 typical and 10 atypical colonies into BHI broth (BHIB) tubes and onto BHI agar (BHIA) plate. Incubate the broth tubes for 24 ± 2 hours at 35 ± 0.5 °C and the agar plates for 48 ± 3 hours at 35 ± 0.5 °C.

10.6.2.2 After 24 hours of incubation (10.6.2.1), transfer a loopful of growth from the BHIB tubes to the following:

10.6.2.2.1 Bile Esculin agar (BEA) and incubate at 35 ± 0.5 °C for 48 ± 3 hours.

10.6.2.2.2 BHI broth with 6.5% NaCl and incubate at 35 ± 0.5 °C for 48 ± 3 hours.

10.6.2.2.3 BHI broth and incubate at 45 ± 0.5 °C for 48 ± 3 hours.

10.6.2.3 After 48 hours of incubation, observe for turbidity (growth) and record any growth in each of the above tubes/plates.

10.6.2.4 After 48 hours of incubation, perform a gram stain on any growth found on each BHI agar plate/slant (10.6.2.1).

10.6.2.5 Gram positive cocci which grow and hydrolyze esculin on BEA (i.e. produce a black or brown precipitate) and grow in BHI broth at 45°C, and BHI broth with 6.5% NaCl at 35 °C, are verified as enterococci.

10.6.2.6 Alternately, commercially available multi-test identification systems (e.g. Vitek®) may be used to verify colonies. Such multi-test identification systems should include Esculin hydrolysis and growth in 6.5% NaCl.

10.6.2.7 Record all information (Typical or Atypical colonies, media batch number, incubation times, etc.) into Enterococci Verification logbook Form #3031. The laboratory manager or his designee must review the Logbook for accuracy.

10.6.3 Adjust results based upon percentage of Enterococcus colonies confirmed. The adjusted count may be REDUCED if the confirmation for any typical colony is negative. The adjusted count may be increased if the confirmation for any atypical colony is positive.

Example:

45 TOTAL Colonies
30 Typical Colonies, and 15 atypical colonies.
Reported Result = 30 colonies / 100 mL presumptive

Confirmation Phase: use percentage of colonies confirmed as below:

8 out of 10 typical show positive: adjust count DOWN to [(8/10) x 30] = 24
2 out of 10 atypical colonies show positive: adjust count UP by [(2/10) x 15] = 3
Actual count = 24 + 3 = 27 colonies / 100 mL

Edit the original data entered in to the company LIMS and send the client a revised report with comment.

11.0 Quality Control

11.1 Test all microbiological media after preparation as directed in SOP QC0448.

11.2 Check each lot # of membrane filters for sterility by placing a membrane on a tryptic soy agar plate for 24 ± 2 hours at 35 ± 0.5 °C. Absence of growth indicates sterility of the filter. Reject any lot that is found to be non-sterile. Record results in the Water Microbiology quality control book.

11.3 Duplicate analyses. Perform duplicate analyses at a minimum of a 5% (1 out of every 20 samples) frequency or 1 per week, whichever is more frequent. Refer to SOP QC0952 for further information.

11.4 Check each batch of PBS and phosphate-buffered rinse water for sterility by adding 50 mL water to 50 mL double strength trypticase soy broth, incubating at 35 ± 0.5°C for 24 ± 2 hours and checking for growth. Record results in the Water Microbiology quality control book.

11.5 On a monthly basis, verify a minimum of 10 typical and 10 atypical enterococci colonies (can be from a single membrane) or 1 typical and 1 atypical colony from 10% of all samples with growth, whichever is more frequent as directed in Section 10.6. Record results in the Method Verification Logbook.

11.6 Initial precision and recovery (IPR)

The IPR analysis is used to demonstrate acceptable method performance (recovery and precision) by each laboratory before the method is used for monitoring field samples. IPR samples must be accompanied by an acceptable method blank (sterile Phosphate-buffered saline (PBS)) and appropriate media sterility checks. The IPR procedure is as follows:

11.6.1 Prepare four, 100-mL samples of **PBS** (Section 8.31) and spike each sample with *Enterococcus faecalis* ATCC 19433 by aseptically adding one BioBall to each container and mixing by vigorously shaking the sample bottle a minimum of 25 times.

11.6.2 Filter and process each IPR sample according to the procedure outlined in Section 10.0 and calculate the number of Enterococci per 100 mL according to Section 12.0.

11.6.3 Calculate the percent recovery (R) for each IPR sample using the following equation:

$$R = 100 \times \frac{(Ns - Nu)}{(T)}$$

R = percent recovery

Ns = Enterococci (CFU/100 mL) in the spiked sample

Nu = Enterococci (CFU/100 mL) in the unspiked sample

(Even if no colonies are found, the minimum value is 1)

T = true spiked Enterococci (CFU/100 mL) manufacturer's lot mean

11.6.4 Using the percent recoveries of the four analyses, calculate the mean percent recovery and the relative standard deviation (RSD) of the recoveries. The RSD is the standard deviation divided by the mean, multiplied by 100.

11.6.5 Compare the mean recovery and the RSD with the corresponding IPR criteria below:

Recovery (mean percent)	**85% - 106%**
Precision (as maximum RSD)	**14%**

If the mean and the RSD for recovery of Enterococci meet acceptance criteria, system performance is acceptable and analysis of field samples may begin. If the mean or the RSD fall outside of the required range for recovery, system performance is unacceptable. In this event, identify the problem by evaluating each step of the analytical process, media, reagents, and controls, correct the problem and repeat the IPR analysis.

11.7 Ongoing precision and recovery (OPR)

To demonstrate ongoing control of the analytical system, the laboratory must routinely process and analyze spiked **PBS** (Section 8.31) samples. The laboratory must analyze one OPR sample after every 20 field and matrix spike samples or one per week that samples are analyzed, whichever occurs more frequently. OPR samples must be accompanied by an acceptable method blank (sterile phosphate-buffered saline (PBS)) and appropriate media sterility checks. The OPR procedure is as follows:

11.7.1 Spike a 100-mL sample of PBS with *Enterococcus faecalis* ATCC 19433 by aseptically adding one BioBall to the container and mixing by vigorously shaking the sample bottle a minimum of 25 times.

11.7.2 Filter and process each OPR sample according to the procedure outlined in Section 10.5 and calculate the number of Enterococci per 100 mL according to Section 12.0.

11.7.3 Calculate the percent recovery (R) for each OPR sample using the equation in section 11.6.3.

11.7.4 Compare the OPR results (percent recovery) with the corresponding recovery criteria below:

OPR (as percent recovery) 78%-113%

If the OPR result for recovery of Enterococci meets acceptance criteria, method performance is acceptable and analysis of field samples may continue. If the OPR result falls outside of the acceptance criteria for recovery, system performance is unacceptable. In this event, identify the problem by evaluating each step of the analytical process, media, reagents, and controls, correct the problem and repeat the OPR analysis.

11.8 Matrix spikes (MS)

MS analysis is performed to determine the effect of a particular matrix on enterococci recoveries. The laboratory must analyze one MS sample when **disinfected** wastewater samples are first received from a new source. Subsequently, 1 per 20 samples received from a disinfected wastewater must include a MS sample. MS samples must be accompanied by the analysis of an unspiked field sample (duplicate) subsequently collected from the same sampling site. Additionally, an OPR sample must be run along side the field samples. MS samples are performed as follows:

11.8.1 Prepare two 100 mL field samples that were subsequently collected from the same site. One sample will remain unspiked and the other will serve as the spiked sample. If 100 mL volume is not available, use two 10-mL volumes from a single field bottle sample.

11.8.2 Select sample sizes that will yield an enterococci value of 20 - 60 colonies on a membrane.

11.8.3 Spike the MS sample with an *E. faecalis* BioBall (Section 8.34).

11.8.4 Filter the spiked field sample and the unspiked field sample as directed in Section 10.5.

11.8.5 After incubation, count all enterococci colonies on both plates. Adjust the colony count of the spiked sample by subtracting any enterococci colonies found on the membrane of the unspiked sample.

11.8.6 Calculate the percent recovery (R) for the MS sample using the equation in section 11.6.3.

11.8.7 Compare the MS result (percent recovery) with the corresponding recovery criteria below:

MS (as percent recovery) 63%-110%

If the MS result for recovery of Enterococci meets acceptance criteria, system performance is acceptable and analysis of field samples from this disinfected wastewater source may continue. If the MS result is unacceptable and the OPR sample result associated with this batch of samples is acceptable, a matrix interference may be causing the poor results. If the MS recovery is unacceptable, all associated field data must be flagged.

11.9 Laboratories with two or more analysts must compare each analyst's colony counts from one positive field sample per month. Colony counts must be within 10% between analysts. Facilities with a single analyst must have that analyst perform duplicate colony counts of a single membrane filter each month. Duplicate colony counts must be within 5% for a single analyst. If no positive field samples are available, an OPR sample may be substituted for these determinations.

11.10 For additional details of OPR, MS, Duplicate and quality control samples analyses refer to SOP QC0952.

11.11 Immediately bring to the attention of the supervisor or his designee any deviations in expected quality control testing results and refer to SOP QC0516 Deviations in Expected Quality Control Data to institute corrective action procedures.

11.12 As part of the laboratory QA program, method recovery results for OPR and IPR samples should be charted and updated records maintained in order to monitor ongoing method performance. Refer to SOP QC0952 for further information.

11.13 A Demonstration of Capability (DOC) must be completed initially, and each time there is a significant change in instrument type, personnel, or test method. Demonstration must be documented using the form "Demonstration of Capability Certification Statement" as described in SOP QC0499.

11.13.1 DOC may be established with the use of IPR and OPR Study. Document the successful completion of the Initial Demonstration of Capability for each analyst using the "Demonstration of Capability Certification Statement".

11.13.2 Submit all raw data, a spreadsheet summarizing the recoveries and standard deviations, and a completed "Initial Demonstration of Capability Certification Statement" to the QA Director for review, via LIMS immediately upon completion.

11.13.3 Following review and approval by the QA Director, the original Certification Statement and spreadsheet will be maintained in the analyst training files, which are kept in the QA office.

11.14 Corrective actions are taken when nonconforming work or departures from policies and procedures in the management system or technical operations have been identified. Preventive action is a proactive process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

- Analytical work may be stopped if necessary during the investigation, and analyses may resume after it is verified that the corrective actions taken have been effective.
- Corrective actions may include, but not limited to instrument repair or maintenance, recalibration of the instrument, resampling, reanalysis of samples, etc.

11.15 Preventive actions may include, but not limited to preventive maintenance, retraining of analysts, change in procedures etc.

12.0 Calculations and Record Keeping

12.1 Compute the count, using membrane filters with 20 to 60 enterococcus colonies or those closest to that, by the following equation:

enterococcus colonies/100 mL=

(enterococcus colonies counted / mL of sample filtered) x 100

Report results as x CFU/100 mL where X represents the number of colonies.

Note: Refer to Section 12.7 for guidance when colony counts are both above and below the upper and lower limits.

12.2 If all MF counts for a given sample are **below the lower acceptable limit** of 20, select the most nearly acceptable count and use the equation in Section 12.1 to obtain enterococcus density.

For example, sample volumes of 100, 10 and 1 mL produced colony counts of 17, 1 and 0, respectively. Calculate on the basis of the most nearly acceptable plate count, 17, and report as 17 CFU/100 mL.

12.3 If the total number of enterococcus colonies are **not distinct enough** for accurate counting (TNTC), use > 60 in the calculation and report the result by using the equation in 12.1. If all membrane counts are above the upper acceptable limit of 60 but countable, calculate the count using the smallest volume filtered.

For example, volumes 1, 0.5, and 0.01 mL all produced plate counts of TNTC. Use the upper range of 60 colonies as the basis of calculation with the smallest filtration volume and estimate the count:

60 / 0.01 X 100 = 600,000 CFU/100 mL

Report this as > 600,000 CFU/100 mL

12.4 If there are counts in the **acceptable range on replicate plates**, carry the counts independently to final reporting units, then calculate the arithmetic mean of those counts to obtain the final reporting value.

Example, if the counts are 24 and 36 for replicate plates of 100 mL each, then the arithmetic mean is calculated as follows:

(24 CFU/100 mL + 36 CFU/100 mL) / 2 = 30 CFU/100 mL

12.5 If there is **more than one dilution having an acceptable range** of counts, carry the counts independently to final reporting units, then average for final reporting value.

For example, volumes 100, 10 and 1 mL produce colony counts of TNTC (too numerous to count), 55, 30, and 1 respectively. Independently carry each MF count to a count of per 100 mL:

55/10 x 100 = 550 CFU/100 mL
30/1 x 100 = 3000 CFU/100 mL

Calculate the arithmetic mean:

(550 CFU/100 mL+ 3000 CFU/100 mL) / 2 = 1775 CFU/100 mL

Report 1775 CFU/10 mL

12.6 If counts from **all membranes are zero**, calculate final result using the largest volume filtered.

For example, sample volumes of 25, 10 and 2 mL produced colony counts of 0, 0 and 0 respectively. Calculate the number of colonies per 100 mL that would have been reported if there had been one colony on the filter representing the largest filtration volume. In this example the largest volume is 25 mL, calculation would be:

1/25 X 100 = 4 CFU/100 mL

Report as <4 CFU/100 mL.

12.7 If colony counts are **both above and below the upper and lower limits**, select the most nearly acceptable count.

For example, colony counts of 64, 6 and 0 from volumes of 100, 10 and 1 mL respectively. Calculate on the basis of the most nearly acceptable plate count, 64, and report 64 CFU/100 mL.

If sample volumes of 100, 10 and 1 mL produced colony counts of 98, 18 and 0 respectively calculate using 18 colonies. This must be reported as an estimated count.

12.8 If there is no result because of confluent growth, >200 atypical colonies (TNTC), lab accident, etc., the data must be reviewed by the Department Manager or his/her designee for any laboratory errors. A result may not be reported; the client must be notified with specific reason for lack of reportable result.

12.9 Documentation of Laboratory work

12.9.1 Enter and initial the date and time sample was taken, received, run, and completed in designated areas on the EQC Chain of Custody form.

12.9.2 Document all laboratory data as outlined in SOP QC0343, Documentation of Laboratory Data.

12.9.3 Immediately bring to the attention of the supervisor or his designee any deviations in expected quality control testing results and refer to SOP QC0516 Deviations in Expected Quality Control Data to institute corrective action procedures.

13.0 Method Performance

13.1 Specificity – The specificity of the medium used in this method is 6.0% false positive and 6.5% false negative for various environmental water samples. The false positive rate was calculated as the percent of colonies, which react typically, but did not verify as members of the enterococcus group. The false negative rate was calculated as the percent of all verified enterococcus colonies not reacting typically.

13.2 Bias – The persistent positive or negative deviation of the results from the assumed or accepted true value is not significant.

13.3 Precision – The precision among laboratories for marine water was 2.2% and for surface water was 18.9%.

14.0 Pollution Prevention/Waste Management

14.1 Keep storage of chemicals in individual departments to a minimum, in order to minimize the potential for large spills and exposure to hazardous substances. Each laboratory manager or designee is required to inspect their department on a semi-annual basis for expired reagents and chemicals. Notify the Safety Director for disposal of expired reagents and chemicals.

14.2 Minimize the amount of waste generated by preparing only the minimum required amount of a reagent.

14.3 Expired hazardous chemicals, reagents, and samples requiring lab packing or other outside disposal/treatment are stored in a designated waste storage facility (such as the chemical shed) until final disposal. This is under the direction and supervision of the Safety Director. Individual analysts may not transfer chemicals or other substances to a waste storage facility without obtaining authorization from the Safety

Director. All microbiological waste generated during the performance of this procedure (including used petri dishes) must be disposed of in accordance to the Laboratory Waste Disposal SOP, QC0479. Additional details regarding specific disposal of chemical waste at EQC are given in the EQC Safety Procedure Manual, which is incorporated herein by reference.

15.0 References and Supplemental Documents

15.1 EPA Method 1600: Enterococci In Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-β-D Glucoside Agar (mEI) July, 2009.

15.2 EPA 600/8-78-017, Part II, Section C 3.5.

15.3 EQC Quality Systems Manual, latest.

15.4 EQC Safety Procedure Manual, latest.

15.5 EQC SOP QC0339, Thermometer Calibration, Maintenance, and Record Keeping, latest.

15.6 EQC SOP QC0343, Documentation of Laboratory Data, latest.

15.7 EQC SOP QC0448, Media and Broth Preparation, latest.

15.8 EQC SOP QC0467, pH Electrometric Measurement, latest.

15.9 EQC SOP QC0470, Laboratory Balance Calibration, latest.

15.10 EQC SOP QC0479, Laboratory Waste Disposal, latest.

15.11 EQC SOP QC0499, General Preparation and Evaluation of Demonstrations of Capability, latest.

15.12 EQC SOP QC0500, Preparation of Phosphate-Buffered Dilution and Rinse Water, latest.

15.13 EQC SOP QC0516, Corrective Action Procedures for Deviations from Expected Microbiological Quality Control Results, latest.

15.14 EQC SOP QC0519, Water and Wastewater Sampling for Microbiological Testing, latest.

15.15 EQC SOP QC0952, General Internal Quality Control Requirements for Analytical Methods in the Water Microbiology Laboratory, latest.

16.0 Supersession

16.1 EQC Southampton address removed from the SOP header; *E.coli* negative control removed from Section 8.24.

16.2 Section 3.2, updated; Section 8.0, restructured and updated; Section 10.1, non-significant addition made; Section 10.3.1, log interval dilutions added; Section 10.4.1.1 through 10.4.1.3 added; Section 10.6.1, 10.6.2.2, and 10.6.2.7 added; Section 11.3 and 11.10 refer to SOP QC0952.

17.0 Tables and Figures

17.1 Figure 1 (Section 10.5.6)

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SOP Number QC0665
E. coli in Water by Membrane Filtration Using Modified Membrane- Thermotolerant *Escherichia coli* Agar (Modified mTEC) by EPA 1603

CONFIDENTIAL

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1.0 Scope and Application

1.1 This procedure is used when the number of *E. coli* in water needs to be determined by the membrane filtration (MF) method using modified membrane-thermotolerant *E. coli* agar (modified mTEC). It is to be performed by trained personnel anytime the enumeration of *E. coli* bacteria using this method is required.

1.2 The MF technique provides a direct count of bacteria in water based on the development of colonies on the surface of a membrane filter. It is highly reproducible, can be used to test relatively large sample volumes, and yields results more rapidly than the multiple-tube procedure. However, the MF procedure has limitations, particularly when testing waters with high turbidity or elevated background bacteria.

2.0 Summary and Discussion of Procedure

2.1 Method 1603 is approved for the detection and enumeration of *E. coli* in both disinfected wastewaters and ambient waters. With respect to the latter, a wide variety of pathogenic microorganisms can be transmitted to humans when bathing in such waters. Historically, fecal coliforms have been recommended as the indicator of choice for evaluating the microbiological quality of recreational waters. Recent studies, however, have demonstrated that *E. coli* and enterococci show a stronger correlation with swimming-associated gastroenteritis than do fecal coliforms, and that both indicators were equally acceptable for monitoring fresh water quality.

2.2 The MF procedure for *E. coli* uses a modified mTEC medium and an incubation temperature of 44.5 ± 0.2 °C for selectivity. Samples up to 100 mL are filtered through a sterile, 47 mm, 0.45 micron membrane filter and incubated on modified mTEC agar, first for 2 ± 0.5 hours at 35 ± 0.5 °C, and then for 22 ± 2 hours in a water bath at 44.5 ± 0.2 °C. All red or magenta colonies are counted as *E. coli.*

Typical and atypical *E. coli* colonies may be confirmed using a verification procedure.

3.0 Definitions

3.1 *E. coli* are those bacteria which produce red or magenta colonies on modified mTEC agar.

4.0 Health and Safety Warnings

4.1 Personnel engaged in laboratory analyses at Eurofins QC, Inc. (EQC) must be familiar with and adhere to the policies set forth in the current version of the EQCL Safety Procedure Manual.

5.0 Cautions

5.1 Start microbiological examination of a water sample promptly after collection to avoid unpredictable changes. Hold temperature of all samples at 0 to <10 °C (do not allow to freeze) during transit to the laboratory and prior to testing. The maximum hold time from time of collection to incubation start time must not exceed 8 hours, with the exception of drinking waters for LT2 (The Long Term 2 Enhanced Surface Water Treatment Rule) projects, which have a maximum hold time of 30 hours. Any deviations in transport or analyzing holding times, missing sampling information, sample volume, or test preformed must be communicated to the client representative and notes made in the sample login and history log.

6.0 Interferences

6.1 Water samples containing colloidal or suspended particulate material can clog the membrane filter and prevent filtration, or cause spreading of bacterial colonies that could interfere with enumeration and identification of target colonies.

7.0 Personnel Qualifications

7.1 Before performing this test independent of secondary supervision and review, each analyst must have an approved Demonstration of Capability Certification Statement (DOC) form (see SOP QC0499) on file in the Quality Assurance office.

8.0 Equipment, Apparatus and Materials

8.1 Erlenmeyer flask for mixing media, clean borosilicate

8.2 Forceps with smooth tips.

8.3 Incubator capable of maintaining a temperature of 35 ± 0.5 °C.

8.4 Petri dishes 60 x 15 mm, plastic, presterilized.

8.5 Stereoscopic microscope with fluorescent light source.

8.6 Filtration funnel units: filter funnels 47-mm magnetic (Gelman or equivalent), graduated at 50 and 100 mL, in assembly with base, sterile, re-usable.

Note: As an alternative, disposable, sterile filtration funnel units can be used (Fisher, Catalog # 09-740-30D or equivalent).

8.7 Membrane filters, 47 mm/0.45 micron, sterile (Millipore or equivalent).

8.8 Water-proof plastic bags.

8.9 Water bath capable of maintaining a temperature of 44.5 ± 0.2 °C.

8.10 Vacuum manifold and pump or laboratory house vacuum system.

8.11 Modified mTEC Agar (Difco or equivalent). Used for the detection and enumeration of *E. coli* in water by the MF method.

8.11.1 Suspend 45.6 g of the powder in 1 L of purified water. Mix thoroughly. Heat with frequent agitation and boil for 1 minute to completely dissolve the powder. Autoclave at 121 °C for 15 minutes.

8.11.2 Cool to 45 - 50 °C in a waterbath and aseptically add sterile 1N NaOH to achieve the pH of 7.3 ± 0.2.

8.11.3 Dispense agar in 4 to 6-mL quantities into 60 x 15 mm disposable petri dishes and allow to solidify.

8.11.4 Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. Store all prepared plates at 2 - 8 °C for up to 2 weeks. The amount of media prepared can be adjusted accordingly to the work load. The positive control for modified mTEC is *E. coli*, negative control is *E. aerogenes*. Media lot comparisons are required for this method. Notify Water Microbiology Manager when a new manufacturer's lot is being used. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.12 Tryptic soy agar (TSA) (BD BBL or equivalent). This medium is used for the cultivation and identification of bacteria.

8.12.1 Suspend 45.7 g of the powder into 1 L of purified water. Mix thoroughly. Heat with frequent agitation and boil for 1 minute to completely dissolve the powder. Autoclave at 121 °C for 15 minutes. Final pH must be 7.3 ± 0.2.

8.12.2 Dispense 15 to 20 mL into 15x100 mm, sterile petri dishes and allow to solidify. Prepared media will be light amber in color. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for TSA is *E. coli*; a negative control is not needed. Store all prepared plates at 2 - 8 °C for up to 2 weeks. Record all media preparation data in the Water Microbiology electronic media book as directed in SOP QC0448.

8.13 Trypticase soy broth (TSB) (BD BBL or equivalent). This medium is used as a general purpose media for cultivation of microorganisms.

8.13.1 Dissolve 30 g of the powder in 1 L of purified water. Mix thoroughly. Warm gently until solution is complete. Dispense 10-mL portions into suitable screw-cap tubes. Autoclave prepared media at 121 °C for 15 minutes. Final

pH must be 7.3 ± 0.2. Prepared media will be clear, yellow to amber in color and free from precipitates. The amount of media prepared can be adjusted accordingly to the work load.

8.13.2 Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for TSB is *E. coli*. No negative control is needed. Store all prepared tubes at 2 - 8 °C for up to 3 months. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.14 Nutrient Agar (Remel or equivalent). Used for the cultivation and enumeration of microorganisms in water.

8.14.1 Suspend 23 g of the medium into 1 L of purified water. Heat to boiling with agitation to completely dissolve the powder. Autoclave prepared media at 121 °C for 15 minutes. Final pH must be 6.8 ± 0.2.

8.14.2 After sterilization, place 12-15 mL into 15 x 100 mm-sterile petri dishes and allow to solidify. Prepared media will be light amber in color and slightly opalescent. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for Nutrient Agar is *E. coli*; a negative control is not needed. Store all prepared plates at 2 - 8 °C for up to 2 weeks. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.15 Lauryl Tryptose Broth (LTB) (Difco or equivalent). Used for detecting coliform bacteria in water and wastewater.

8.15.1 Suspend 35.6 g of the powder in 1 L of purified water. Mix thoroughly. Warm slightly to completely dissolve the powder. Prepare tubes with inverted 10 by 75 mm culture tubes before dispensing media. Dispense 10-mL portions into autoclavable, borosilicate glass tubes of sufficient size to contain both the culture media and the sample without being three quarters full. Autoclave prepared media at 121 °C for 15 minutes. Final pH must be 6.8 ± 0.2. Prepared media will be yellow to gold in color with some haziness. The amount of media prepared can be adjusted accordingly to the work load.

8.15.2 Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for LTB is *E. coli* and the negative control is *P. aeruginosa*. Store all prepared tubes at 2 - 8 °C for up to 3 months. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.16 Simmons Citrate Agar (Acumedia or equivalent). Simmons Citrate will differentiate microorganisms based upon their ability to utilization of citrate.

8.16.1 Suspend 24.2 g of the medium in 1 L of purified water. Heat with frequent agitation and boil for one minute to completely dissolve the medium. Dispense agar into suitable screw cap tubes and autoclave at 121 °C for 15 minutes. Final pH must be 6.9 ± 0.2. After sterilization, slant tubes until media is solid. Prepared media will be forest green in color and slightly hazy. The amount of media prepared can be adjusted accordingly to the work load. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for Simmons citrate is *E. areogenes* and the negative control is *E. coli*. Store all prepared tubes at 2 - 8 °C for up to 3 months. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.17 EC Medium (EC Broth) (Acumedia or equivalent). Used in this method for the detection of *E. coli* at 44.5 °C.

8.17.1 Dissolve 37 g of the medium to 1 L of purified water. Mix thoroughly. Place 10 x 75 mm culture tubes (inverted) into autoclavable, borosilicate glass tubes. Dispense 10 mL of EC broth into the autoclavable, borosilicate glass tubes of sufficient size to contain both the culture media and the sample without being three quarters full. Autoclave prepared media at 121 °C for 15 minutes. Final pH must be 6.9 ± 0.2. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for EC broth is *E. coli* and the negative control is *E. aerogenes*. Store prepared media at 2 - 8 °C for two weeks in tubes with "pop" tops and three months for screw tops. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

Note: Do not use tubes if the inverted tubes (durham tubes) are not completely filled with medium after sterilization.

8.18 Cytochrome oxidase reagent (Difco or equivalent).

N,N,N',N'-tetramethyl-*p*-phenylenediamine dihydrochloride, 1% aqueous solution (1 g per 100 mL reagent-grade water).

8.19 Kovacs indole reagent (Difco or equivalent).

p-dimethylaminobenzaldehyde (10 g), amyl or isoamyl alcohol (150 mL) and concentrated (12 M) hydrochloric acid.

8.20 Inoculating loops, sterile, plastic.

8.21 Tryptone Water – Bacto Tryptone (BD or equivalent). Tryptone Water is used to detect *E. coli* based on indole production.

8.21.1 Composition:

Bacto Tryptone	10.0 g
Sodium chloride	5.0 g
Reagent-grade water	1.0 L

8.21.2 Add reagents to 1 L of purified water and mix thoroughly to dissolve. Dispense 5 mL portions into autoclavable, borosilicate glass tubes of sufficient size. Autoclave prepared media for 15 minutes at 121 °C. Final pH must be 7.3 ± 0.2. Prepared media will be light to medium amber and slightly opalescent. The amount of media prepared can be adjusted accordingly to the work load. Label each batch with the date prepared, batch ID, date of expiration, lot number, storage temp, method number and media name. Test for sterility and growth promotion properties as directed in SOP QC0448. The positive control for Tryptone Water is *E. coli* and the negative control is *E. aerogenes*. Store prepared media at 2 - 8 °C for up to 3 months. Record all media preparation data in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.22 Phosphate Buffered Saline (PBS)

8.22.1 Composition:

Sodium dihydrogen phosphate (NaH_2PO_4)	0.58 g
Disodium hydrogen phosphate (Na_2HPO_4)	2.5 g
Sodium Chloride	8.5 g
Reagent-grade water	1.0 L

8.22.2 Dissolve the reagents in 1 L of reagent-grade water and dispense in appropriate amounts for dilutions in screw cap bottles. Autoclave at 121 °C for 15 minutes. Final pH must be 7.4 ± 0.2. Store prepared PBS at room temperature. Record in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.22.3 Ingredients can be modified to prepare larger or smaller amounts of PBS. The following is an example of how to make 10 L of PBS.

8.22.3.1 Measure out the total amount of reagents needed for 10 L. Pour these ingredients into 3 L of reagent-grade water. Boil the mixture to dissolve the salts. Add the solution to 7 L of reagent-grade water contained in a carboy. Dispense into screw cap bottles and/or into containers. Autoclave at 121 °C for 15 minutes. Final pH must be 7.4 ± 0.2.

Note: Use PBS when performing IPR and OPR sample analyses.

8.23 Phosphate Buffered Dilution water

8.23.1 Prepare as directed in SOP QC0500. The amount of dilution water prepared can be adjusted accordingly to the work load. Record media in the Water Microbiology electronic media logbook as directed in SOP QC0448.

8.24 Sample containers, 125 mL, polypropylene, containing Sodium Thiosulfate tablet for chlorine neutralization.

8.25 Positive control culture *Escherichia coli*, ATCC 11775 or equivalent (BioBalls).

8.26 Negative control culture *Enterococcus faecalis*, ATCC 19433 or equivalent (BioBalls), or *Enterobacter aerogenes* (*E. aerogenes*) ATCC 13048.

8.27 White Filter Paper (Whatman or equivalent).

8.28 60 x 15 mm presterilized, plastic petri dishes.

8.29 Carboy capable of holding 20 L.

8.30 Hotplate.

8.31 Water bath capable of maintaining 50 °C to temper agar.

8.32 A computer capable of real time sample analysis via the WM logbook.

8.33 Autoclave indicator tape.

8.34 Autoclave funnel wrap: aluminum foil or kraft paper.

9.0 Calibration

9.1 Calibrate thermometers used to monitor the temperature of incubators and water baths against a NIST thermometer annually according to SOP QC0339. Calibrate all others (digital, infrared, etc.) quarterly.

9.2 Schedule annual calibration and maintenance of balances through the manufacturer or other qualified, contracted personnel.

9.3 Calibrate pH meters according to manufacturer's recommendations and SOP QC0467.

9.4 Check incubator temperatures twice daily, at least four hours apart to ensure temperature requirements are being met. Record readings in the temperature logbooks.

10.0 Sample Preparation and Analysis

10.1 Collect samples as directed in SOP QC0519 Water and Wastewater Sampling for Microbiological Testing. Store collected samples from the field to the laboratory on ice at a temperature between 0 and 10 °C (do not freeze). When samples are stored at the testing laboratory, prior to analysis, store refrigerated between 0.5 and 5 °C (do not freeze). At no time shall the sample be frozen.

10.2 Initiate analysis as soon as possible after collection to minimize changes in bacterial population. The maximum time allowed between collection and analysis of a water sample is 8 hours, with the exception of waters for LT2 projects, which have a maximum holding time of 30 hours from time of collection to analysis.

10.3 Sample size

10.3.1 The size of the sample will be governed by the expected bacterial density based on the previous historical *E. coli* levels of the source. An ideal sample volume will yield 20 to 80 *E. coli* colonies on a membrane filter surface.

10.3.2 **A minimum of 3 dilutions must be used for any new sample source.**

10.3.3 In instances where the bacterial density is expected to be high, turbidity situations exist, no known history of bacterial density or for legal cases, filter at least three appropriate dilutions from 1 to 100 mL using log interval (e.g. 100, 10, 1, 0.1, etc.) or half log intervals (e.g. 100, 30, 10, 3, 1 mL) prepared in phosphate buffered dilution water through a membrane.

Note: When analyzing smaller sample volume (e.g., <20 mL), add 20-30 mL of phosphate buffered dilution water to the funnel prior to filtration. This will allow even distribution of the sample on the membrane.

10.3.4 If a sample is too turbid to filter, use a different technique for analysis, such as an MPN method.

10.4 Sterile filtration units

10.4.1 Use for filtration series

10.4.1.1 Use sterile filtration units to begin each filtration series. A filtration series is considered to be interrupted when an interval of 30 minutes or longer elapses between sample filtrations. After such interruption, treat any further sample filtration as a new filtration series and replace the filter funnels with new sterile filter funnels.

10.4.1.2 Do not process more than ten (10) filtrations on any funnel. That is, after ten filtrations, including samples, rinse water or sample dilutions, change-out the filter funnel to a second, sterile funnel.

10.4.1.3 During testing in the laboratory, multiple funnels may be used for less than 10 field sample filtrations in order to meet holding times or when, in the judgment of the analyst, a new funnel should be used following a sample with a suspected high level of bacteria. **Always complete any funnel use with a filter blank.**

10.4.2 Use for serial diluted single sample (i.e., river samples, etc.)

10.4.2.1 Use separate sterile filtration unit for each sample to be tested. Start filtration from the highest dilution to lowest. Rinse the interior surface of the funnel 3 times with a 20-30 mL of the sterile dilution water after each filtration. Following the third (final) rinse, remove the filter funnel and replace with a new, sterile disposable funnel.

10.5 Sample Filtration

10.5.1 Using sterile forceps, place a sterile membrane filter (grid side up) over the porous plate of the filtration unit. Pour sample into filtration unit and filter under partial vacuum.

10.5.2 With the membrane still in place, rinse the interior surface of the funnel 3 times with a 20-30 mL portion of sterile dilution water from a squeeze bottle. Thorough rinsing is required to prevent cross-contamination.

10.5.2.1 Where the bacterial density is expected to be high and/or turbidity situations exist additional rinses should be employed.

10.5.2.2 Perform at least one additional rinse to prevent cross-contamination to the following sample in the filtration series.

10.5.3 Upon completion of the final rinse, and the filtration process, disengage vacuum, unlock and remove funnel, and immediately remove the membrane filter with sterile forceps. Place the filter on a modified mTEC agar dish which has been allowed to warm to room temperature with a rolling motion to avoid entrapment of air.

10.5.4 The first two samples filtered on any sterile funnel is a "Sterility Blanks". These serves as the 'Initial Sterility Blank', and is a check on the efficiency of the autoclave sterilization for re-usuable funnels. Refer to Section 11.3.

10.5.5 When more than one sample is processed on an individual funnel, the last sample filtered on a funnel is a "Final Sterility Blank". Refer to Section 11.3.

10.5.6 Analyze a Rinse Water check as a sample, one time, for each new bottle of sterile rinse water bottle opened. Rinse water counts as a sample in the filtration series. Refer to Section 11.3.

10.6 Incubate samples at 35 ± 0.5 °C for 2 ± 0.5 hours to rejuvenate injured or stressed bacteria.

10.7 Transfer samples to waterproof plastic bags, seal, and submerge in a water bath at 44.5 ± 0.2 °C for 22 ± 2 hours. Anchor dishes below water surface to maintain critical temperature requirements.

10.8 Counting *E. coli* colonies

10.8.1 Use a colony counter or a low power stereoscopic microscope with a cool white fluorescent light source directed to provide optimal viewing.

10.8.2 Colonies produced by *E. coli* on modified mTEC are red or magenta in color. Red or magenta colonies are considered "typical" *E. coli*.

10.8.3 For samples with multiple volumes tested refer to Section 12.0 for further instructions.

10.9 *E. coli* Verification Procedure

10.9.1 Using sterile, plastic, inoculating loops, transfer growth from the centers of 10 well-isolated typical (red /magenta) colonies and 10 well-isolated atypical colonies to nutrient agar plates or slants and to trypticase soy broth.

10.9.2 Incubate the nutrient agar plates and trypticase soy broth cultures for 24 ± 2 hours at 35 ± 0.5 °C.

10.9.3 After the incubation outlined in 10.9.2, transfer growth from the nutrient agar and perform a cytochrome oxidase test. This test uses a sterile plastic loop to transfer a loop full of growth to a piece of white filter paper. Holding the cytochrome oxidase dropper, gently crush the ampule one time. After tapping the dropper bottle a few times on the bench top turn the dropper upside down and put a few drops of oxidase reagent onto the bacteria already on the filter paper. A positive reaction will take place within 15 seconds. If the area where the bacteria smear is applied turns deep purple within 15 seconds after applying cytochrome oxidase, the test is positive. Disregard any color change after 15 seconds. No color change is a negative reaction. Since *E. coli* is oxidase negative there should be no color change.

10.9.4 Transfer growth from the trypticase soy broth tube (after incubation in Section 10.9.2) to a Simmons citrate agar slant, tryptone water and an EC broth tube as outlined below.

10.9.4.1 Simmons Citrate: Take a loop full of growth from tryptic soy broth and transfer it to Simmons Citrate. To do this; stab the Citrate

with a loop full of bacteria, pushing the loop to the bottom of the tube. While pulling the loop out of the media streak the loop across the slant of the Citrate in a left to right motion. Incubate the Simmons Citrate agar for 4 days at 35 ± 0.5 °C in an aerobic atmosphere. A positive reaction is indicated by growth with an intense blue color on the slant. Since *E. coli* is citrate negative, there should be little or no growth and no change in agar color (i.e., medium remains dark green).

10.9.4.2 EC broth: From the trypticase soy broth tube, take a loop full of growth and inoculate it into EC medium (with an inverted culture tube). Incubate the EC broth tube at 44.5 ± 0.2 °C in a water bath for 24 ± 2 hours. The water level must be above the level of the EC broth in the tube. A positive *E. coli* test is indicated by turbidity and production of gas in the inverted 10 x 75 mm culture tube. No gas in the inverted culture tube is *E. coli* negative. *E coli* is EC positive for growth and gas.

10.9.4.3 Tryptone Water: From the trypticase soy broth, take a loop full of growth and transfer it to Tryptone water. Incubate the tryptone water (broth) for 18-24 hours at 35 ± 0.5 °C with loosened caps. After incubation gently crush the indole ampule one time. After tapping the dropper bottle a few times on the bench top turn the dropper upside down and put 0.5 mL of Kovacs indole reagent into the typtone water tube. Shake the tube gently. Allow the tube(s) to stand for 5-10 minutes at room temperature. A positive *E. coli* test is indicated by a deep red color, which develops in the alcohol layer on top of the broth. *E coli* is indole positive.

10.9.4.4 *E. coli* are oxidase negative, citrate negative, EC growth and gas positive, and indole positive.

10.9.4.5 Adjust results based upon percentage of *E. coli* colonies confirmed. For example, if only a few suspect colonies are verified to be *E. coli* the reported value needs to be adjusted as follows:

Total # of colonies counted = 60

# of colonies selected for verification = 10

# of colonies confirmed = 5

Adjusted final *E. Coli* result = 60 x 5/10 = 30

Note: Alternately, commercially available multi-test identification systems may be used to verify colonies. Refer to Section 12.0 of EPA 1603, July 2006.

10.9.4.6 Record all information (Typical or Atypical colonies, media batch number, incubation times, etc.) into *E.coli* Verification logbook Form #2084. The laboratory manager or his designee must review the Logbook for accuracy.

10.9.5 Frequency Tracking

The main lab and satellites offices must track the number of samples that contain typical and atypical colonies. Verification tests are performed at the main lab.

10.9.5.1 Following plate counting, use the Sample Tracking file for this method (EPA 1603) and bar-code each sample that has either typical or atypical colonies into the file for tracking frequency.

10.9.5.2 For satellites offices, take a picture of the plate. Send the plate and photo to the main lab for verification. Notify the main lab staff when plates are being sent.

Note: The main lab will use the picture as a reference for confirmation of original count of typical and atypical colonies.

10.9.5.3 After receiving plates from a Satellite office, initiate the verification the same day or at a minimum by the following day to ensure the quality of data.

10.9.5.4 Verification must be performed each month based on the following frequency: Verify a minimum of 10 typical (positive) and 10 atypical (negative) *E. coli* colonies or 1 typical and 1 atypical *E. coli* colony from 10% of all plates showing growth, whichever is more frequent.

10.9.5.5 When routine samples do not provide at least 10 typical and at least 10 atypical colonies, a source known to satisfy this requirement must be analyzed and verified. Such sources can include samples from local pounds or streams.

10.9.5.5.1 Collect a sample from local pound or stream and analyzed as a regular sample.

11.0 Quality Control

11.1 Test all microbiological media after preparation as directed in SOP QC0448.

11.2 Check each lot # of membrane filters for sterility by placing a membrane on a tryptic soy agar plate for 24 ± 2 hours at 35 ± 0.5 °C. Absence of growth indicates sterility of the filter. Reject any lot that is found to be non-sterile. Record results in the Water Microbiology quality control book.

11.3 Perform the following checks when using autoclavable (multi-use) funnels.

11.3.1 Analyze an initial sterility blank on TSA, as the first sample for each sterile funnel used as follows:

11.3.1.1 Rinse each funnel with 20-30 mL of phosphate-buffered dilution water as is done during the rinse step for a sample. Do not use additional rinses. Place the filters on TSA plates and incubate for 24 ± 2 hours at 35 ± 0.5 °C. Absence of growth indicates sterility of the phosphate-buffered dilution water and the filtration assembly. Record results in the Water Microbiology Logbook in LIMS.

11.3.2 Analyze an initial sterility blank on modified mTEC, as the second sample for each sterile funnel used as follows:

11.3.2.1 Rinse each funnel with 20-30 mL of phosphate-buffered dilution water as is done during the rinse step for a sample. Do not use additional rinses. Place the filter on a modified mTEC plate and complete the analysis of the sterility blank as a regular sample. Absence of growth indicates sterility of the phosphate-buffered dilution water and the filtration assembly for *E.coli*. Record results in the Water Microbiology Logbook in LIMS.

11.3.3 Analyze a final sterility blank following all samples analyzed with any funnel, WHEN more than one sample is analyzed on a funnel. If only one sample is processed per funnel, a final sterility blank is not required.

11.3.4 Analyze a Rinse Water check as a sample, one time, for each new bottle of sterile rinse water bottle opened. Pour 50 mL of sterile water into filtration unit and filter. Rinsing the interior surface of the funnel 3 times is not required. Complete the analysis of the sterility blank as a regular sample.

11.3.5 For each autoclavable funnel, up to a maximum of ten (10) filtrations may be performed before being replaced with an un-used sterile funnel. A filtration includes any: sample, sample dilution or rinse water check.

11.4 Disposable sterile funnels

11.4.1 When using disposable sterile funnels, an initial sterility check or final sterility blank is not required.

11.4.2 Disposable sterile funnels are lot checked for sterility when received at the laboratory.

11.5 Duplicate analyses. Perform duplicate analyses at a minimum of a 5% (1 out of every 20 samples) frequency or 1 per week, whichever is more frequent. Refer to SOP QC0952 for further information.

11.6 Check each batch of PBS and phosphate-buffered rinse water for sterility by adding 50 mL of PBS or rinse water to 50-mL double strength trypticase soy broth, incubating at 35 ± 0.5 °C for 24 hours and checking for growth. Record results in the Water Microbiology quality control logbook in LIMS.

11.7 On a monthly basis, verify a minimum of 10 typical and 10 atypical *E. coli* colonies (can be from a single membrane) or 1 typical and 1 atypical colony from 10% of all samples with growth, whichever is more frequent. Record results in the Water Microbiology Verification Book.

11.8 Initial precision and recovery (IPR)

The IPR analysis is used to demonstrate acceptable method performance (recovery and precision) by each laboratory before the method is used for monitoring field samples. IPR samples should be accompanied by an acceptable method blank (sterile Phosphate-buffered saline (PBS)) and appropriate media sterility checks. The IPR procedure is as follows:

11.8.1 Prepare four, 100-mL samples of **PBS** (Phosphate Buffered Saline, Section 8.22 above) and spike each sample with *E. coli* ATCC 11775 by aseptically adding 1 BioBall or known density of the laboratory prepared culture spike to each container and mixing by vigorously shaking the sample bottle a minimum of 25 times.

11.8.2 Filter and process each IPR sample according to the procedure outlined in Section 10.0 and calculate the number of *E. coli* per 100 mL according to Section 12.0.

11.8.3 Calculate the percent recovery (R) for each IPR sample using the following equation:

$$R = 100 \times \frac{(Ns - Nu)}{(T)}$$

R = percent recovery

Ns = *E. coli* (CFU/100 mL) in the spiked sample

Nu = *E. coli* (CFU/100 mL) in the unspiked sample (minimum value is 1 even if no colonies are found)

T = true spiked *E. coli* (CFU/100 mL) manufacturer's lot or lab culture spike mean

11.8.4 Using the percent recoveries of the four analyses, calculate the mean percent recovery and the relative standard deviation (RSD) of the recoveries. The RSD is the standard deviation divided by the mean, multiplied by 100.

11.8.5 Compare the mean recovery and the RSD with the corresponding IPR criteria below:

Recovery (mean percent): detect - 144%
Precision (as maximum RSD): 61%

If the mean and the RSD for recovery of *E. coli* meet acceptance criteria, system performance is acceptable and analysis of field samples may begin. If the mean or the RSD falls outside of the required range for recovery, system performance is unacceptable. In this event, identify the problem by evaluating each step of the analytical process, media, reagents, and controls, correct the problem and repeat the IPR analysis.

11.9 Ongoing Precision and Recovery (OPR)

To demonstrate ongoing control of the analytical system, the laboratory shall routinely process and analyze spiked PBS samples. The laboratory shall analyze one OPR sample after every 20 field and matrix spike samples or one per week that samples are analyzed, whichever occurs more frequently. OPR samples shall be accompanied by an acceptable method blank (sterile Phosphate-buffered saline) and appropriate media sterility checks. The OPR procedure is as follows:

11.9.1 Spike a 100-mL sample of **PBS** (Phosphate Buffered Saline, Section 8.22 above) with *E. coli* ATCC 11775 by aseptically adding 1 BioBall to the container and mixing by vigorously shaking the sample bottle a minimum of 25 times.

11.9.2 Filter and process each OPR sample according to the procedure outlined in Section 10.0 and calculate the number of *E. coli* per 100 mL according to Section 12.0.

11.9.3 Calculate the percent recovery (R) for each OPR sample using the equation in Section 11.8.3.

11.9.4 Compare the OPR results (percent recovery) with the corresponding recovery criteria below:

OPR (as percent recovery) detected - 144%

If the OPR result for recovery of *E. coli* meets acceptance criteria, method performance is acceptable and analysis of field samples may continue. If the OPR result falls outside of the acceptance criteria for recovery, system performance is unacceptable. In this event, identify the problem by evaluating each step of the analytical process, media, reagents, and controls, correct the problem and repeat the OPR analysis.

11.10 Matrix spikes (MS)

MS analysis are performed to determine the effect of a particular matrix on *E. coli* recoveries. The laboratory must analyze one MS sample when disinfected wastewater samples are first received from a new source. Subsequently, 1 per 20 samples received from a disinfected wastewater must include a MS sample. MS samples must be accompanied by the analysis of an unspiked field sample (duplicate) subsequently collected from the same sampling site. Additionally, an OPR sample must be run along side the field samples. MS samples are performed as follows:

11.10.1 Prepare two 100-mL field samples that were subsequently collected from the same site. One sample will remain unspiked and the other will serve as the spiked sample. If 100 mL volume is not available, use two 10-mL volumes from a single field bottle sample.

11.10.2 Select sample sizes that will yield an *E. coli* value of 20-80 colonies on a membrane.

11.10.3 Spike the MS sample with an *E. coli* BioBall (Section 8.26).

11.10.4 Filter the spiked field sample and the unspiked field sample as directed in Section 10.5.

11.11 Laboratories with two or more analysts must compare each analyst's colony counts from one positive field sample per month. Colony counts must agree within 10% between analysts. Facilities with a single analyst must have that analyst perform duplicate colony counts of a single membrane filter each month. Duplicate colony counts must be within 5% for a single analyst. If no positive field samples are available an OPR sample may be substituted for these determinations.

11.12 For additional details of OPR, MS, Duplicate and quality control samples analyses refer to SOP QC0952.

11.13 Immediately bring to the attention of the Director of Microbiology or his designee any deviations in expected quality control testing results and refer to SOP QC0516 Deviations in Expected Quality Control Data to institute corrective action procedures.

11.14 As part of the laboratory QA program, method recovery results for OPR and IPR samples should be charted and updated records maintained in order to monitor ongoing method performance. Refer to SOP QC0952 for further information.

11.15 A Demonstration of Capability (DOC) must be completed initially, and each time there is a significant change in instrument type, personnel, or test method. Demonstration must be documented using the form "Demonstration of Capability Certification Statement" as described in SOP QC0499.

11.15.1 DOC may be established with the use of IPR and OPR Study. Document the successful completion of the Initial Demonstration of Capability for each analyst using the "Demonstration of Capability Certification Statement".

11.15.2 Submit all raw data, a spreadsheet summarizing the recoveries and standard deviations, and a completed "Initial Demonstration of Capability Certification Statement" to the QA Director for review, via LIMS immediately upon completion.

11.15.3 Following review and approval by the QA Director, the original Certification Statement and spreadsheet will be maintained in the analyst training files, which are kept in the QA office.

11.16 Corrective actions are taken when nonconforming work or departures from policies and procedures in the management system or technical operations have been identified. Preventive action is a proactive process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

- Analytical work may be stopped if necessary during the investigation, and analyses may resume after it is verified that the corrective actions taken have been effective.
- Corrective actions may include, but not limited to instrument repair or maintenance, recalibration of the instrument, resampling, reanalysis of samples, etc.

11.17 Preventive actions may include, but not limited to preventive maintenance, retraining of analysts, change in procedures etc.

12.0 Calculations and Record Keeping

12.1 Compute the count, using membrane filters with 20 to 80 *E. coli* colonies or those closest to that as described below, by the following equation:

$$\textit{E. coli}\ \text{colonies/100 mL} = \frac{\textit{E. coli}\ \text{colonies counted}}{\text{mL sample filtered}} \times 100$$

12.2 If all MF counts for a given sample are **below the lower acceptable limit** of 20, select the most nearly acceptable count and use the equation in 12.1 to obtain *E. coli* density.

12.2.1 For example, sample volumes of 100, 10 and 1 mL produced colony counts of 17, 1 and 0, respectively.

12.2.1.1 Calculate on the basis of the most nearly acceptable plate count, 17, and report as 17 colonies/100 mL.

In this case, because no calculations were done (i.e. this is the count for 100 mL), the count is reported as 17 CFU/100 mL rather than an "estimated count of 17 CFU/100 mL".

12.2.2 As a second example, sample volumes of 10 and 1 mL produced colony counts of 18 and 0, respectively.

12.2.2.1 Calculate on the basis of the most nearly acceptable plate count, 18, and calculate as in Section 12.1 above.

$$\frac{18}{10} \mathrm{X} 100 = 180 \text{ colonies /100 mL}$$

Report this as estimated count 180 CFU/100 mL. Use the "E" qualifier code.

12.3 If the total number of *E. coli* colonies are not distinct enough for accurate counting or too numerous to count (TNTC), record the results as > 80 and report the actual result by using the equation in 12.1.

12.4 If all membrane counts are **above the upper acceptable limit of 80 but countable**, calculate the count using the smallest volume filtered.

12.4.1 For example, sample volumes 1, 0.1, and 0.01 mL, produced colony counts of TNTC, 150, and 110 colonies, respectively, use the colony count from the smallest sample volume filtered.

$$\frac{110}{0.01} \mathrm{X} 100 = 1{,}100{,}000 \text{ colonies /100 mL}$$

Report this as estimated count 1,100,000 CFU/100 mL. Use the "E" qualifier code.

12.5 If there are counts in the **acceptable range on replicate plates**, carry the counts independently to final reporting units, then calculate the arithmetic mean of those counts to obtain the final reporting value.

12.5.1 Example, if the counts are 24 and 36 for **replicate plates** of 100 mL each, then the arithmetic mean is calculated as follows:

$$\frac{(24 \text{col}/100\text{mL} + 36 \text{col}/100\text{mL})}{2} = 30 \text{ colonies/100 mL}$$

12.6 If there is **more than one dilution having an acceptable range** of counts, carry the counts independently to final reporting units, then average for final reported value.

12.6.1 For example, sample volumes 100, 10, 1 and 0.1 mL, produced colony counts of TNTC, 75, 30, and 1, respectively, then two volumes, 10 mL and 1 mL, produced colonies in the acceptable counting range.

12.6.2 Independently carry each MF count to a count per 100 mL:

$$\frac{75}{10}\text{X}100 = 750 \text{ colonies/100 mL}$$

and

$$\frac{30}{1}\text{X}100 = 3000 \text{ colonies/100 mL}$$

12.6.3 Calculate the arithmetic mean as in Section 12.1.

$$\frac{(750\,\text{CFU/100mL} + 3000\,\text{CFU/100mL})}{2} = 1875 \text{ Colonies/100 mL}$$

12.7 If counts from **all membranes are zero**, calculate final result using the largest volume filtered.

12.7.1 For example, sample volumes of 25, 10, and 2 mL, produced colony counts of 0, 0, and 0, respectively. The largest volume filtered was 25 mL, so the calculation would be:

$$\frac{1}{25}\text{X}100 = 4 \text{ Colonies/100 mL}$$

Report this as < (less than) 4 colonies/100 mL.

12.8 If colony counts are **both above and below the upper and lower limits**, select the most nearly acceptable count.

12.8.1 For example, sample volumes of 100, 10, and 1 mL, produced colony counts of 84, 8, and 0, respectively. Calculate on the basis of the most nearly acceptable plate count, 84, and report as 84 colonies/100 mL:

84 colonies/100 mL

In this case, because no calculations were done (i.e. this is the count for 100 mL), the count is reported as 84 CFU/100 mL rather than an "estimated count of 84 CFU/100 mL".

12.8.2 As a second example, sample volumes of 100, 10, and 1 mL, produced colony counts of 98, 18, and 0, respectively. Calculate on the basis of the most nearly acceptable plate count, 18, and calculate as in section 12.1 above.

$$\frac{18}{10}\text{X}100 = 180 \text{ Colonies/100 mL}$$

Report this as estimated count 180 CFU/100 mL. Use the "E" qualifier code.

12.9 If there is **no result** because of confluent growth, >200 atypical colonies, lab accident, etc. **report as No Data** and specify the reason.

12.10 Documentation of Laboratory work

12.10.1 Enter and initial the date and time sample was taken, received, run, and completed in designated areas on the EQCL Chain of Custody form.

12.10.2 Document all laboratory data as outlined in SOP QC0343 Documentation of Laboratory Data.

12.10.3 Immediately bring to the attention of the Director of Microbiology or his designee any deviations in expected quality control testing results and refer to SOP QC0516 Deviations in Expected Quality Control Data to institute corrective action procedures.

12.10.4 Use the Water Micro Electronic Notebook to document all sample, sample duplicate and QC check samples.

12.10.5 Verification documentation is maintained in manual logbooks.

13.0 Method Performance

13.1 Method performance is evaluated by the review of blanks, OPR and MS/MSD. Refer to Section 15.0 of EPA method 1603 for additional information.

14.0 Pollution Prevention/Waste Management

14.1 Keep storage of chemicals in individual departments to a minimum, in order to minimize the potential for large spills and exposure to hazardous substances. Each laboratory manager or designee is required to inspect their department on a semi-annual basis for expired reagents and chemicals. Notify the Safety Director for disposal of expired reagents and chemicals.

14.2 Minimize the amount of waste generated by preparing only the minimum required amount of a reagent.

14.3 Expired hazardous chemicals, reagents, and samples requiring lab packing or other outside disposal/treatment are stored in a designated waste storage facility (such as the chemical shed) until final disposal. This is under the direction and supervision of the Safety Director. Individual analysts may not transfer chemicals or other substances to a waste storage facility without obtaining authorization from the Safety Director. All microbiological waste generated during the performance of this procedure (including used petri dishes) must be disposed of in appropriately labeled biohazardous waste bags and must be autoclaved prior to final disposal. Additional details regarding specific disposal of chemical waste at EQC are given in the EQC Safety Procedure Manual, which is incorporated herein by reference.

15.0 References and Supplemental Documents

15.1 EPA Method 1603 - *E. coli* in Water by Membrane Filtration Using Modified Membrane-Thermotolerant *Escherichia coli* Agar (modified mTEC), Dec. 2009

15.2 EQC Quality Systems Manual, latest.

15.3 EQC Safety Procedure Manual, latest.

15.4 EQC SOP QC0339, "Thermometer Calibration, Maintenance, and Record Keeping", latest.

15.5 EQC SOP QC0343, "Documentation of Laboratory Data", latest.

15.6 EQC SOP QC0448, "Media and Broth Preparation", latest.

15.7 EQC SOP QC0449, 'Reporting of Positive Microbiology Results', latest.

15.8 EQC SOP QC0499, "General Preparation and Evaluation of Demonstrations of Capability", latest.

15.9 EQC SOP QC0500, "Preparation of Phosphate-Buffered Dilution and Rinse Water", latest.

15.10 EQC SOP QC0516, "Corrective Action Procedures for Deviations from Expected Microbiological Quality Control Results", latest.

15.11 EQC SOP QC0519, "Water and Wastewater Sampling for Microbiological Testing", latest.

15.12 EQC SOP QC0952, General Internal Quality Control Requirements for Analytical Methods in the Water Microbiology Laboratory, latest.

16.0 Supersession

16.1 This SOP supersedes the previous versions of SOP QC0665.

16.2 The following changes were made: Section 5.1: "analysis" changed to "incubation start time"; "Validation" logbook replaced by "electronic media" logbook through SOP; Section 10.9.3: "30 seconds" changed to "15 seconds"; Section 11.8.1 and 11.8.3 "laboratory prepared culture spike" added; Section 15 updated company abbreviation

16.3 Section 8.0, 10.1, 10.3.3, 10.3.4, 10.8, 10.9.4.2 updated; Section 10.4 extended; Section 10.9.5 added; Section 11.3 and 11.4 deleted; Reference SOP QC0952 added.

APPENDIX C

Weston Field Sampling Analysis Plan and Standard Operating Procedures

SAMPLING ANALYSIS PLAN

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

CHESTER, DELAWARE COUNTY PENNSYLVANIA

Prepared For:

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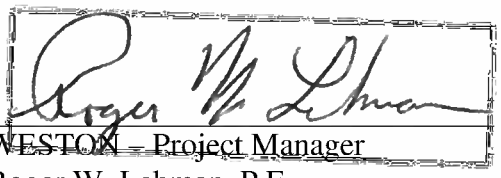
March 2017

SAMPLING ANALYSIS PLAN
DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
CHESTER, DELAWARE COUNTY, PENNSYLVANIA

Approved by:  3/20/2017

WESTON – Project Manager — Date

Roger W. Lehman, P.E.

Approved by: _____ _____

Date

Aproved by: _____ _____

Date

Aproved by: _____ _____

Date

Approved by: _____ _____

Date

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1.0 BACKGROUND

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1 (DELCORA, 2017b). The total service area served by DELCORA, as shown on Figure 1-2 (DELCORA, 2017b), is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2 (DELCORA, 2017b).

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant

Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

2.0 SAMPLING AND ANALYSIS PLAN OVERVIEW

The Sampling and Analysis Plan (SAP) is designed to collect data that will be used to develop and calibrate watershed and receiving water quality models which will be used to assess water quality concerns for the POCs identified in the Identification of Sensitive Areas and Pollutants of Concern Report (DELCORA, 2016a). These POCs are fecal coliform, *E. coli*, and *Enterococcus*. Additional *in situ* parameters, such as salinity, temperature, and conductivity will also be collected to inform the development of the Water Quality Model.

Water quality monitoring will be undertaken at up to thirteen (13) in-stream locations (seven of which are Delaware River sampling locations), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) storm water locations in the City of Chester municipal separate storm sewer system, as shown in Figure 1. Maps of each sample location are also provided in DELCORA, 2017b. Water quality monitoring and sampling will be conducted as follows:

- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area will be sampled for water quality for (3) dry weather events; one of which will be targeted for collection during a tributary low-flow period (less than 25th percentile flow). The mid-stream and far-shore Delaware River locations will not be sampled during the dry weather surveys because it is expected that water quality in the river will be relatively uniform laterally due to the lack of active sources during dry weather. These dry weather events would preferably be distributed across the sampling season, which is assumed to be March through June of 2017. Grab samples and *in situ* measurements will be collected at each location during each event.
- Thirteen (13) in-stream locations will be sampled for water quality using grab samples and *in situ* monitoring for three (3) discrete wet weather events, according to the surface water quality monitoring program protocols described in this SAP;

- Up to four (4) CSO and two (2) stormwater outfall locations will be sampled for water quality for the same three (3) discrete wet weather events according to the outfall monitoring program protocols described in this SAP. Samples for all outfalls will be collected as grab samples.
- Standard operating procedures (SOPs) referenced in the following sections of this SAP.

The sampling events are planned to be distributed across the sampling season, which is assumed to be March through June 2017. Additionally, bathymetry surveys in the lower portion of the tributaries may be required to inform the development of the Water Quality Model, pending delivery of HEC models with transect information for these portions of the receiving waters.

2.1 SAMPLE LOCATIONS

Monitoring locations have been selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters are designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in Figure 1 and listed in Table 1, Table 2, and Table 3.

The tables include summaries of the rationales for each sampling location selected. The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater and Chester CSO pollutant loads. The Delaware River sampling locations will provide a characterization of water quality entering the Chester CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples will be collected across the transect corresponding to the DR-04 sampling location during each sampling round, when sampling across the river is feasible, to characterize lateral variability in the Delaware River during storm events. Delaware River conditions may be too hazardous for safe collection of one or more samples and/or sampling rounds (e.g. during periods of heavy barge traffic, small craft advisories, lightning, etc.). When these conditions occur, sampling will not be conducted in the river for safety reasons.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency of overflow, their overflow volume, and their accessibility. The stormwater

sampling locations were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the study area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

Figure 1: Proposed Receiving Water (RW), Combined Sewer (CSO), and Stormwater (SW) Monitoring Locations

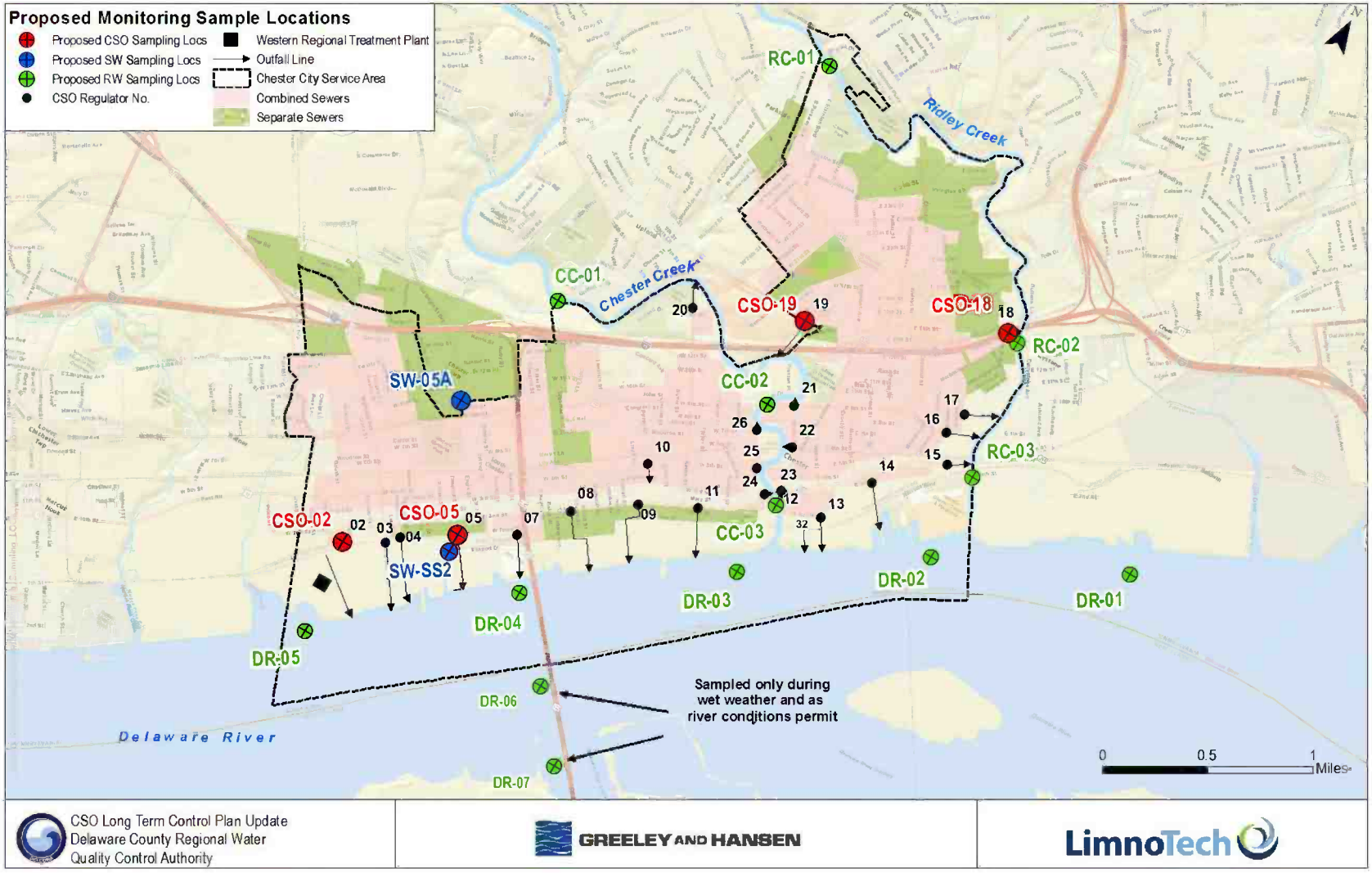

Table 1: Tributary Receiving Water Sampling Locations

Station ID	Sampling Location	Receiving Water	Type	Activity/Notes	Accessibility
CC-01	Upland Rd. / Incinerator Rd. Bridge. **39.850122, -75.386348**	Chester Creek	Tributary	20 ft. from rail to water. Upstream of CSO outfall. Creek is non-tidal.	Upland road access gated from both ends, may need to contact police for access or walk in from gate. Minimal traffic.
CC-02	9th St Bridge (54 W 9th St) **39.850709, -75.365530**	Chester Creek	Tributary	23 ft. from rail to water. Bridge is located next to Chester High School.	Accessible from 9th Street. Can pull vehicle on shoulder or pull into school. Light traffic.
CC-03	Intersection of Edgmont and 2nd street. William Penn's Landing Park (126 E 2nd St) **39.845227, -75.360284**	Chester Creek	Tributary	Site is in William Penn's Landing Park. Sample off of Concrete plaza that overhangs Chester Creek. Tidal influence. Grab samples upstream of bridge.	Can pull vehicle off of 2nd Street and walk into park. Light traffic.
RC-01	Chester Park Drive Bridge (298 East Elkington Blvd) **39.873264, -75.375183**	Ridley Creek	Tributary	19 ft. rail to water. Sample upstream of CSO outfall. Upstream of CSO-33. Creek is non-tidal here.	Can park in lot adjacent to Chester Park Drive Bridge. Minimal traffic.
RC-02	Morton Ave. Bridge (1300 Sun Drive) **39.863016, -75.348686**	Ridley Creek	Tributary	22 ft. rail to water (low tide), with 2 ft. water depth. Site is in same area as CSO-18.	Can park on Sun Drive and use sidewalk when sampling off of bridge. Medium traffic.
RC-03	4th Street (Harrah's) Bridge. Bridge No. 157 (Chester-Eddystone Bridge) (1050 East 4th St Eddystone) **39.853435, -75.346350**	Ridley Creek	Tributary	25 ft. rail to water (low tide) shallow during low tide. Creek is tidal. Lower bottle from bridge using a rope or other means.	Can park on shoulder north of bridge use sidewalk when sampling off of bridge. Medium traffic.

Table 2: Main Stream Receiving Water Sampling Locations

Station ID	Longitude	Latitude	Receiving Water	Type	Description	Rationale
DR-01	39.85282	-75.3299	Delaware River	Main stem	Delaware River between Ridley Creek and Crum Creek	"Upstream" of DELCORA's CSO discharges[1]
DR-02	39.84715	-75.3462	Delaware River	Main stem	Delaware River between CSO-14 and Ridley Creek	Characterize Ridley Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03	39.8398	-75.3606	Delaware River	Main stem	Delaware River between CSO-11 and Chester Creek	Characterize Chester Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-04	39.83132	-75.3766	Delaware River	Main stem	Delaware River at the boat launch off Highway 322	Priority area, in the lower Delaware River (Primary contact area)
DR-05	39.82182	-75.3917	Delaware River	Main stem	Delaware River between CSO- 002 and Stoney Creek	"Downstream" of DELCORA's CSO discharges[1], in the Atlantic sturgeon sensitive area
DR-06[2]	39.82636	-75.371	Delaware River	Main stem	Delaware River mid-stream along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events
DR-07[2]	39.82203	-75.3665	Delaware River	Main stem	Delaware River far shore (left descending bank) along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events

Notes:
[1] **"Upstream" and "downstream" subject to tidal conditions at time of sampling**
[2] **These locations will be sampled during the wet weather events only, when river conditions permit. POC concentrations are assumed to be laterally well-mixed during dry weather due to the absence of significant pollutant sources.**

Table 3: CSO and Stormwater Sampling Locations

Station ID	Sampling Location	Receiving Water	Type	Activity/Notes	Accessibility
CSO-02	Front and Booth St (100 Booth St) **39.828334, -75.392570**	Delaware River	CSO	SCADA level sensor installed. Concrete dam diverts flow to right side MH flow to WRTP (has an orifice plate). Overflow over the dam will flow to CSO outfall at Delaware River.	Can park at the end of Booth St. prior to rail tracks. Minimal traffic. MH cover is marked with white dot.
CSO-05	Front and Townsend (101 Townsend St) **39.832598, -75.383958**	Delaware River	CSO	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to right side MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Delaware River.	Can park at the end of Townsend St. Minimal traffic. MH cover is marked with white dot.
CSO-18	Hancock St. and Sun Dr. (1310 Sun Dr) **39.863501, -75.349203**	Ridley Creek	CSO	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to right side MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Ridley Creek.	Can park at the end of Hancock St. Minimal traffic. MH cover is marked with white dot.
CSO-19	14th and Crozer Hospital (1 Medical Center Blvd) **39.857132, -75.366105**	Chester Creek	CSO	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to interceptor MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Chester Creek.	Can park in the cul-de-sac off of 14th St. High traffic. MH cover is on lawn area marked with white dot.
SW-SS2	105 Townsend St **39.832853, -75.384193**	Delaware River	SW	Industrial storm water MH. MH is clear and on gravel area near CSO-05.	Can park at the end of Townsend St. Minimal traffic. MH cover is marked “storm” with white dot.
SW-05A	7th and Engle Street (by tennis courts) **39.838501, -75.387708**	Chester Creek	SW	Residential storm water MH. MH is clear and on grass area off of road.	Can park on 7th St. shoulder and access MH on lawn next to traffic light. Medium traffic. MH cover is on lawn area marked with white dot.

2.2 SAMPLING SCHEDULE

2.2.1 DRY WEATHER SAMPLING

Collection of water quality samples will be performed for three (3) dry weather events; with one dry weather sampling event planned to be collected during a low-flow period (less than 25th percentile flow) in Chester Creek and Ridley Creek (if possible). Two rounds of sampling will be conducted for each dry weather survey: one round to be completed during ebb (outgoing) tide and the second round to be completed during flood (incoming) tide.

Dry weather event samples will be taken at up to eleven (11) locations:

- **Three (3) locations on Chester Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Three (3) locations on Ridley Creek** that will characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations will also reflect these tidal influences on water quality.
- **Five (5) locations on the Delaware River** that will characterize water quality in the vicinity of DELCORA's CSO discharges. Sampling locations have been selected to separate to the extent possible the effect of DELCORA's CSOs on water quality from other sources contributing pollutants to the waterways. Sampling will be conducted near the shoreline adjacent to the City of Chester.

The locations of these stations are shown in Figure 1. Details for these stations are provided in Table 1, Table 2, and Table 3. The set of parameters for which the samples will be analyzed is provided in Table 5. In-situ measurements of physical parameters, such as salinity, temperature, and conductivity will be collected at each sampling location with a sonde. In the Delaware River, *in situ* measurements will be made at three depths at each sampling location during each round of sampling.

2.2.2 WET WEATHER SAMPLING

Collection of water quality samples will be performed for three (3) wet weather events. The purpose of the wet weather sampling is to characterize the impact of CSO discharges and non-CSO source runoff on in-stream water quality. The wet weather events will span a range of precipitation, flow and seasonal conditions. Wet weather event samples will be taken at all 13 in-stream locations as well as at up to six source locations in the intervals described below:

- **Six (6) In-Stream Tributary Sampling Locations:** Three (3) locations will be on Chester Creek and three (3) locations on Ridley Creek. The locations will be the same locations used for the dry weather surveys. Tributary locations will be sampled up to five times per event at the following approximate intervals: Hour 0.5-2.5, Hour 4.5-6.5, Hour 8.5-10.5, Hour 14.5-16.5, and Hour 22-24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. A total of 30 samples will be collected during each wet weather sampling event from in-stream locations. One field blank and one field duplicate will be collected during each event to be used as field quality control (QC).
- **Up to Seven (7) In-Stream Delaware River Locations:** Up to seven locations will be on the Delaware River and will be sampled up to ten times per event at the following approximate intervals: Hour 0, Hour 2, Hour 4, Hour 6, Hour 9, Hour 12, Hour 15, Hour 18, Hour 21, and Hour 24. Sampling intervals will be defined by the start of rainfall rather than CSO or SSO activation. The frequency of sampling is intended to capture in-stream impacts in the vicinity of DELCORA's service area from both DELCORA's CSOs as well as upstream sources. Two additional locations on the Delaware River, one at mid-stream and one near the far shore, have been added to characterize lateral variability in water quality during storm event conditions, when sampling across the river is feasible. The sampling regimen is also designed to allow a semi-quantitative mass balance to be computed over a complete tidal cycle. A total of 70 samples may be collected during each wet weather sampling event. If river conditions are unsafe for sampling (e.g. small craft advisories, heavy barge traffic, etc.), sampling may be suspended for one or more locations and/or sampling rounds. One field blank and one field duplicate will be collected during each event to be used as field QC. Final selection of sampling locations and sampling intervals will be determined prior to the start of the sampling program and will be based on logistic considerations (e.g. can seven locations be sampled and dropped off to a courier within the 3 hour sampling window), safety and accessibility to the Delaware River, and available resources.
- **Up to Six (6) Outfall Locations:** Sampling will be conducted at up to two (2) stormwater outfalls and up to four (4) combined sewer overflow outfalls. The CSO and stormwater sampling locations will be finalized prior to the initiation of the sampling program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources. It is assumed that each of the outfall locations will have up to eight sets of samples collected for each event at the following intervals: 1st flush, 30 minutes, and 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours. If a location is not flowing, no sample will be collected. As many as 48 samples may be collected during each wet weather sampling event, depending on the number of monitored outfalls and if all monitored

outfalls discharge for 24 hours. However, the actual number of samples is likely to be less than the amount indicated since it is unlikely that all of the monitored outfalls will discharge for the full 24 hour monitoring period. One field blank and one field duplicate will be collected during each event to be used as field QC.

The locations of these stations are shown in Figure 1. Details for these stations are provided in Table 1, Table 2, and Table 3. The set of parameters for which the samples will be analyzed are summarized in Table 5. *In-situ* measurements will not be collected at the outfall locations.

Sampling crews will conduct all wet weather event sampling using the protocols described in the Quality Assurance Project Plan (DELCORA, 2017a). Samples will be delivered to the laboratory where the samples will be analyzed for the laboratory parameters identified in Table 5.

Determination to mobilize for a Wet Weather Event will be a collaborative effort between Greeley and Hansen, LimnoTech, the field sampling contractor and the laboratory contractor personnel. The intent is to identify a 4 to 6 hour window in which a wet weather event may commence 24 hours in advance to assist in mobilization of the sampling crews.

2.3 FIELD SAMPLING METHODS AND PROCEDURES

2.3.1 RECEIVING WATER AND SOURCE SAMPLE COLLECTION METHODS

The physical, microbiological and chemical data that will be collected from the waterbodies are obtained either through direct (*in situ*) measurements or through analysis of a water sample. The microbiological and chemical data collected from the outfall discharges will be obtained through laboratory analysis of the water samples. The general collection procedures for receiving water and outfall sampling are as follows:

1. Clean and decontaminate all sampling equipment prior to and after sample collection according to the procedures in the SOP No. 301.
2. Don appropriate personal protective equipment as required by the Health and Safety Plan (HASP).
3. Collect samples by dipping a container on a pole, into the water. The water is then poured into the clean sample containers pre filled with preservative. The collection container will then be disposed of. Care should be taken to avoid capturing bottom sediment or surface foam/scum during sample collection.
4. Creek water samples collected from bridges higher than 25 ft above the water surface will be collected by bailer, or from a new wide mouth glass jar, connected to new string. The water is then poured into the clean sample containers pre filled with preservative. The

collection container will then be disposed of. Care should be taken to avoid capturing bottom sediment or surface foam/scum during sample collection.

5. CSO samples will be collected using a "clean hands, dirty hands" technique. In accordance with the HASP, atmospheric conditions, such as lower explosive limit, and hydrogen sulfide, will be monitored inside the manhole prior to sample collection, or any other invasive activity. CSO sample collection from CSO-19 (wet weather only), will be screened for radioactivity as there may be the potential for medical treatment waste to be present.
6. Label all sample containers with the date, time, site location, sampling personnel, and other requested information.
7. Record sample collection information on the field logs and then store the samples in a cooler with ice as described in the SOP No. 103.
8. Handle, pack, and ship samples according to the procedures in the SOP No. 103, including the completion of a Chain-of-Custody (COC) form for each cooler shipped to the laboratory for analyses

2.3.2 IN SITU MEASUREMENTS (RECEIVING WATER ONLY)

Instantaneous water quality measurements (such as salinity, temperature, and conductivity) using field instruments will be collected at the receiving water locations as specified in DELCORA, 2017b. These measurements, along with calibration and maintenance, will be conducted following manufacturer's instructions (YSI, 2009)

Field instruments will be calibrated before initiating monitoring activities for each event and a post-monitoring calibration check will be conducted at the end of the event. All calibration and maintenance activities will be documented on the Instrument Calibration Sheet. The field instrument calibration must be conducted in accordance with the manufactures instructions.

Salinity, temperature, and conductivity will be measured at all in-stream sampling locations using a YSI 6920 or similar instrument during both wet and dry sampling events, prior to sample collection. Measurements will be made mid-channel at mid-depth in the tributaries, whenever possible. In the Delaware River, measurements will be made at the surface, mid-depth and near the bottom, whenever possible. Measurements will be documented in the field logs. Documentation will include: date/time, location, type of measurement, personnel, equipment identification, and general site observations (e.g. weather, stream conditions).

2.3.3 SAMPLING EQUIPMENT

The sampling equipment required for the DELCORA monitoring program is included in Table 4.

Table 4: Sampling Equipment list

Sampling Activity	Required Equipment	
General Equipment (Required for all sampling activities)	Field log book with weather-proof paper and pen ("Rite- in-the-Rain") or field data sheets Pens/pencils and Maps Sample bottles and labels Swing sampler/dipper Chain-of-custody Zip lock bag Coolers with ice Amber glass bottles Bailer twine Intrinsically safe headlamps Intrinsically safe flashlight Extra batteries Hydrolab/YSI multi-parameter First Aid Kit and BBP Kit	12" Nitrile gloves Hand spray bottles with Liquinox solution Scrub brush and bucket Distilled water (10 gallons) Sun screen PPE as specified in HASP Phone Emergency Contact List Field Safety Instruction Eye Wash Cell phone Calibration materials and solutions/gases Sonde and instrument (sonde) calibration sheet Sonde instrument manual Sonde service kit Extra batteries for instruments (sondes)
Wet Weather In-Stream Sampling	General Equipment Rain Gear Submersible Marine Radio 16' Jon Boat with motor Tide Charts and Navigation Charts Float Plan Depth Finder Boat Gear (Personal and throwable PFD's, whistle, oars, anchor, line, nav lights, bailer, air horn) Mustang Suits	
Wet Weather CSO & Outfall Sampling	General Equipment Rain Gear RAD meter with pancake probe Multi RAE for LEL and H2S screening	
Dry Weather Sampling	General Equipment	

2.4 SAMPLE IDENTIFICATION

Sample packaging and shipping procedures are designed to ensure that the samples and the chain- of-custody forms will arrive at the laboratory intact and together.

1. All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The laboratory will pre-label each bottle with all information except for the date and time of sample collection using the method described below. The person collecting the sample will complete the label with date and time. No bottle sets will be distributed without the pre-labeling unless specifically agreed upon among Greeley and Hansen, LimnoTech, the field sampling and laboratory contractors prior to the sampling event.

   Use indelible waterproof marking pen and include:

   - ***Sample identification code (ID)***– will include*:*
     - Site designation number - sampling round number, as follows:

       _ _ - _ _ _ - _ - _
       1 2 3 4 5 6 7

       Where,

       Characters 1-5: Sample Site ID (column 1 in Table 1, Table 2 and Table 3)

       Character 6: Sampling round number

       Character 7: B - Blank sample qualifier (if required)

     - Duplicate samples will be labeled with a sample ID of:

       "DUP _ _ _ - _ _".
       1 2 3 4 5

       Where

       Characters 1-3: Duplicate ID number (numbers will be assigned to each sampling crew)

       Characters 4-6: Designation of RW for receiving water sample duplicate or OF for outfall sample duplicate. A blank line will be placed in the location, date and time boxes of the sample label so the laboratory does not know where the sample was collected. The duplicate number in the duplicate sample ID will be assigned in the field and recorded in the field log book.

     - Blank samples will be given a normal sample ID, with a B qualifier at the end of the ID.

       - *Sample type (water);*
       - *Analysis required;*
       - *Date sampled;*

- *Time sampled;*
- *Name or initials of person who collected the sample;*
- *Mode of collection (composite or grab);*
- *Preservation added, if applicable.*

2. Check the caps on the sample containers so that they are tightly sealed.
3. Cover the label with clear packing tape to secure the label onto the container and prevent the label from being illegible if wet.
4. Store samples in coolers with ice to maintain the samples at ≤4 degrees Celsius until they are received in the laboratory.
5. Complete the information needed on the field log book and the chain-of-custody, primarily sample date and time and any notes regarding deviations from the planned sampling protocol (e.g. limited volume precluded collecting the full volume required).

2.5 SAMPLE MANAGEMENT

Samples will be properly packaged for transport to the laboratory as summarized below.

1. Using packaging tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport.
2. Place the sealed container upright in the cooler.
3. Place additional cushioning material around the sides of each sample container as needed.
4. Place ice on top of sample containers. Do not pack ice so tightly that it may prevent the addition of sufficient cushioning material. Ensure that bottle caps will not be submerged in water if ice melts.
5. Fill the remaining space in the cooler with vermiculite or other cushioning material if the coolers are being shipped.
6. Place the chain-of-custody forms in a large Ziploc© type bag and tape the forms to the inside of the cooler lid.
7. Close the cooler lid and fasten with packaging tape. Wrap strapping or packaging tape around both ends of the cooler at least twice, if coolers are being shipped.

All shipments will be accompanied by the chain-of-custody form identifying the contents. It is preferred that a separate chain-of-custody form be completed for and placed in each shipping container/cooler. The original form will accompany the shipment and copies will be retained by the sampler for the project records.

During the dry weather and wet weather sampling events, representatives from the laboratory will be responsible for collecting and delivering the samples to the laboratory quickly enough so that

hold times can be achieved for the bacteria parameters (8 hours from the time of sample collection). The Field Manager will manage the coordination of field crews and couriers during the sampling event.

2.5.1 SAMPLE DOCUMENTATION

2.5.2 FIELD DATA COLLECTION FORMS

The field log book will serve as a daily record of events, observations and measurements during all field activities. All information pertinent to sampling activities will be recorded in the field logs and will include:

- Names of field crew and specifically the author of the field log
- Date and time of the sample round beginning and ending
- Location of sampling activity
- Date and time of collection
- Sample identification numbers
- Field measurements

Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, stream flow description, etc.)

The field log book may also include:

- Sampling method
- Sampling equipment used
- Number and volume of samples collected
- Type of sample
- Summary of any meetings or discussions with the public, state agency, etc.
- Levels of safety protection

Field meters will be calibrated daily in accordance with the manufacturer's recommendations. Standards, solutions used, concentrations and readings taken will be recorded daily in Instrument Calibration Sheet.

2.5.3 SAMPLE CHAIN-OF-CUSTODY FORMS

A chain-of-custody is a legally-binding record of the date and time periods that samples were in the possession (e.g. custody) of the parties indicated. Transfers between parties are documented by the custodial party signing over custody to the receiving party and the receiving party signing

for receipt of the samples. Completed chain-of-custody forms will be required for all samples to be analyzed.

Chain-of-custody forms will be prepared in advance by the laboratory for each sampling location and round of sampling. Chain-of-custody forms will be initiated by the sampling crews in the field during the sampling events and must remain with the samples at all times. The samples and signed chain-of-custody form will remain in the possession of the sampling crew until samples are either delivered to the lab or placed in the custody of the personnel responsible for their delivery to the laboratory.

The chain-of-custody form will contain the sample's unique identification number, sample date and time, sample description, sample type and analyses required. Copies will be made prior to shipment for field documentation. The original chain-of-custody form will accompany the samples to the laboratory.

2.5.4 DATA SUBMITTAL

Instrument Calibration Sheets and copies of the field log book will be turned over to the LimnoTech Water Quality Monitoring Program Task Manager following each monitoring event. Following review by the LimnoTech Water Quality Monitoring Program Task Manager, all field logs, photographs and chain-of-custody forms will be included in the project database.

2.5.5 QUALITY CONTROL

The purpose of any quality assurance/quality control (QA/QC) program is to ensure that all sampling protocols and procedures are followed such that samples are representative of the water quality to which they are associated. The monitoring data that will be collected is intended to meet the quality assurance objectives described in the QAPP. Data quality will be measured in terms of accuracy and precision, completeness, representativeness, comparability, and the required detection limits for the analytical methods. Each of these data quality indicators is defined in the QAPP. QC samples will be collected in the field to support the assessment of data quality. The QA/QC program includes the following elements:

- Training of all field staff;
- Field quality control procedures;

- QA/QC samples; and,
- Equipment calibration.

2.6 DECONTAMINATION AND INVESTIGATION-DERIVED WASTE

If sampling equipment, such as buckets, etc., are to be reused at more than one location in the field, they must be cleaned prior to collecting the next sample. Prior to leaving a site, the equipment will be washed with a mild disinfectant solution (1:25 ratio household bleach to tap water), followed by a detergent solution (Alconox, or equivalent) wash, and must be rinsed at least three (3) times with distilled water. A brush may be used to remove deposits of material or sediment if necessary. At the next sampling site, the equipment must be rinsed at least one time at each location with creek water prior to sampling.

Equipment and instruments used for sample collection or monitoring at CSO locations (wet weather only) will be wiped down using a disinfectant wipe, followed by a distilled water rinse.

Decontamination water generated during the sampling events will be collected in 5 gallon buckets and disposed of at the DELCORA treatment facility at the end of the sampling shift.

3.0 ANALYTICAL PARAMETERS AND METHODS

Samples will be analyzed by Eurofins, in their network of accredited laboratories for fecal coliform, E coli, and enterococcus through laboratory analysis by the following methods, or in accordance with 40CFR136.

- Fecal coliform, Membrane Filters Technique for Members of the Fecal Coliform Group, Standard Methods 9222-D, 2006, 22nd Edition
- E. coli, Membrane Filtration Using Modified Membrane- Thermotolerant Escherichia coli Agar by EPA 1603
- Enterococci, EPA Method 1600, Membrane Filter Technique.

Table 5 summarizes the analytical parameters, the matrices, analyses, analytical methods, containers, preservatives, QA/QC samples, and technical holding times for the samples proposed for collection during the sampling event.

Table 5: Guidelines for Water Sample Container and Preparation and Preservation

Parameter	Sample Container	Sample Volume	Storage Requirement	Preservative	Sample Holding Time	Analytical Method	Detection Limit
Fecal coliform	Plastic- Sterile	250 ml	Place on ice, or refrigerate to ≤6°C	None	8 Hours	Standard Methods 9222-D	10 no./100 ml
E coli	Plastic- Sterile	250 ml	Place on ice, or refrigerate to ≤6°C	None	8 Hours	EPA 1603	10 no./100 ml
Enterococcus	Plastic- Sterile	250 ml	Place on ice, or refrigerate to ≤6°C	None	8 Hours	EPA 1600	10 no./100 ml

4.0 QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

This section describes the QA and QC procedures for personnel during the site sampling event, including responsibilities, field QC, laboratory QC, data evaluation, and data management.

4.1 FIELD QUALITY CONTROL

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, necessary precautions must be taken to protect samples from contamination and deterioration. Procedures detailed in SOP No. 203 for Collection of Discrete Water Samples and instrument manufacturer's instructions (YSI, 2009) will be followed to ensure field quality control.

Field accuracy will be assessed through the use of field or equipment blanks. In order for the accuracy assessment to be relevant, all appropriate protocols concerning sample collection, handling, preservation, and hold times must be maintained. Equipment that is used to collect samples for analysis may become cross-contaminated through the normal course of monitoring. If not properly cleaned and rinsed, samples may be contaminated during sampling from previous locations.

4.1.1 FIELD BLANKS

Field blanks will consist of a reagent grade blank water transferred into separate sample collection containers, transferred into the sample bottle ware, and submitted to the laboratory for

quality control. The laboratory will provide the sampling crews with the water to be used to prepare the field blanks.

Field blanks will be collected at a frequency of one blank during each sampling event per sampling crew.

4.1.2 FIELD DUPLICATES

Precision is a measure of the agreement between two or more measurements. Duplicate or replicate samples will be taken for a portion of the samples to assess field precision. A field duplicate is defined as a sample produced when a single sample is split into two or more aliquots immediately after the sample is collected. Each aliquot is placed into a separate container and analyzed separately.

Field duplicates will be collected at a frequency at least one field duplicate per sampling crew.

4.1.3 CALIBRATION OF FIELD EQUIPMENT

Instantaneous water quality measurements (such as salinity, temperature, and conductivity) using field instruments will be collected as specified in DELCORA, 2017b. Salinity, temperature, and conductivity will be measured at the specified sampling locations using an YSI 6920 or similar instrument, prior to sample collection. All field instruments will be calibrated at the beginning of the day of sampling and checked again at the end of each day, as required by the QAPP. Field instrument calibration and sample measurement data will be recorded on the Instrument Calibration Sheet and in the field log book, respectively.

4.1.4 DATA REPRESENTATIVENESS AND COMPLETENESS

The intent of this SAP is to obtain a complete data set which is representative of site conditions. Data will be reviewed for completeness. If not all samples were collected, resulting in less than 100% completeness, the reason for the data gaps will be identified in the Trip Report. If any data are rejected, the reason for the data rejection will be discussed in the Trip Report. If sampling activities or procedures vary significantly from this SAP due to unexpected conditions in the field or other unforeseeable factors, WESTON will discuss these deviations from the SAP and whether the changes affect data representativeness in the Trip Report.

5.0 REFERENCES

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ATTACHMENTS

STANDARD OPERATING PROCEDURES

WESTON SOLUTIONS, INC.
STANDARD OPERATING PROCEDURE

SOP 101 LOGBOOK DOCUMENTATION

Revision 2 December 2015

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to provide Weston Solutions, Inc. (WESTON®) members with a step-by-step guide for logbook documentation.

2.0 LOGBOOKS

2.1 Personal Logbooks

All WESTON members are required to document daily office activities in personal logbooks. Information in these logbooks shall be factual and objective and must be kept current at all times. Entries should include daily events, such as specific work order numbers, activities, task numbers, phone calls and meetings. It is important to note that all personal logbooks are property of WESTON® and may be reviewed by management at any time. A copy of Attachment A "Logbook Operating Practices" must be affixed to the inside cover of the personal logbook. Personal logbooks must be obtained through WESTON® Administrative support staff and must include a WESTON® logbook tracking number.

2.2 Site Logbooks

All WESTON members are required to document site activities in site logbooks. Information in these logbooks shall be factual and objective and must be kept current at all times. Entries should include daily events, such as site activities, safety meetings, names of personnel entering/exiting site, sampling data, etc. A copy of Attachment A "Logbook Operating Practices" must be affixed to the inside cover of the site logbook. All site logbooks are the property of client and must remain with the site file. Site logbooks will be maintained by the WESTON® Project Team Leader. Information may be entered into the site logbook by any appropriate team member. Entries will be made in waterproof ink. Site logbooks must be obtained through WESTON® Administrative support staff and must include a WESTON® logbook tracking number.

3.0 SPECIFIC PROTOCOL

Adhere to the following protocol for both personal and site logbooks (see Attachment A for additional information):

1. Logbooks are permanently bound, all pages numbered.
2. Entries begin on page 1.
3. Use only blue or black ink (waterproof).
4. Write Weston Solutions, Inc., as well as the mailing address and phone number on the inside covers of both the site and personal logbooks.

5. Print the site name, volume number, and coverage dates on the site logbook cover and inside cover.
6. Do not write in the margins or between written lines, and do not leave blank pages to fill in later.
7. Fill in all pages in all logbooks.
8. Place a single line through mistakes and initial each one.
9. At the end of any partial page, draw a single diagonal line across the page and initial the line to indicate the end of that pages notes.
10. If a line on the page is not completely filled, draw a horizontal line through the blank portion of the line and initial it.
11. Write late notes/entries as soon as possible and identify this entry as such (use "Late Note:" on a new line to begin a late note and "End Late Note" on a new line to finish a late note).
12. Be objective for all logbook entries
13. Ensure that the logbook clearly shows the sequence of the day's events.
14. If an error is made, draw a single line through the error and initial it.
15. Sign or initial all completed pages (typically in the lower right corner) as they are completed.
16. Sign entries at the end of the day, or before someone else writes in the logbook.
17. Maintain control of the logbook and keep in a secure location.

Personal logbooks will contain (see Attachment A for additional information) the following information:

1. Employee's name, work address, and telephone number.
2. Full names and affiliations for all persons cited in the logbook. Be sure to check the spelling of names and affiliations for accuracy.
3. Sequence of daily events.
4. Task numbers, full dates (i.e. 12 January 2012), and military time (i.e. 0800).
5. Initialed daily entries.

Site logbooks will contain (see Attachment A for additional information) the following information:

1. The name and location of the site.

2. Names of Site Leader and Assistant Site Leaders.
3. Site sketches if appropriate. Draw a box around the sketch to separate the sketch from the text in the logbook.
4. Dates of sample collection or event.
5. Time of sample collection or event.
6. Weather conditions on a daily basis.
7. Field observations.
8. Numbers and types of samples collected and sample identification numbers.
9. Description of sampling methodology by referenced Standard Operating Procedures or FSP.
10. Type(s) of laboratory analyses requested.
11. Phone calls and/or contacts with people at the site on a daily basis.
12. Name of subcontractor and excavation equipment.
13. Any modifications in work activities from approved work plans, FSPs, etc. (i.e., sampling locations, deviations from procedures with reasons, etc.).
14. Visual description of samples and test pits, as required. Includes color, texture, moisture, and other physical soil characteristics.
15. Levels of personal protective equipment worn for tasks performed.
16. Significant changes during the day (i.e., stoppage of work during a lightning storm).

3.1 Audits

Personal and Site logbooks are subject to audit by WESTON® Quality Assurance personnel at any time. Logbook audits will be documented and maintained in the site project file and/or personnel file. Attachment B Logbook Auditing Check sheet or another method of documentation will be used to document all logbook audits.

4.0 REFERENCES

WESTON® (Roy F. Weston, Inc.). 1993. Standard Operating Practices (SP) Manual. SP No. 16-11-016, "Test Pit Excavation and Sampling". West Chester, PA.

ATTACHMENT A: LOGBOOK OPERATING PRACTICES

Logbook Operating Practices

Procedure

- Logbooks are permanently bound, all pages numbered and entries begin on page 1.
- Use only blue or black ink (waterproof).
- Written Legibly.
- Write Weston Solutions, Inc., as well as the mailing address and phone number on the inside covers of both the site and personal logbooks.
- Print the site name, volume number, and coverage dates on the site logbook cover and inside cover.
- Do not write in the margins or between written lines; do not leave blank pages to fill in later.
- Fill in all pages in all logbooks.
- Include the date on every page.
- At the end of any partial page, draw a single diagonal line across the page and initial the line to indicate the end of that pages notes.
- If a line on the page is not completely filled, draw a horizontal line through the blank portion of the line and initial it.
- Write late notes/entries as soon as possible and identify this entry as such (use "Late Note:" to begin a late note and "End Late Note" to finish a late note).
- Be objective for all logbook entries.
- Ensure that the logbook clearly shows the sequence of the day's events.
- If an error is made, draw a single line through the error and initial it.
- Sign or initial all completed pages (typically in the lower right corner).
- Sign entries at the end of the day, or before someone else writes in the logbook.
- Maintain control of the logbook and keep in a secure location.
- End of Logbook noted on last page ("End of Logbook").

General Information

- Team members listed at beginning of day.
- Other Personnel & Affiliation (e.g. OSC-Smith, OSC-Jones) identified.
- Signatures when change of recorder.
- Team Members' Site Entries and Exits are documented.
- Late Entries Noted Appropriately.

Field Logbooks

- General Information.
- Name, location of site, and work order number.
- Name of the Site Manager or Field Team Leader.
- Names and responsibilities of all field team members using the logbook (or involved with activities for which entries are being made).
- Weather conditions.
- Objective narratives written.
- Field observations.
- Names of any site visitors including entities that they represent.

Sampling (a table in the logbook can be used for sample information)

- Time Collected.
- Grab/Composite.
- Sample Location.
- Type of Analysis.
- CLP Case Number(s)
- Shipping Information.
- Number and types of collected samples.
- Sample identification numbers, including any applicable cross-references to split samples or samples collected by another entity.
- A description of sampling methodology, or reference to any governing document (i.e. Work Plan, QAPP). Any deviations from governing document(s) are identified with reasons for deviations specified.
- Summary of equipment preparation and decontamination procedures.
- Sample description including depth, color, texture, moisture content, and evidence of waste material or staining.
- Air monitoring (field screening) results.
- Types of laboratory analyses requested.

Photo Logs

- Camera and PDA (IDs).
- Date of pictures.
- Time of pictures.
- Directions of photos.
- Description of photos.
- Photographer/Witness.

Safety

- All safety, accident, and/or incident reports.
- Real-time personnel air monitoring results, if applicable.
- Heat/cold stress monitoring data, if applicable.
- Level of protection for tasks.
- Reasons for upgrades or downgrades in personal protective equipment.
- Health and safety inspections, checklists (drilling safety guide), meetings/briefings.
- Equipment make, model, and serial number for monitoring instruments.
- Calibration records for monitoring instruments.
- Site Safety Meeting (time/topics).
- Site Objectives/ Plan of Activities.
- Chemical/Physical Hazards.
- Personnel Attending.

Equipment

- Equipment Type (make, model, a serial numbers).
- Calibration records.
- Background Readings & Locations.
- Monitoring Readings & Locations.
- Sampler(s) initials

Contractor Oversight Activities

- Progress and activities performed by contractors including operating times.
- Deviations of contractor activities with respect to project governing documents (i.e., specifications).
- Contractor sampling results and disposition of contingent soil materials/stockpiles.
- Excavation specifications and locations of contractor confirmation samples.
- General site housekeeping and safety issues by site contractors.
- Equipment and personnel on-site.
- Duration of equipment use vs. standby.
- Inventory of shipments received (or verification of items on packing slip).
- Document inspection of disposal trucks arriving at site (e.g., visual observation of clean tankers or truck trailers, etc.).

Logbook OP_Rev3 December 2015

ATTACHMENT B: SITE LOGBOOK AUDITING CHECKSHEET

Site Name:_____

Work Assignment/TDD No. _____

Site Name:_____ Site Location:_____

Logbook Recorder:_____ Logbook Reviewer:_____

As a part of WESTON's quality assurance program, the following checklist should be used as a guide for items, at a minimum, to include in your logbook. In the future, please make your best effort to thoroughly document all field activities.

LOGBOOK AUDITING CHECKSHEET				
INFORMATION:	***YES***	***NO***	***N/A***	***COMMENTS***
Logbook is permanently bound, all pages numbered and entries begin on page 1.				
Only blue or black ink used.				
Written Legibly.				
"Weston Solutions, Inc." as well as the mailing address and phone number are included on the inside cover.				
The site name, volume number, and coverage dates (if the logbook is completed) are included on the site logbook cover and inside cover.				
No writing in the margins or between written lines.				
No blank pages; all pages are filled in.				
Date is included on every page.				
At the end of any partial page, a single diagonal line is drawn across the page and initialed.				
Where a line on the page is not completely filled, a horizontal line is drawn through the blank portion of the line and initialed.				
Any late notes/entries are identified as such (i.e., "Late Note:" to begin a late note and "End Late Note" to finish a late note).				
Logbook entries are objective.				
The logbook clearly shows the sequence of events.				
If an error was made, a single line was drawn through the error and it was initialed.				
All completed pages are signed or initialed (typically in the lower right corner).				
Signature of author at the end of the day				
Signature of author at change of recorder.				

ATTACHMENT B: SITE LOGBOOK AUDITING CHECKSHEET

LOGBOOK AUDITING CHECKSHEET				
INFORMATION:	***YES***	***NO***	***N/A***	***COMMENTS***
End of Logbook noted on last page ("End of Logbook") for completed logbooks.				
General Information				
Team members are listed at beginning of day.				
Other Personnel & Affiliation (e.g. OSC-Smith, OSC-Jones) are identified.				
Team Members' Site Entries and Exits are documented.				
Name, location of site, and work order number is identified.				
Name of the Site Manager or Field Team Leader is identified.				
Weather conditions are noted.				
Field observations are sufficiently detailed.				
Sampling (a table in the logbook can be used for sample information)				
Sample identification numbers, are noted.				
Time Collected is identified.				
Grab/Composite is identified (or FSP/SAP is referenced).				
Sample Locations are identified (or FSP/SAP is referenced).				
Type of Analysis is identified (or FSP/SAP is referenced).				
CLP Case Number(s) is noted.				
Number and types of collected samples are identified (or FSP/SAP is referenced).				
A description of sampling methodology is included (or FSP/SAP is referenced).				
Any deviations from the FSP/SAP or other governing document(s) are noted, including specified reasons for deviations.				
Summary of equipment preparation and decontamination procedures are noted (or FSP/SAP is referenced).				
Sample description including depth, color, texture, moisture content, and evidence of waste material or staining are noted.				
Air monitoring (field screening) results are included.				
Types of laboratory analyses requested are identified (or FSP/SAP is referenced).				
Logbook is permanently bound, all pages numbered and entries begin on page 1.				

ATTACHMENT B: SITE LOGBOOK AUDITING CHECKSHEET

LOGBOOK AUDITING CHECKSHEET				
INFORMATION:	***YES***	***NO***	***N/A***	***COMMENTS***
Only blue or black ink used.				
Written Legibly.				
"Weston Solutions, Inc." as well as the mailing address and phone number are included on the inside cover.				
The site name, volume number, and coverage dates (if the logbook is completed) on the site logbook cover and inside cover.				
No writing in the margins or between written lines				
No blank pages; all pages are filled in.				
Date is included on every page.				
At the end of any partial page, a single diagonal line is drawn across the page and initialed.				
Where a line on the page is not completely filled, a horizontal line is drawn through the blank portion of the line and initialed.				
Any late notes/entries are identified as such (i.e., "Late Note:" to begin a late note and "End Late Note" to finish a late note).				

_____ _____

Signature of Reviewer Date

WESTON SOLUTIONS, INC.
STANDARD OPERATING PROCEDURE

SOP 103 CHAIN-OF-CUSTODY DOCUMENTATION

August 2011

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to provide Weston Solutions, Inc. (WESTON®) team members with a step-by-step guide for chain-of-custody documentation.

2.0 SCOPE

This SOP describes the minimum requirements for sample chain-of-custody procedures. These procedures permit traceability from the time of sample collection to generation of the analytical data report.

These procedures are intended to document sample possession from the time of sample collection to sample disposal (i.e., sample shipment, sample storage, sample analysis).

3.0 GENERAL PROTOCOL

A chain-of-custody record will be maintained from the time of sample collection until final disposition.

For the case of the chain-of-custody forms and the traffic report chain-of-custody forms, every transfer of custody will be noted and signed. The distribution of the chain-of-custody forms will be done in accordance with the distribution list at the bottom of each form. The chain-of-custody record shall contain, at a minimum, the following information:

- Project identification
- Project identification number
- Sample number
- Sample type and description
- Sample location
- Time and date of sample collection (military time)
- Requested analyses
- Sample information (e.g., no. of bottles, preservatives, etc.)
- Names and signatures of samplers
- Signatures of individuals who have had sample custody
- The name of the carrier and the airbill number, if the sample is shipped

4.0 PROTOCOL FOR SHIPMENTS

All pertinent data must be recorded legibly in black or blue ink. Mistakes can only be corrected by drawing a single line through the mistake and then initialing and dating the correction.

Listed below are the information needed in each section of the chain-of-custody record:

- The PROJ. NO. section of the form will always contain the site Project Control System (PCS) number.
- The PROJECT NAME section of the form will contain the Site name only if the samples are being analyzed by the EPA Region III Laboratory, otherwise it will contain the START Analytical Technical Directive Document (TDD) number or the DAS project number.
- The SAMPLERS (Signature) section should contain the printed name and signature of samplers.
- The TIME section should be in military time.
- The LOCATION section should give a description of the sample location (note: never put resident's names or full addresses in this section).
- The diagonal lines on the top of the form should contain the analyses to be performed for each sample. An X should be placed in the block beneath the analyses to be performed for each sample.
- The airbill number and shipper should be identified in the REMARKS section at the bottom of the form.

Every time the samples are relinquished to a different individual the current sample custodian is required to relinquish the custody to the new individual.

5.0 SAMPLE LABELS AND CUSTODY SEALS

In addition to chain-of-custody forms, sample labels and custody seals are needed to ensure sample custody has been maintained. Sample labels should contain the same information contained on the chain-of-custody record to ensure the proper analyses are being performed on the samples. Custody seals ensure that the samples have not been tampered with during sample shipment. Below is a description of the information needed for the labels and custody seals.

5.1 Sample Labels

The following information will be recorded on the sample labels affixed to each container:

- Project identification number
- Sample number
- Time and date of sample collection
- Sample type (composite/grab)

- Sample location
- Analyses requested
- Preservatives used

5.2 Custody Seals

Custody seals confirm that samples have not been tampered with. The individual who has custody of the samples will sign, date, and affix the seals to the cooler or shipping box which contains the samples so that it cannot be opened without breaking the seal. A wide clear tape will be placed over the seals to ensure that the seals are not accidentally broken during transportation.

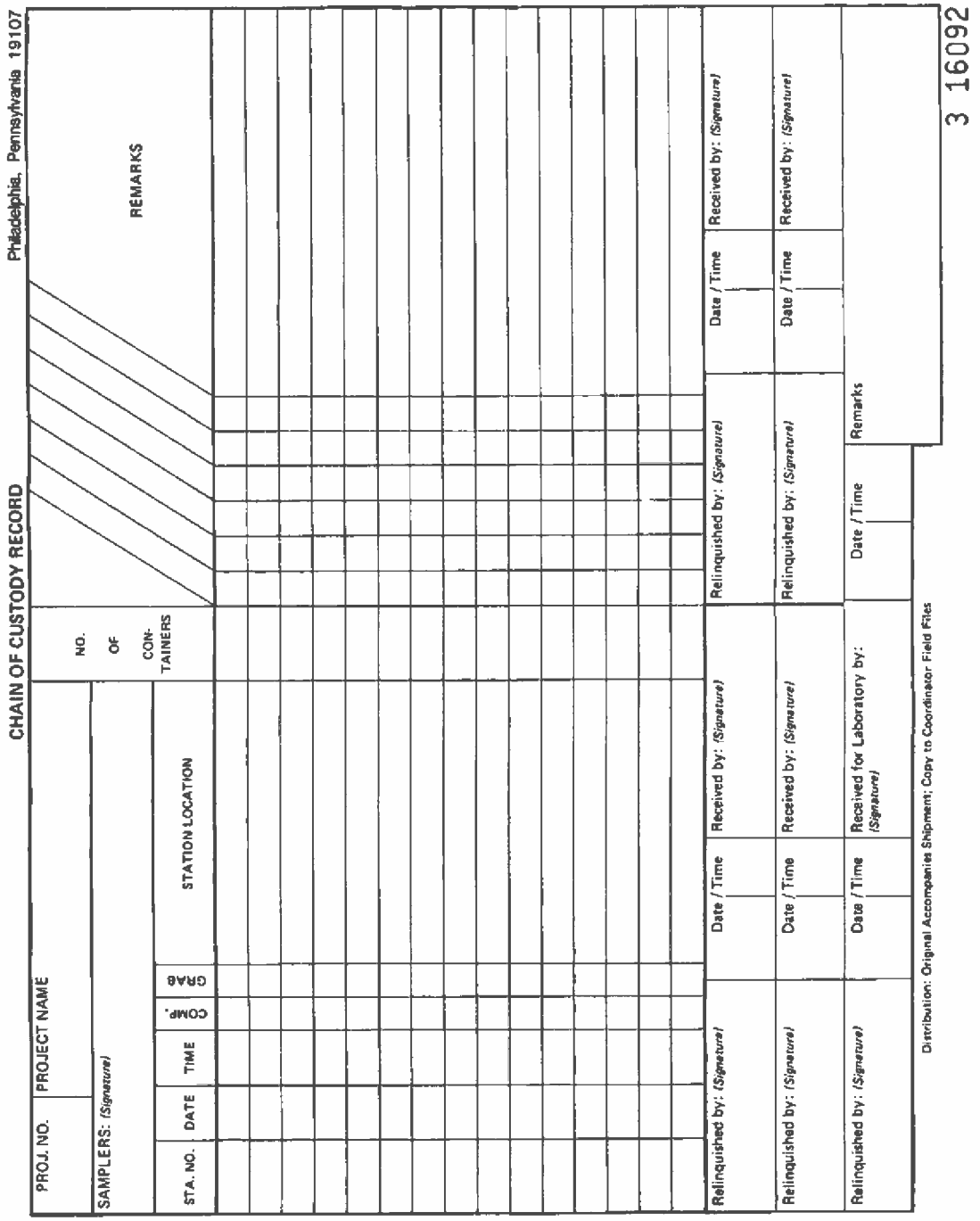
6.0 REFERENCES

American Standards for Testing and Materials (ASTM). 1993. Standard Practices for Sampling Chain-of-custody Procedures. Designation D 4840-88 (Reapproved 1993). Philadelphia, PA. May. (Replaced with ASTM D4840 - 99(2010) Standard Guide for Sampling Chain-of-Custody Procedures)

SOP 103 CHAIN-OF-CUSTODY DOCUMENTATION

August 2011

ATTACHMENT 1: CHAIN-OF-CUSTODY RECORD



WESTON SOLUTIONS, INC
STANDARD OPERATING PROCEDURE

SOP 104 PHOTOGRAPHIC AND VIDEO DOCUMENTATION

Revised November 2015

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to provide Weston Solutions, Inc. (WESTON®) team members with a step-by-step guide for photographic and video documentation. Photographs/videos should be used to document field activities including initial site conditions during assessments and emergencies prior to, during and after removal and remedial actions, during enforcement actions, and at special events and outreach programs.

2.0 PHOTOGRAPHIC AND VIDEO DOCUMENTATION

2.1 Photographs

Unless specifically requested otherwise, WESTON will document all site, sampling and special events using digital photographs.

Date and time should be accurately set for all digital cameras to document the date of the photography. Descriptions of the photograph subject, date, time, site name and location should be documented in the site logbook for all photographs. This information can also be documented in the digital camera or other electronic data collection device; however, written logbook descriptions should be maintained.

2.2 Video

If requested WESTON team members will document site activities using hand-held digital video cameras. Film video will only be taken if specifically requested, and such documentation, as well as High-definition digital video or other specialized video services, may require subcontractor support.

Date and time should be accurately set for all digital video cameras to document the date of the video. Descriptions of the video subject, date, time, site name and location should be documented in the site logbook for all video. This information can also be documented in the digital camera or other electronic data collection device; however, written logbook descriptions should be maintained.

3.0 SPECIFIC PROTOCOL

Adhere to the following protocol for both photographic and video documentation:

- Enter description of filming activities in the site logbook documenting type of camera, time (military time) and date, filming individual, and orientation angle of the viewing angle.

- Print the site name, the project number, and coverage dates on each storage media that has been used.
- Prepare a photographic log and label all photographs with the following information: the project number, site name, site location, date and time, description of photograph, orientation, and photographer.
- Store all storage media (SandDisk [SD] or other memory card, MicroSD, Digital tape, Universal Serial Bus [USB] flash drive, site negatives, original videos or other media) in the official site file.
- Be objective for all photographs/video. Ensure the purpose of the photograph is entered into the site log (e.g., documenting labels for enforcement, or condition of neighboring properties prior to the initiation of a removal action, or documenting an exposure pathway).

4.0 REFERENCES

NEIC Policies and Procedures. EPA-330/9-78-001-R, May 1978 (Revised 1983)

WESTON SOLUTIONS, INC
STANDARD OPERATING PROCEDURE

SOP 104 PHOTOGRAPHIC AND VIDEO DOCUMENTATION

Revised November 2015

ATTACHMENT A: EXAMPLE PHOTOGRAPHIC DOCUMENTATION LOG

PHOTOGRAPHIC DOCUMENTATION LOG

Client:		**Prepared by:**	Weston Solutions, Inc.
Site Name:	Site	**Photographer(s):**	C. Body; D. Person
Location:	Somewhere, PA	**TDD Number:**	WS01-10-07-002
Phase:	Creek Reconstruction	**Date:**	May 30, 2014

Date: 9/9/2011

Time: 09:00

Orientation: SW

Description: Damage assessment of after Tropical Storm Lee.

Date: 9/14/2011

Time: 13:50

Orientation: E

Description: Collection and staging of flood debris for disposal.

WESTON SOLUTIONS, INC.
STANDARD OPERATING PROCEDURE

SOP 203 SURFACE WATER SAMPLING

Revised November 2015

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) is applicable to the collection of representative liquid samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

2.0 METHOD SUMMARY

Sampling situations vary widely and therefore no universal sampling procedure can be recommended.

However, sampling of liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or sampling techniques:

- Kemmerer bottle
- Van dorn sampler
- bacon bomb sampler
- dip sampler
- direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, follow these procedures:

1 Transfer the sample(s) into suitable labeled sample containers.
2 Preserve the sample if appropriate, or use pre-preserved sample bottles.
3 Cap the container, put it in a resealable plastic bag and place it on ice in a cooler.
4 Record all pertinent data in the site logbook and on a field data sheet.
5 Complete the chain-of-custody form.
6 Attach custody seals to the cooler prior to shipment.
7 Decontaminate all sampling equipment prior to the collection of additional samples.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross-contamination of samples and improper sample collection.

- Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary.

- Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples includes:

- Kemmerer bottles
- Van Dorn sampler
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles and preservatives
- pH paper
- Resealable plastic bags
- Ice for sample preservation
- Coolers
- Ball-point pen, permanent marker, grease pencil, marking spray paint
- Chain of custody forms, EPA custody seals, field data sheets
- Sample bottle labels/tags
- Decontamination equipment (brushes, buckets, garden sprayer, alconox or liquinox, water, etc.)
- Paper towels
- Plastic sheeting
- Map/plot plan/sketches
- Personal protective equipment and monitoring equipment (as specified in the Health and Safety Plan)
- Field data measurement equipment as specified in the FSP (such as YSI)
- Compass
- Tape measure (up to 300 ft)
- Survey stakes, flags, or buoys and anchors
- Global positioning system (GPS) unit with sub-meter accuracy or better
- Digital camera with adequate storage media
- Logbook/waterproof pen and field data sheets
- Plastic garbage bags
- Scissors

- Nitrile or latex sample gloves
- Shipping documents (Federal Express forms/shipping labels/etc.)
- Strapping/packing tape

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in SOP No. 301, Decontamination Procedures.

7.0 PROCEDURES

7.1 Preparation

- Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
- Obtain necessary sampling and monitoring equipment.
- Decontaminate or pre-clean equipment, and ensure that it is in working order.
- Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
- Perform a general site survey prior to site entry in accordance with the site specific health and safety plan.
- Use stakes, flags, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sampling Considerations

7.2.1 Representative Samples

In order to collect a representative sample, the hydrology and morphometrics (e.g., measurements of volume, depth, etc.) of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist that would affect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using an appropriate instrument, such as a YSI (or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths anytime surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- Will the sample be collected from the shore or from a boat on the impoundment?
- What is the desired depth at which the sample is to be collected?
- What is the overall depth and flow direction/flow rate of river or stream?

7.2.2 Sampler Composition

The appropriate sampling device must be of a proper composition. Samplers constructed of glass, stainless steel, polyvinyl chloride (PVC) or Polytetrafluoroethylene (PFTE such as Teflon®) should be used based upon the analyses to be performed.

7.3 Sample Collection

Photograph sample locations with landmarks in view. Keep in mind that sample locations may need to be referenced in the future, often years after your sampling event.

7.3.1 Kemmerer Bottle

Kemmerer bottle may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Using a properly decontaminated Kemmerer bottle, set the sampling device so that the sampling end pieces are pulled away from the sampling tube, allowing the substance to be sampled to pass through the tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.
4. Retrieve the sampler and discharge the first 10 to 20 mL to clear any potential contamination on the valve. Transfer the sample to the appropriate sample container.

7.3.2 Van Dorn Sampler

A Van Dorn sampler is used to collect surface water from a very specific sampling depth or from a shallow water body. Since the sampler is suspended horizontally, the depth interval sampled is the diameter of the sampling tube. The sampling procedure is as follows:

1. Use a properly decontaminated Van Dorn sampler. Set the device so that the end stoppers are pulled away from the body allowing surface water to enter the tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
3. When the Van Dorn is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
4. Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve. This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

7.3.3 Bacon Bomb Sampler

A bacon bomb sampler may be used in similar situations to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to the appropriate sample container by pulling the trigger.

7.3.4 Dip or Swing Sampler

A dip sampler and/or a swing sampler are useful for situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.5 Direct Method

For streams, rivers, lakes and other surface waters, the direct method may be utilized to collect water samples from the surface. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants are a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface, pointing the sample container upstream. The container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general QA/QC procedures apply:

- Field QA/QC samples (e.g., field blanks, equipment rinsate blanks, trip blanks, duplicate samples, MS/MSD, etc.) must be collected in accordance with the FSP and QAPP
- All data must be documented in site logbooks.
- All sample locations should be recorded using a GPS unit.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout must occur prior to sampling/operation and should be documented.

9.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and specific health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, take adequate precautions. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him or her to lose their balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment, including a Type II PFD.

Sampling over and around water can be dangerous, be sure to follow all HAS procedures and have an approved HASP. Whenever boats are to be used to collect samples, a Float Plan must be prepared and included as part of the approved HASP. When working around and over cold water, appropriate survival suits are required (such as Mustang suits), as specified in the approved HASP.

10.0 REFERENCE

EPA. 1991. Compendium of Emergency Response Team (ERT) Surface Water and Sediment Sampling Procedures. Office of Solid Waste and Emergency Response, Washington, DC. EPA/540/P-91/005.

WESTON SOLUTIONS, INC.
STANDARD OPERATING PROCEDURE

SOP 203 SURFACE WATER SAMPLING

Revised November 2015

ATTACHMENT 1: FIGURES

Figure 1: Kemmerer Bottle

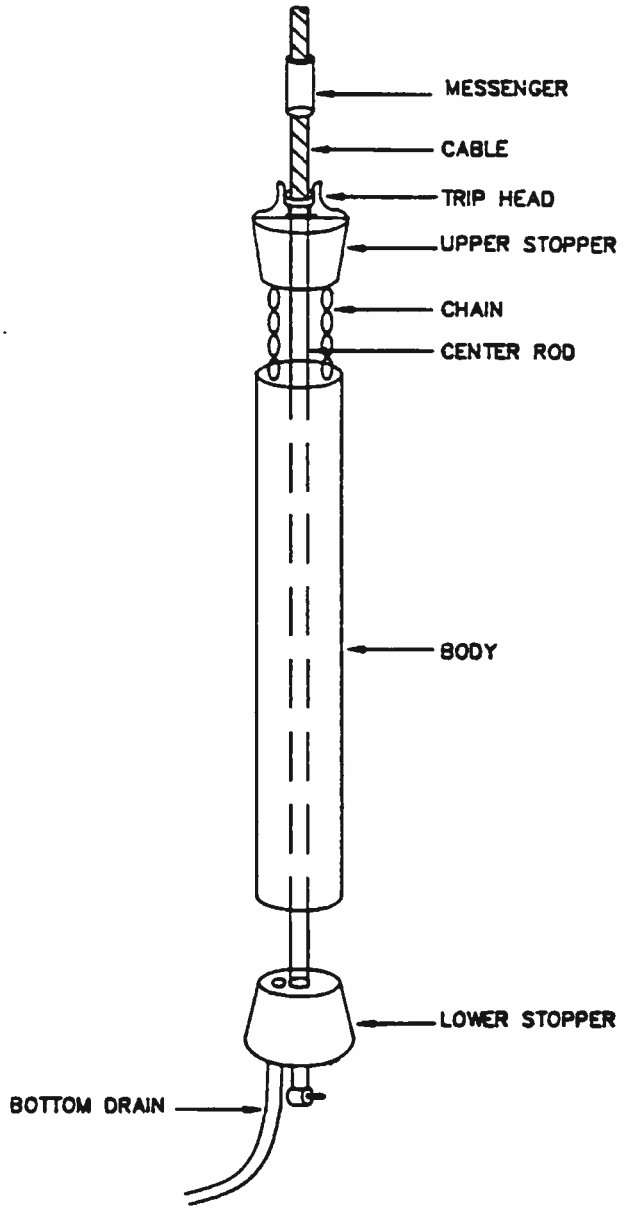


Figure 2: Van Dorn Sampler

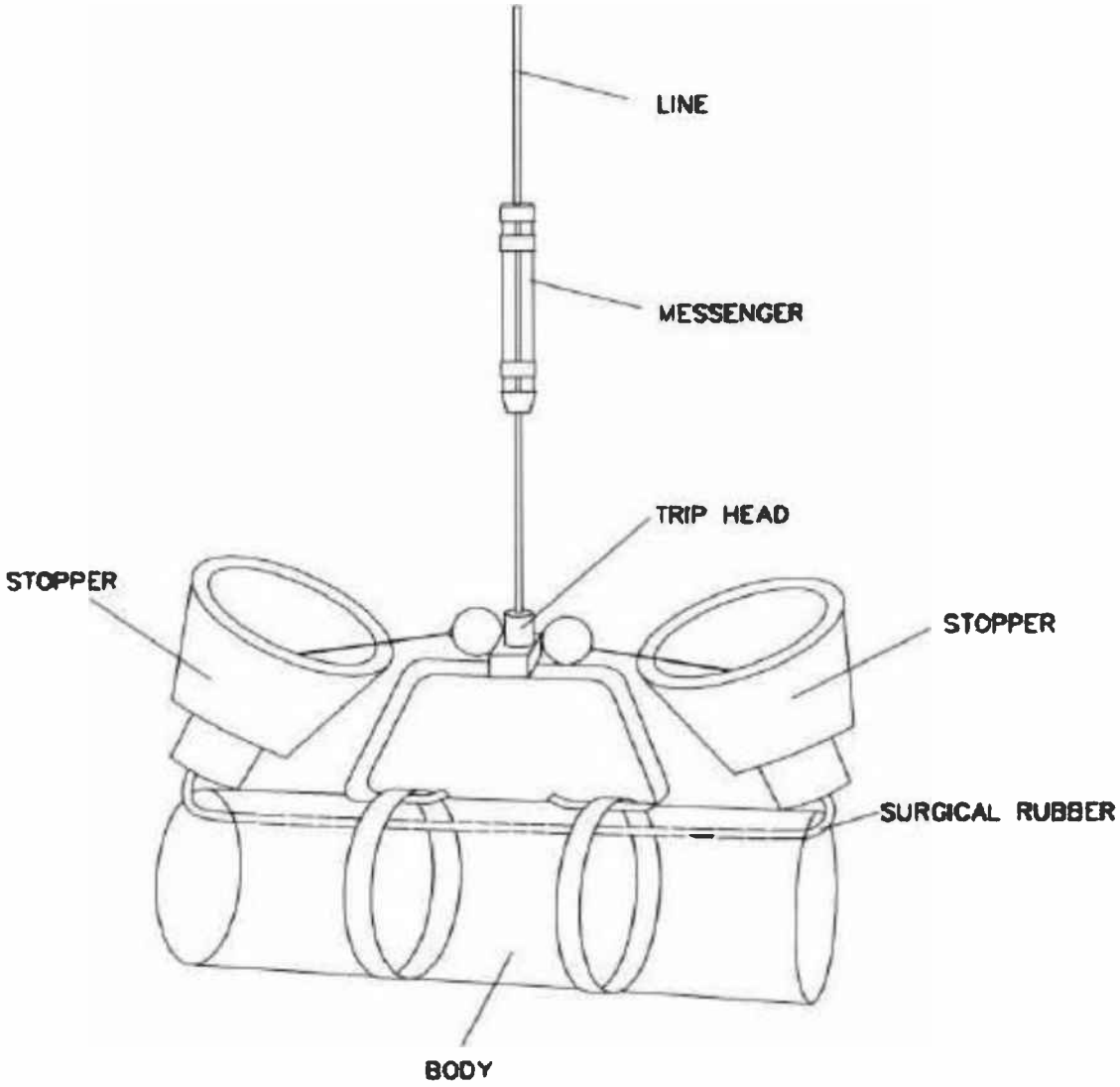


Figure 3: Bacon Bomb Sampler

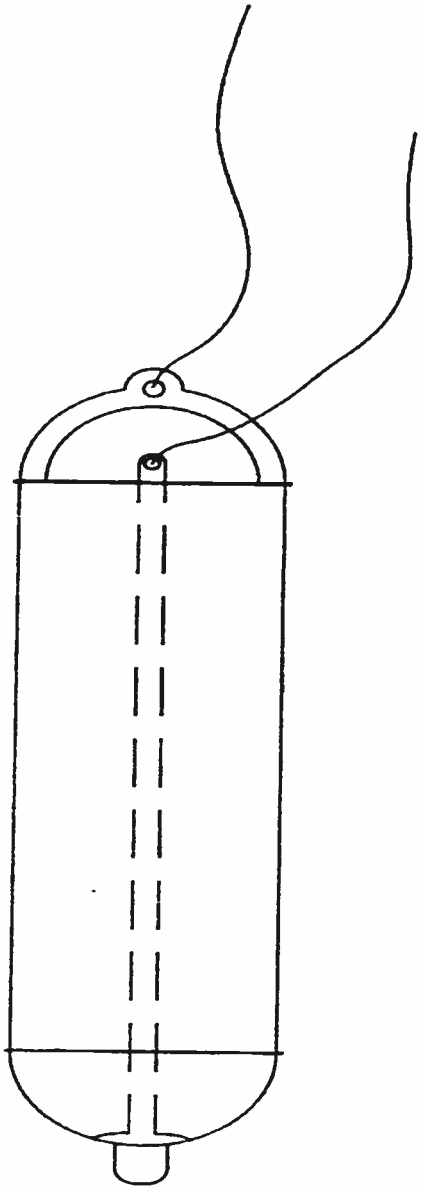
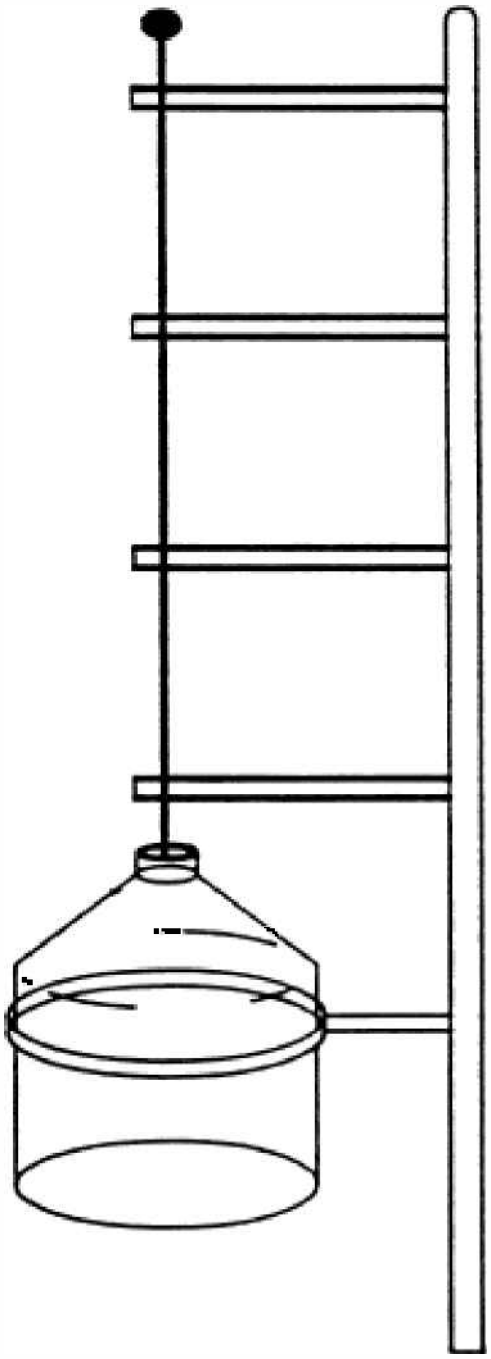


Figure 4: Dip Sampler



WESTON SOLUTIONS, INC.
STANDARD OPERATING PROCEDURE

SOP 301 DECONTAMINATION PROCEDURES

Revised November 2015

1.0 PURPOSE

To provide guidance for the decontamination of equipment used to sample, install sample points (monitor wells, soil borings and test pits), and make field measurements. This operating practice is not intended to be site specific or equipment specific, but to provide guidance in place of non-existent state or federal guidelines or in cases where the site-specific work plan or Field Sampling Plan does not provide additional detail on decontamination procedures.

2.0 DISCUSSION

2.1 Introduction

The objective of decontamination procedures is to provide clean equipment for the retrieval of representative environmental samples. Decontamination procedures differ depending on the nature of the equipment used. The three categories of decontamination procedures are discussed below:

- Intrusive equipment used to install sample points including drilling (tools, augers, rods, etc.) and excavation equipment (backhoes, excavators, etc.).
- Equipment used to measure the characteristics of the media to be sampled including water level, pH, specific conductivity, and temperature probes. This category also includes pumps to purge water.
- Equipment that has contact with the sample to be submitted for laboratory analysis including bailer, split-spoons, hand auger, stainless steel bowls and scoops.

Because items from the first two categories do not contact the sample media that is sent to a laboratory for analysis, the decontamination procedures are less stringent. Dedicated and disposable equipment will be used whenever feasible to limit decontamination and the possibility of cross-contamination. This includes rope, tubing, filterware and, in some cases, soil scoops, pans, and bailers.

3.0 PROCEDURES

3.1 Intrusive Equipment

Drilling tools, including augers, rods, drill bits, hand tools, etc. will be steam cleaned prior to use and after each location. Split spoons will also be steam cleaned if not used for sample collection. Backhoe buckets and arms will also be steam cleaned prior to use and between each sample location.

3.2 Field Measurement Equipment

Water level probes will be cleaned using the following procedures:

- Wipe the probe with a paper towel.
- Alconox®, Liquinox®, or other appropriate cleaning solution and potable water wash.
- Deionized water rinse.

Other measurement equipment should be rinsed with deionized water between readings. Pumps used for well purging shall be decontaminated using the following procedures:

- Alconox®, Liquinox®, or other appropriate cleaning solution and potable water scrub and pump through.
- Potable water rinse and pump through.

Rope and tubing used with the pump will be made of polyethylene and be dedicated (and disposable) to one sample location.

3.3 Sampling Equipment

Equipment used for sample collection include but are not limited to:

- Teflon bailers
- Stainless steel scoops and bowls
- Hand augers
- Split spoons

This equipment will be cleaned using the following procedures:

- Alconox®, Liquinox®, or other appropriate cleaning solution and potable water scrub.
- Thorough potable water rinse.
- Deionized water rinse.
- Specialized decontamination fluid rinse, if necessary for the type of sampling and level of analyses.
- Deionized water rinse, if a specialized decontamination fluid rinse is used.
- Total air dry (only if sample is to be analyzed for organics).

Sampling instruments should be wrapped in aluminum foil after decontamination to keep clean before sampling. Note that this may be eliminated if low level metals analyses are being

conducted and aluminum is a potential contaminant of concern. Also note that aluminum foil should not be used if sampling for Perfluorinated Compounds.

4.0 DOCUMENTATION

Decontamination efforts should be documented in the field logbook. Decontamination fluids should be disposed of properly. Depending on site conditions, it may be appropriate to contain spent decontamination fluids. In that case, the appropriate vessel (i.e., drum) should be used depending on the ultimate disposition of the material. See *SOP 019 Investigative Derived Waste Compliance Plan* for more detailed information on handling and disposal of these wastes.

5.0 INTERPRETATION

If there are questions on the interpretation or applicability of items in this operating practice, the Project Manager, Technical Manager or Quality Manger should be consulted.

6.0 REFERENCES

New Jersey Department of Environmental Protection and energy Field Sampling Procedures Manual, May 1992. {Updated 2011, See NJDEP website. Specific changes listed}

"Standard Practice for Decontamination of Field Equipment Used at Non-radioactive Waste Sites", ASTM Designation D5088-90.

WATER QUALITY SAMPLING SITE VISIT NOTES

Water Quality Sampling Site Visit Notes

March 7, 2017

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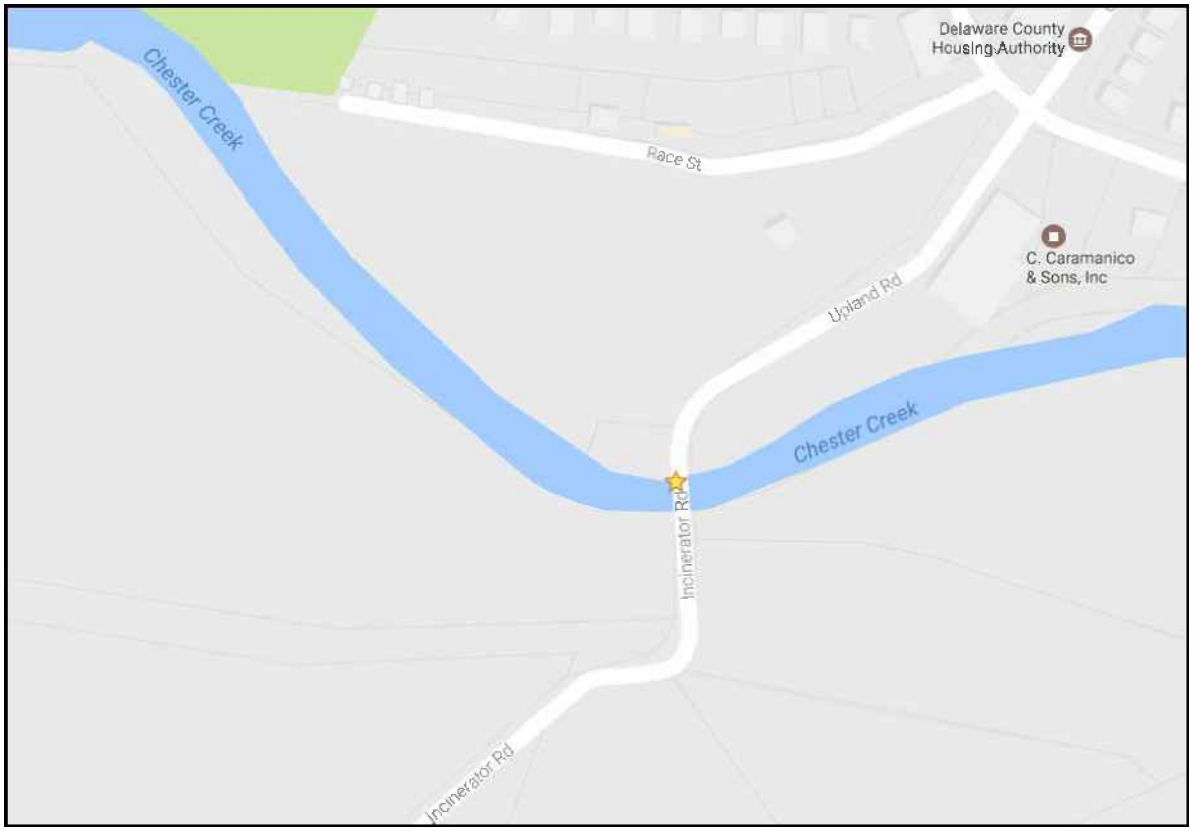
SITE VISIT NOTES

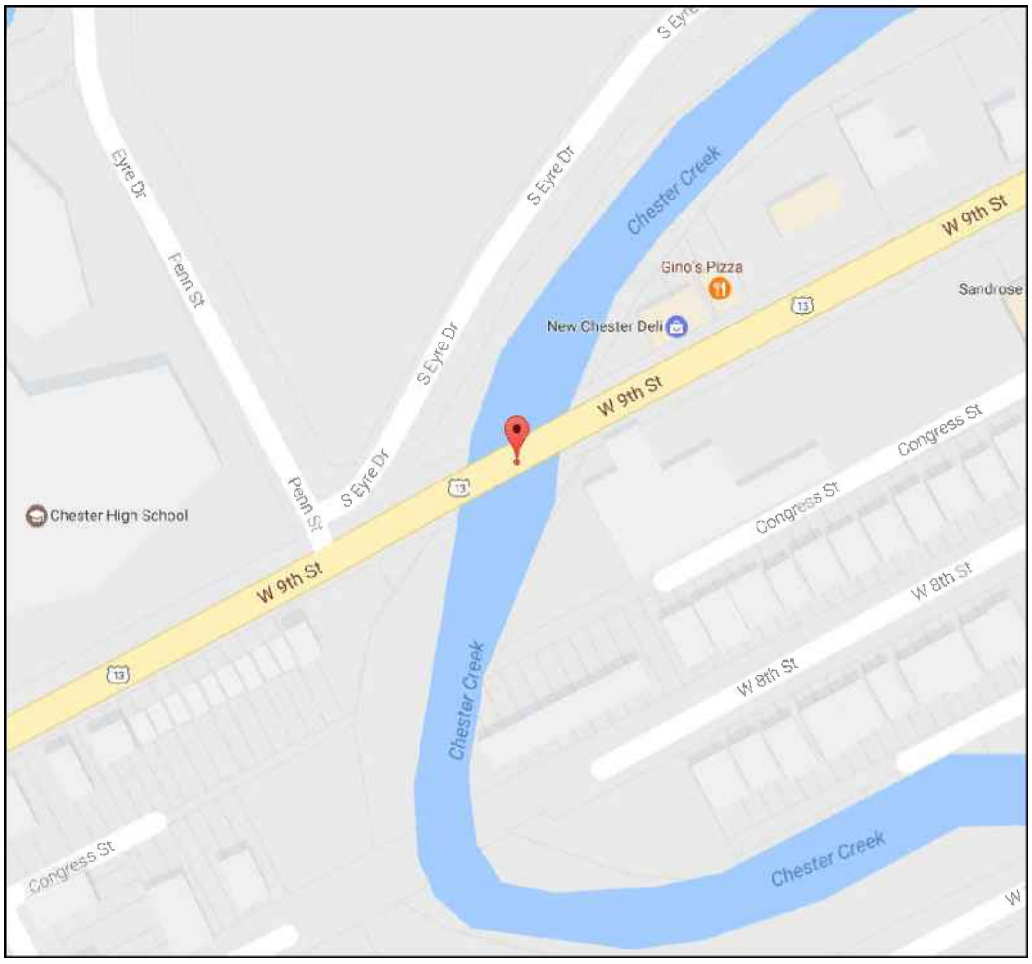
Sampling ID	Sampling Location	Activity / Notes	Accessibility
CC-01	Upland Rd. / Incinerator Rd. Bridge. **39.850122, -75.386348**	20 ft. from rail to water. Upstream of CSO outfall. Creek is non-tidal. Lower bottle with rope or other means	Upland road access gated from both ends, may need to contact police for access. Minimal traffic.



CC-01 Location Plan Map

CC-01 - Photos

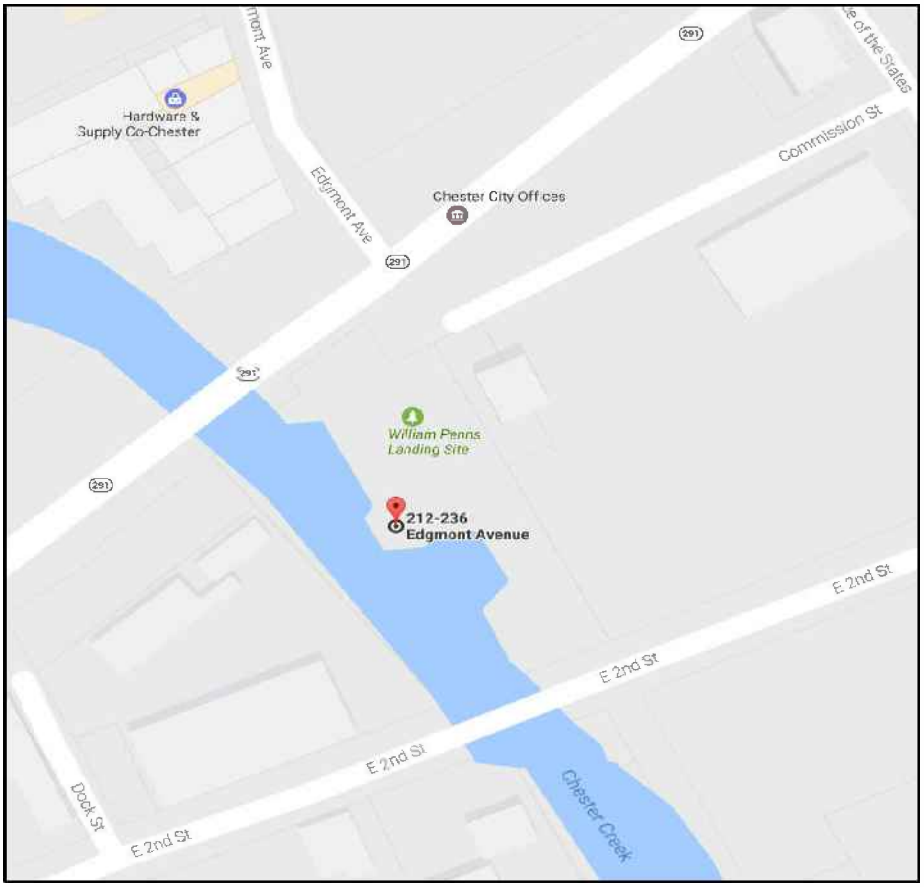
Sampling ID	Sampling Location	Activity / Notes	Accessibility
CC-02	9th and Penn St. Bridge **39.850709, -75.365530**	23 ft. from rail to water. Bridge is located next to Chester High School.	Accessible from 9th Street. Can pull vehicle on shoulder. Light traffic.



CC-02 Location Plan Map

CC-02 - Photos

Sampling ID	Sampling Location	Activity / Notes	Accessibility
CC-03	Intersection of Edgmont and 2nd street. William Penn's Landing Park **39.845227, -75.360284**	Site is in William Penn's Landing Park. Sample off of Concrete plaza that overhangs Chester Creek. Tidal influence. Grab samples upstream of bridge.	Can pull vehicle off of 2nd Street and walk into park. Light traffic.

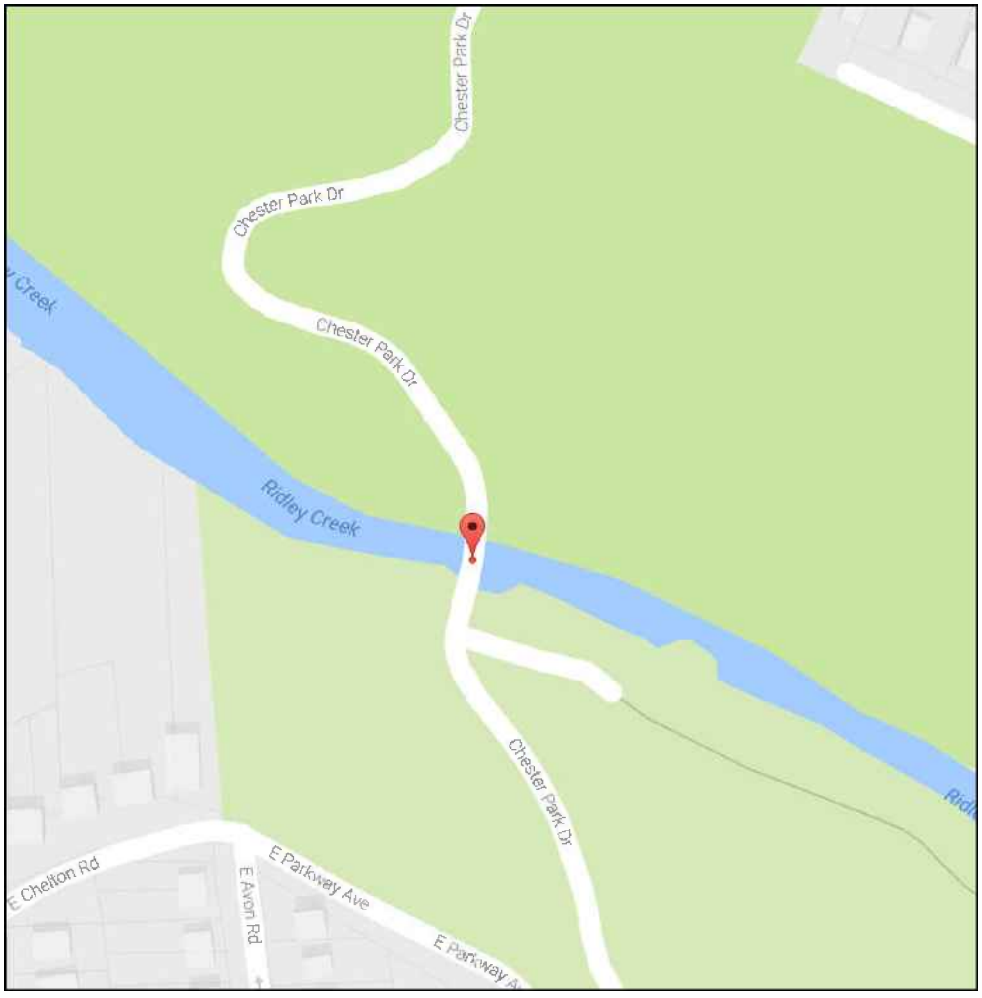


CC-03 Location Plan Map

CC-03 – Photos

Commission St
William Penns
Landing Site
Chester Creek
E 2nd St

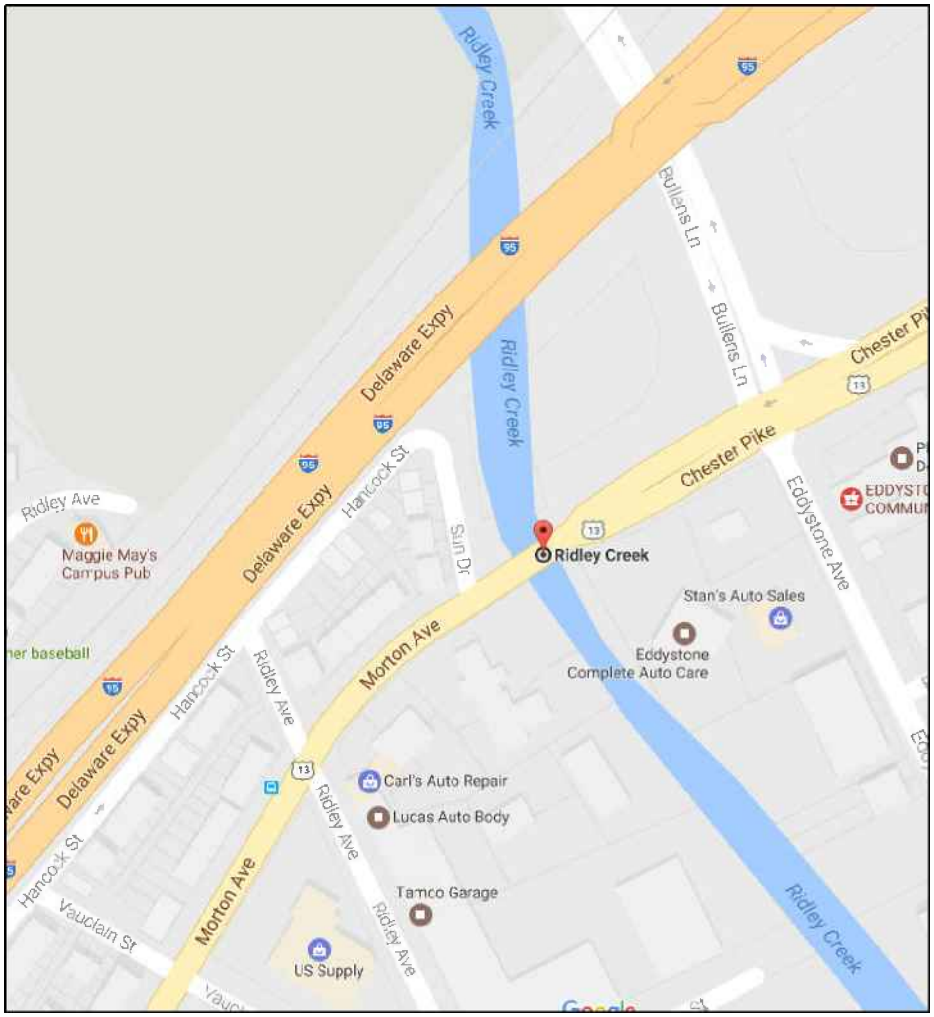
Sampling ID	Sampling Location	Activity / Notes	Accessibility
RC-01	Chester Park Drive Bridge **39.873264, -75.375183**	19 ft. rail to water. Sample upstream of CSO outfall. Upstream of CSO-33. Creek is non-tidal here. Lower bottle with rope or other means.	Can park in lot adjacent to Chester Park Drive Bridge. Minimal traffic.



RC-01 Location Plan Map

RC-01 – Photos

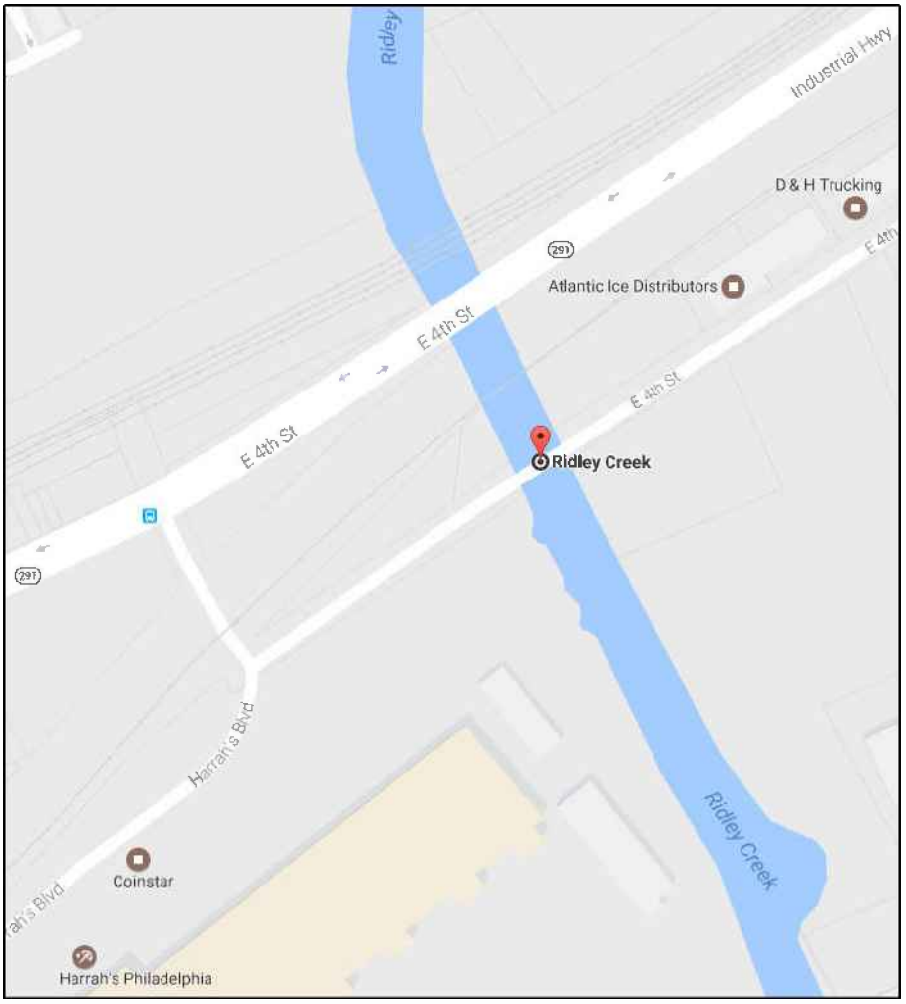
Sampling ID	Sampling Location	Activity / Notes	Accessibility
RC-02	Morton Ave. Bridge **39.863016, -75.348686**	22 ft. rail to water (low tide), with 2 ft. water depth. Site is in same area as CSO-18.	Can park on Sun Drive and use sidewalk when sampling off of bridge. Medium traffic.



RC-02 Location Plan Map

RC-02 – Photos

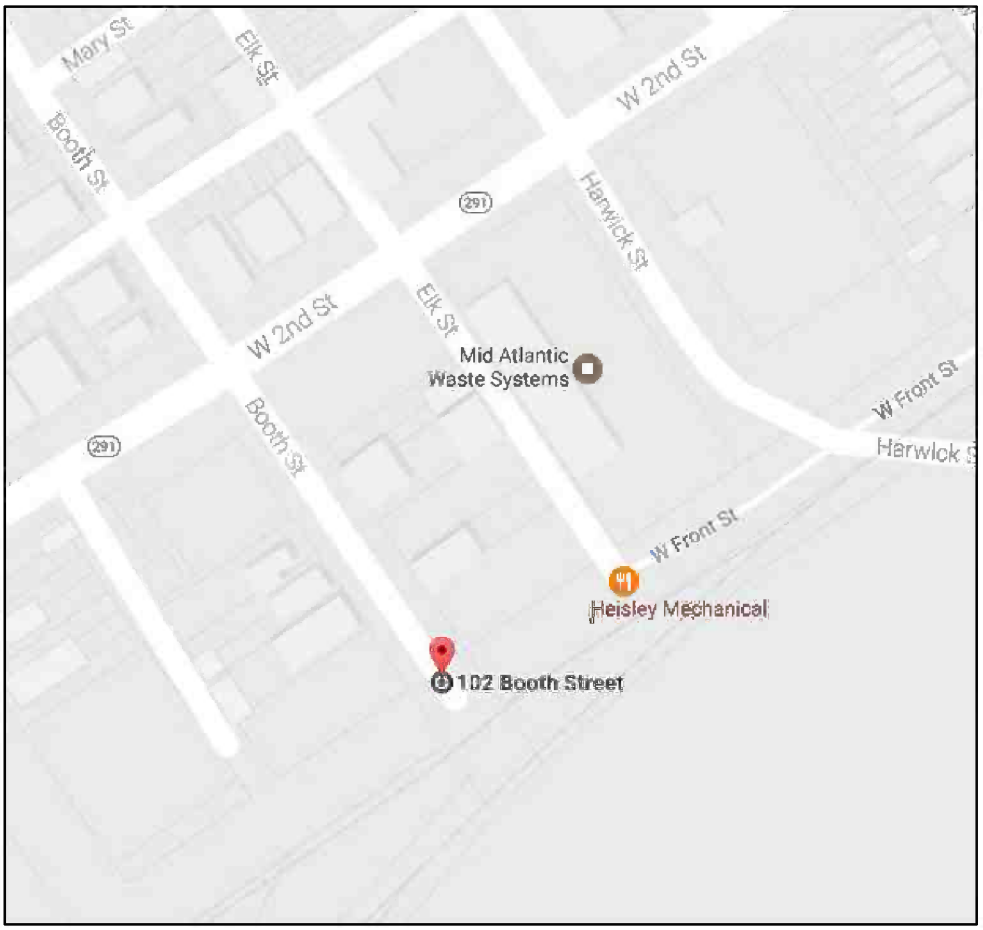
Sampling ID	Sampling Location	Activity / Notes	Accessibility
RC-03	4th Street (Harrah's) Bridge. Bridge No. 157 (Chester-Eddystone Bridge) **39.853435, -75.346350**	25 ft. rail to water (low tide), shallow during low tide. Creek is tidal. Lower bottle from bridge using a rope or other means.	Can park on shoulder north of bridge use sidewalk when sampling off of bridge. Medium traffic.



RC-03 Location Plan Map

RC-03 – Photos

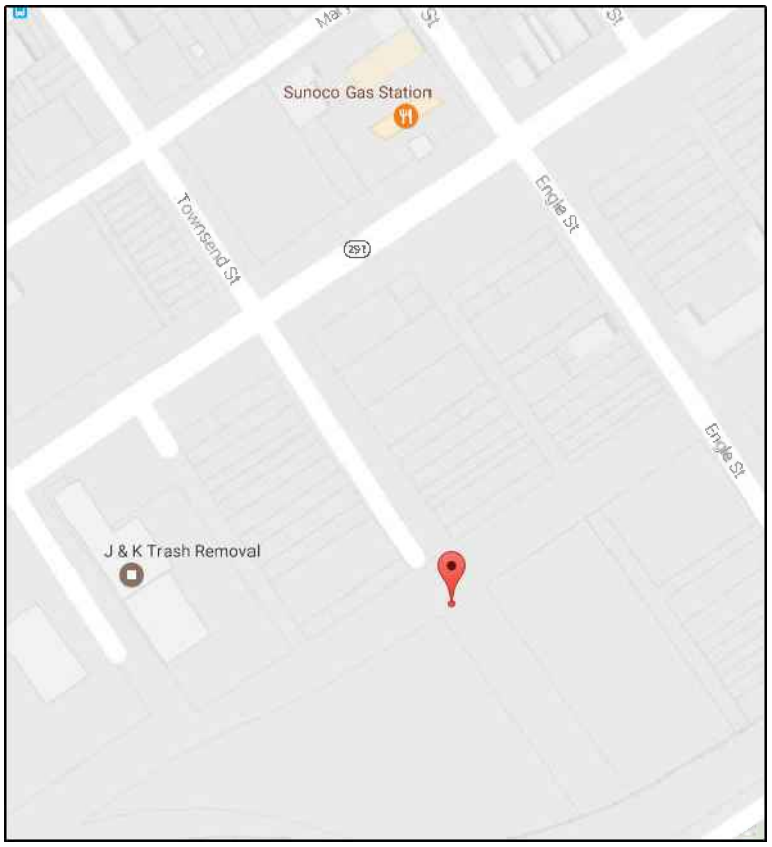
Sampling ID	Sampling Location	Activity / Notes	Accessibility
CSO-02	Front and Booth St. **39.828334, -75.392570**	SCADA level sensor installed. Concrete dam diverts flow to right side MH flow to WRTP (has an orifice plate). Overflow over the dam will flow to CSO outfall at Delaware River.	Can park at the end of Booth St. prior to rail tracks. Minimal traffic. MH cover is marked with white dot.



CSO-02 Location Plan Map

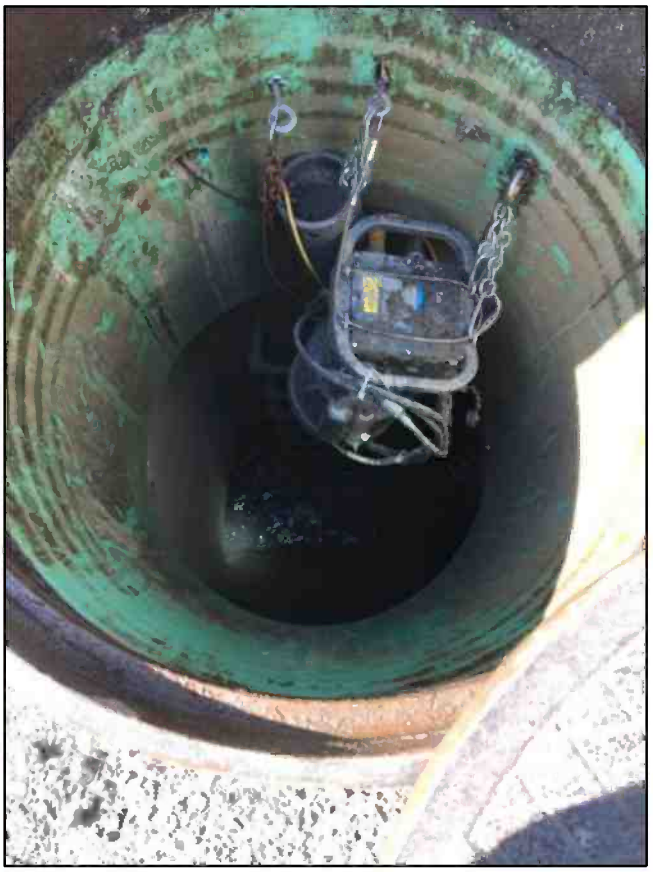
CSO-02 Photos

Sampling ID	Sampling Location	Activity / Notes	Accessibility
CSO-05	Front and Townsend **39.832598, -75.383958**	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to right side MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Delaware River.	Can park at the end of Townsend St. Minimal traffic. MH cover is marked with white dot.

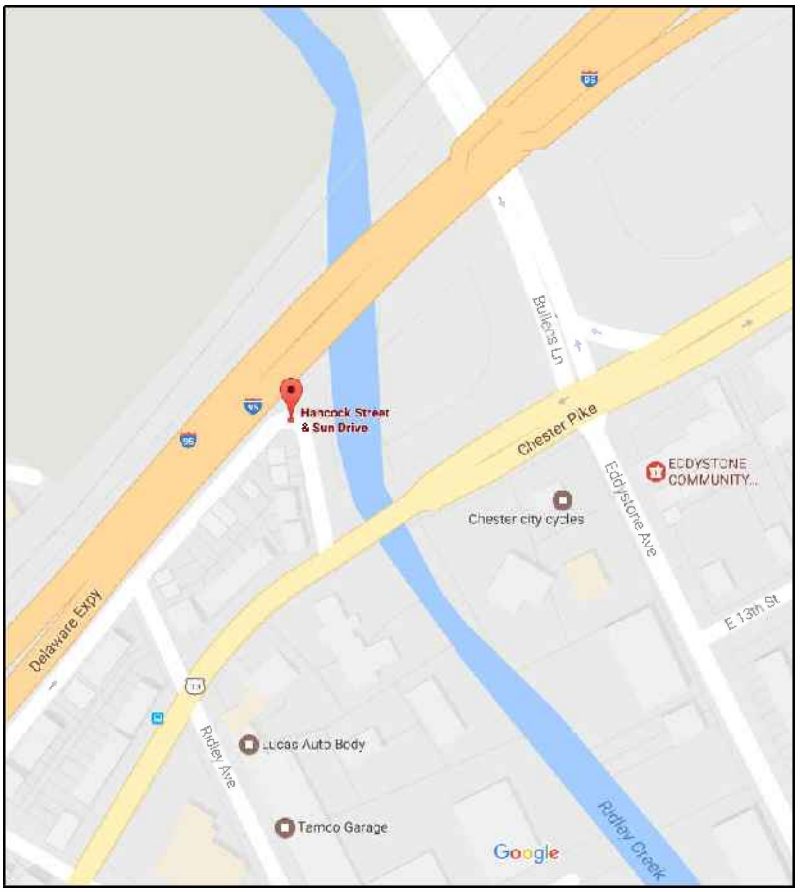


CSO-05 Location Plan Map

CSO-05 Photos



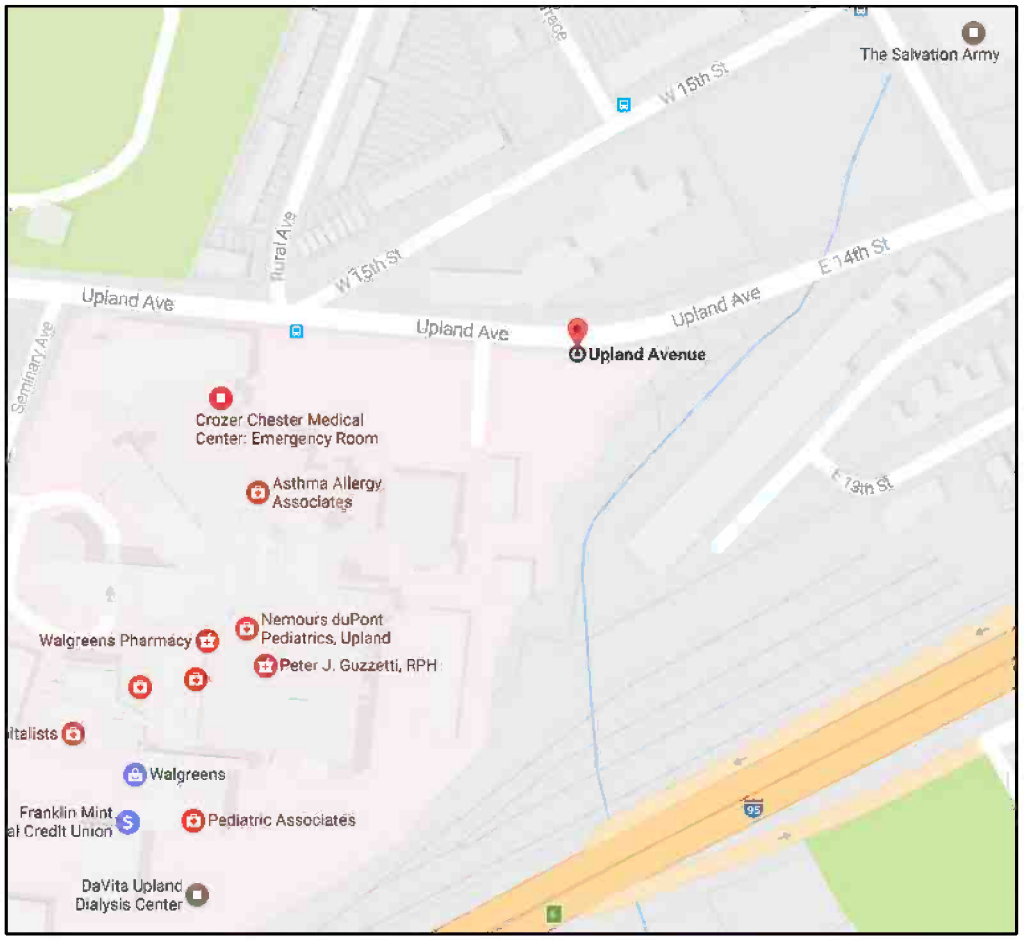
Sampling ID	Sampling Location	Activity / Notes	Accessibility
CSO-18	Hancock St. and Sun Dr. **39.863501, -75.349203**	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to right side MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Ridley Creek.	Can park at the end of Hancock St. Minimal traffic. MH cover is marked with white dot.



CSO-18 Location Plan Map

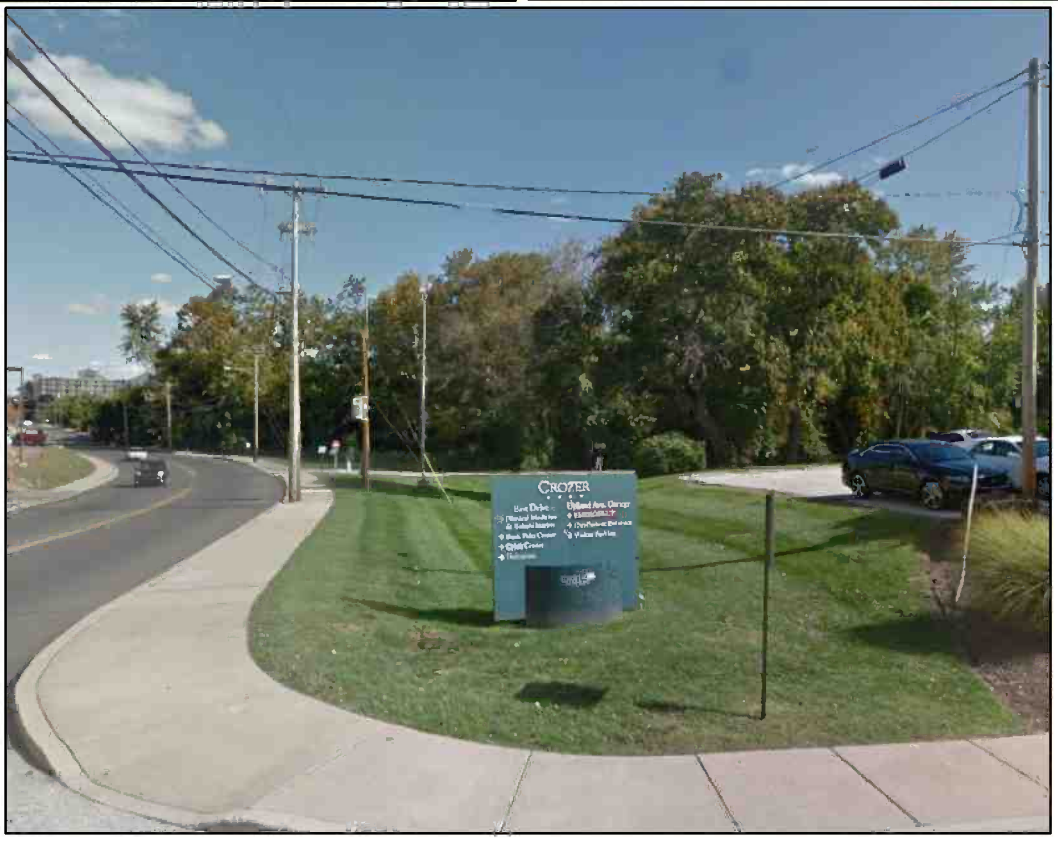
CSO-18- Photos

Sampling ID	Sampling Location	Activity / Notes	Accessibility
CSO-19	14th and Crozer Hospital **39.857132, -75.366105**	SCADA level sensor and Hach flow meter installed. Concrete dam diverts flow to interceptor MH flow to WRTP. Overflow over the dam will flow to CSO outfall at Chester Creek.	Can park in the cul-de-sac off of 14th St. High traffic. MH cover is on lawn area marked with white dot.

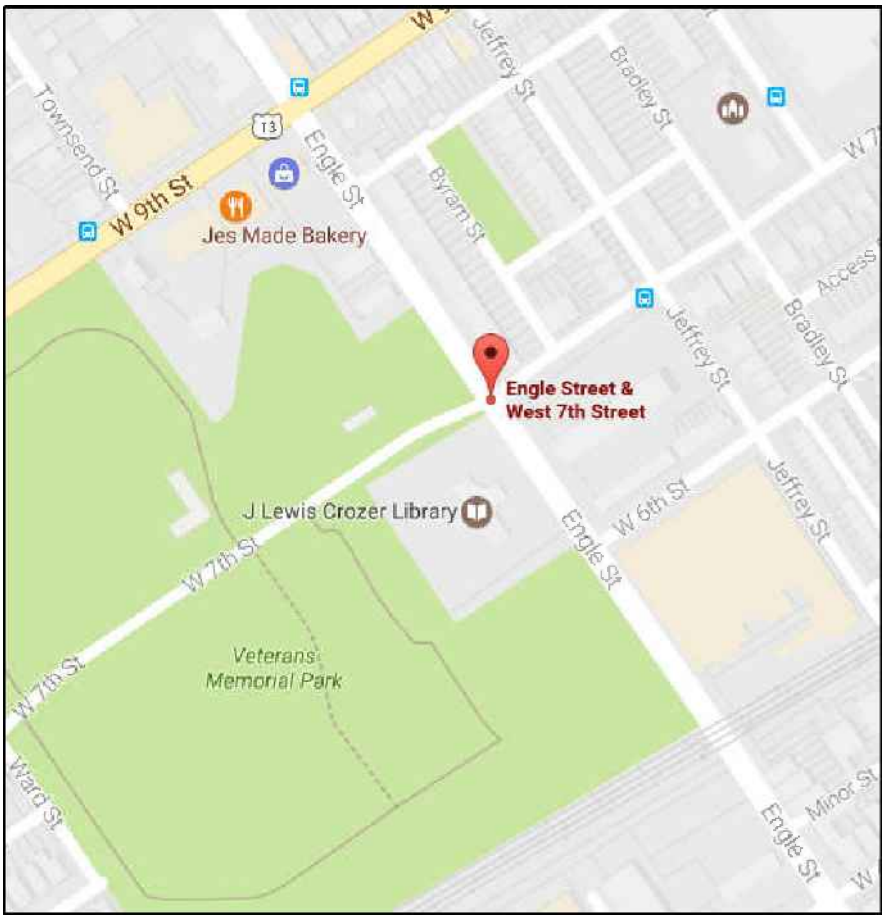


CSO-19 Location Plan Map

CSO-19- Photos

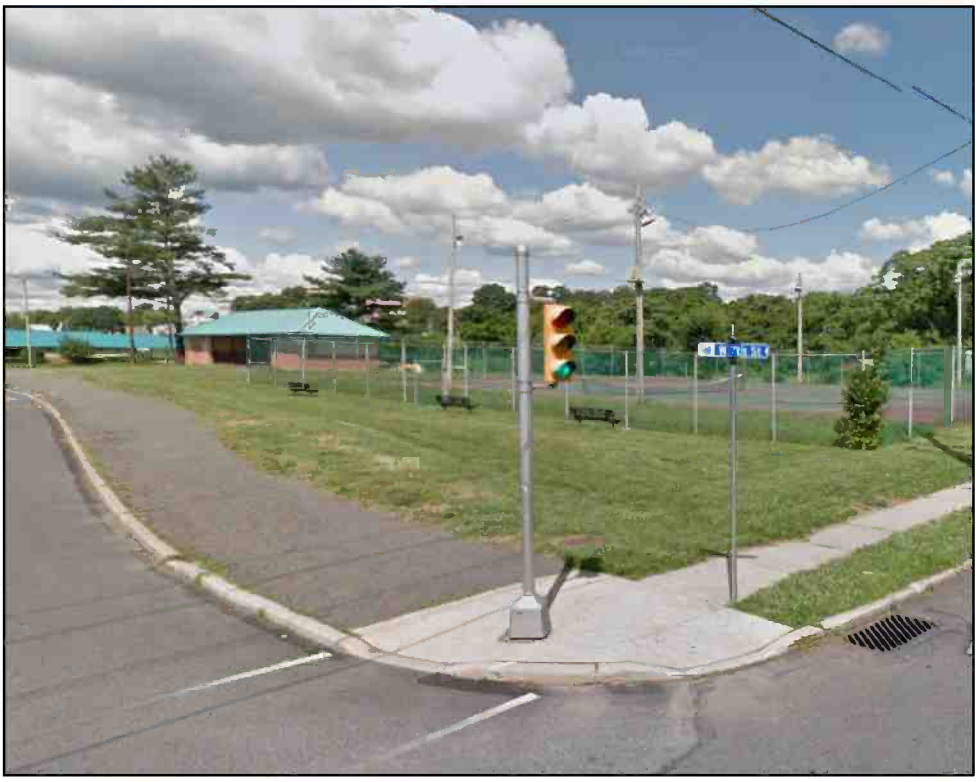


Sampling ID	Sampling Location	Activity / Notes	Accessibility
SW-05A	7th and Engle Street **39.838658, -75.387550**	Residential storm water MH. MH is clear and on grass area off of road.	Can park on 7th St. shoulder and access MH on lawn next to traffic light. Medium traffic. MH cover is on lawn area marked with white dot.

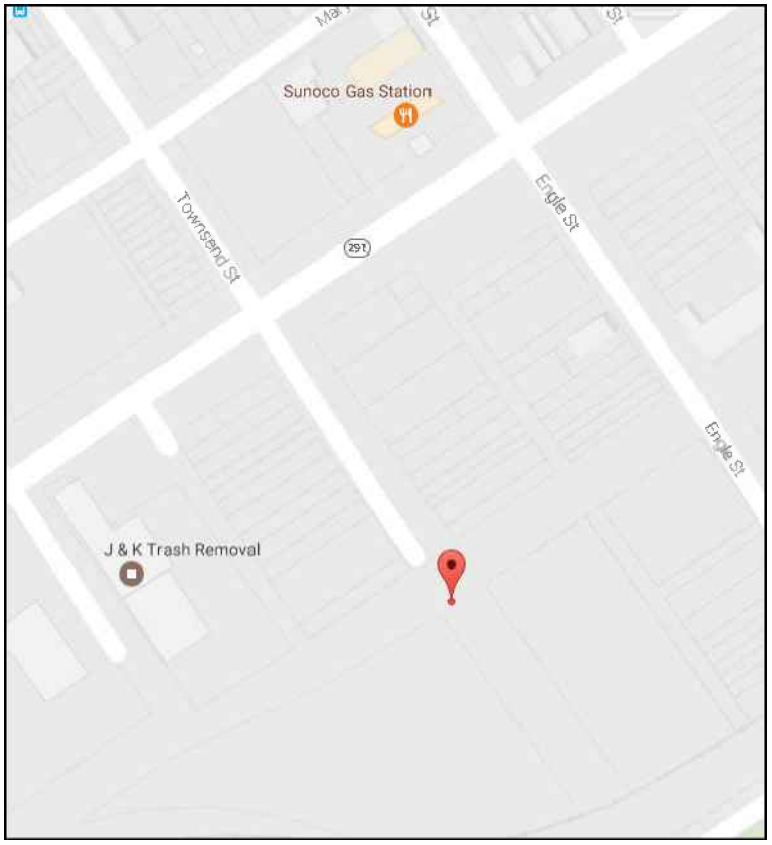


SW-05A Location Plan Map

SW-05A-Photos



Sampling ID	Sampling Location	Activity / Notes	Accessibility
SW-SS2	105 Townsend Street **39.832687, -75.384032**	Industrial storm water MH. MH is clear and on gravel area near CSO-05.	Can park at the end of Townsend St. Minimal traffic. MH cover is marked "storm" with white dot.



SW-SS2 Location Plan Map

SW-SS2-Photos

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REGION III
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Philadelphia, Pennsylvania 19103-2029

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Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Water Quality Modeling and Monitoring Work Plan Update WQMMWP dated July 31, 2017. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). This letter served to iterate the original approval and formally notify you that EPA accepted the updated WQMMWP and is approved.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: P. Yeany, EPA
M. DeSantis, DELCORA
Tom Magee, PaDEP, SERO
C. Hurst, DELCORA

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APPENDIX J

Water Quality Modeling Report

- DELCORA Water Quality Model Report - Final dated February 2018
- USEPA Approval of the Water Quality Water Quality Model Report dated April 17, 2018

Delaware County Regional Water Quality Control Authority
CSO Long Term Control Plan Update

Water Quality Model Report

Final

Submitted: February 2018

GREELEY AND HANSEN

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Report Signature Cover Sheet

Signature of this cover signifies agreement with the content of the DELCORA Water Quality Model Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	_____ *Signature*	_____ *Date*
DELCORA ENGINEERING		
Director of Engineering	*Signature*	2/27/18 *Date*
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	*Signature*	2/27/18 *Date*

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Glossary

CDPS: Central Delaware Pump Station
CSO: Combined sewer overflow
CSS: Combined sewer system
CWA: Clean Water Act
DCIA: Directly connected impervious area
DEM: Digital elevation model
EFDC: Environmental Fluid Dynamic Code
EMC: Event mean concentration
HSG: Hydrologic soil group
LiDAR: Light detection and ranging
LTCP: Long Term Control Plan
MRLC: Multi-Resolution Land Characteristics
MS4: Municipal separate storm sewer system
NCDC: National Climatic Data Center
NLCD: National Land Cover Database
NMC: Nine Minimum Controls
NOAA: National Oceanic and Atmospheric Administration
NPDES : National Pollutant Discharge Elimination System
NRCS: National Resources Conservation Service
PADEP: Pennsylvania Department of Environmental Protection
PWD-SWPCP: Philadelphia Water Department's Southwest Water Pollution Control Plant
SSO: Sanitary sewer overflow
SSURGO: Soil Survey Geographic database
SWMM: Stormwater Management Model
USGS: United States Geological Survey
WRTP: Western Regional Treatment Plant

Executive Summary

Introduction

The DELCORA Consent Decree requires that a Water Quality Model be developed to support the Long Term Control Plan Update. This report describes DELCORA's receiving water quality model, including the development and calibration of the model, and the initial application of the model to quantify baseline pollutant of concern (POC) water quality conditions in the receiving waters for the typical period. The POCs include Fecal coliform, *E.coli*, and *Enterococcus*. The objective of the water quality modeling was to compute POC concentrations in the tidal portions of Chester Creek and Ridley Creek, and in the Delaware River, by accounting for all major POC sources within the model domain. The intended use of the water quality modeling framework is to evaluate the water quality under typical year conditions and to evaluate CSO control alternatives.

Model Development

Three types of models, which comprise the modeling framework, were jointly applied to compute POC concentrations in Chester and Ridley Creeks and the Delaware River:

- A watershed model which simulates flows and POC loads from the Chester and Ridley Creeks watersheds;
- CSO models to simulate flows and POC loads from the DELCORA and Philadelphia Water Department (PWD) combined sewer systems (CSS) to the streams; and,
- A receiving water quality model that computes POC concentrations in Chester and Ridley Creeks and the Delaware River resulting from the various sources of POCs to the streams.

The watershed and CSS models were developed using the EPA Stormwater Management Model (SWMM) and the receiving water quality model was developed using the EPA Environmental Fluid Dynamics Code (EFDC) model.

Model Calibration

Site specific data was used for calibrating the various models, including USGS flow data, NOAA tide data, wet and dry weather water quality data obtained by DELCORA, and ambient water quality data obtained from the Delaware River Basin Commission (DRBC). The water quality data obtained by DELCORA proved particularly useful in calibration the water quality model, as it contained both wet and dry weather data at various locations within the study area, including both upstream and downstream of the DELCORA CSO discharges.

Calibration of the various models was evaluated using metrics such as total runoff volume, peak flow rates, timing of the flow response, frequency of discharge, water levels, water velocities, and

in-stream water quality concentration. The calibration approach was to adjust model parameters and evaluate changes in model results against the entire calibration dataset, and identify the model values that were most consistent with the central tendencies of the dataset by stream. Each model within the framework was developed and calibrated using the best available data, and found to be reasonably consistent with observed data and therefore reliable to be applied for the Long Term Control Plan Update.

Model Application

The water quality model was applied for the typical year hydrologic period of 1994-1996, which includes one relatively dry year, a relatively wet year, and an average year (DELCORA, 2016b). Modeled POC concentrations were compared to the currently applicable and potential future water quality standards, as described in the table below. The Upper Delaware River and the tidal zones of Chester and Ridley Creek currently have secondary contact water quality standards whereas the Lower Delaware River currently has primary contact water quality standards for bacteria. The boundary between the Upper and Lower Delaware River occurs at river mile 81.8, which is just downstream of Chester Creek and CSO-11.

Table ES-1: Water Quality Standards for Comparisons with Model Results

Segment	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E.coli*[1] (#/100 mL)
Upper Delaware River and Tidal Zones of Creeks	Monthly Geomean: 88 #/100 mL	Monthly Geomean: 770 #/100 mL	n/a
Lower Delaware River	Monthly Geomean: 33 #/100 mL	Monthly Geomean: 200 #/100 mL	Monthly Geomean: 126 #/100 mL Statistical Threshold Value: 410 #/100 mL

1. *E.coli* (EC) standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.M. 81.8, during recreational months only (May 1 - September 30).

Model results were summarized over the stream reaches that receive CSO discharges, and that occur within Pennsylvania water. Generally, the modeling indicated that the *Enterococcus* standards are the most stringent (relative to current concentrations) among the three POCs. Excursions above the WQS are frequent in the two Creeks and infrequent in the Delaware River. The excursions are almost always due to background sources coming from upstream of the DELCORA CSO area. DELCORA CSOs have a relatively smaller (less than 10%, on average) impact on monthly geometric mean concentrations than background sources.

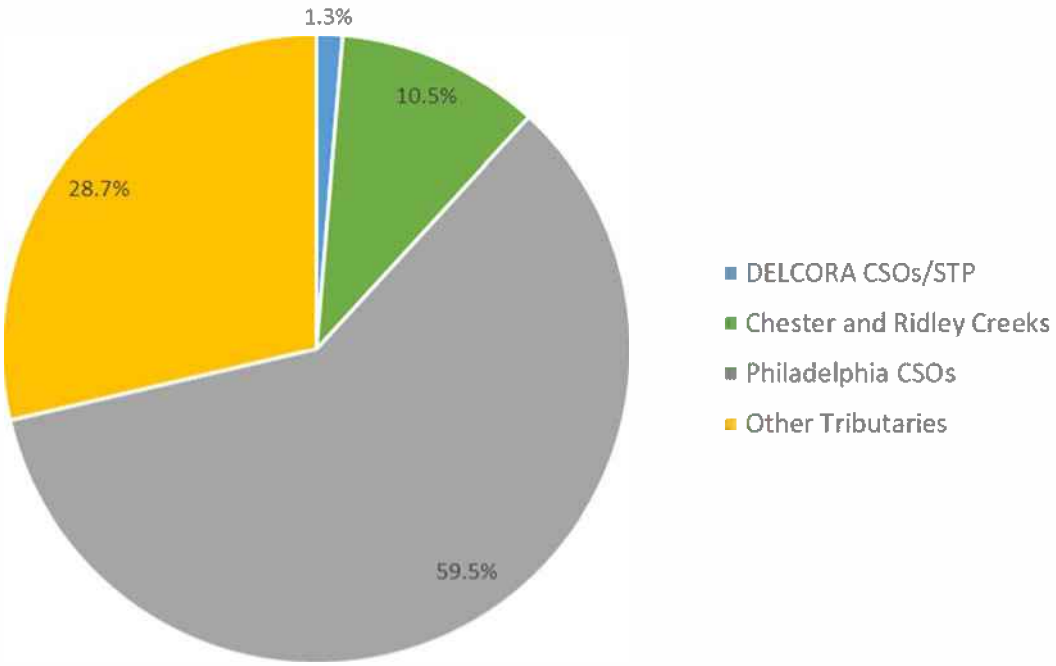
Findings and Implications

A water quality model was developed to compute POC concentrations in the tidal sections of Chester Creek and Ridley Creek, as well as in the Delaware River. Major findings of the modeling are as follows:

- The model is deemed adequate to assess the local water quality conditions in the DELCORA project area, including in the tidal portions of Chester and Ridley Creek, and in the Delaware River from roughly river mile 80 near Marcus Hook Creek, to river mile 85 near Crum Creek.
- Outputs of the hydrologic and hydraulic model relative to volumes and loadings were adequate for utilization as inputs for the development of the water quality model.
- The monitoring data shows that wet weather concentration at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek often exceed the monthly geometric mean WQS concentration for the three POCs. Wet weather exceedances are also observed in the most upstream monitoring location for the Delaware River, but less frequently as compared to the creeks. The *E.coli* statistical threshold value WQS[1] concentration (410 #/100 mL) was exceeded once under wet weather conditions during the sampling periods in the Delaware River.
- The modeling results show that when water quality standards are exceeded during wet weather events, upstream and background sources typically prevent the attainment of both the monthly geometric mean and STV water quality standards.
- The modeling results show that CSOs by themselves do not cause water quality violations in any of the stream segments.
- The DELCORA CSO loads are small compared to upstream and background loads entering the DELCORA project area (Figure ES-1).

[1] E.coli (EC) standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.M. 81.8, during recreational months only (May 1 - September 30).

Figure ES-1: Percent of Bacteria Load by Source



Further, each model within the framework was developed and calibrated using the best available data, and found to be reasonably consistent with observed data and therefore reliable to be applied for the LTCPU. Two major observations can be made from the water quality modeling application results. One is that background sources dominate the modeled POC concentrations (and by extension, DELCORA CSO loads are small compared to background loads, as shown in the figure above), and the second is that the DELCORA CSOs by themselves do not cause non-attainment, or preclude the attainment, of WQS. Moreover, the modeling results show that regardless of additional CSO controls, even complete separation, water quality standards would still be exceeded under current conditions because background sources typically prevent compliance with WQS. While the Consent Decree addresses the issue of background sources by requiring CSO controls to also be assessed assuming that background sources are reduced to 75% of the applicable WQS, it is not clear that imposing CSO controls under these conditions is reasonable given that there is no current plan for reducing background loads in Chester and Ridley Creeks. The CSO Policy states that "where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads". Such apportionment of loads does not currently exist for Ridley and Chester Creeks for bacteria.

The intended use of the water quality modeling framework is to evaluate CSO control alternatives with respect to applicable water quality standards and demonstrate that alternatives selected for the LTCPU program will meet the water quality-based requirements of the Clean Water Act and Consent Decree. The water quality model is adequate to assess presumption levels of control to show that the CSOs after controls are in place do or do not preclude the attainment of water quality standards. The model framework could also be used to assess the demonstration approach, however, as explained in this report, the modeling shows that CSOs alone do not cause WQS violation and do not preclude the attainment of WQS, and background loads are currently causing WQS violations upstream of the CSOs and the CSO influence. Without a State plan for estimating the cost and practicality for controlling the background load upstream of DELCORA's CSO area, it is difficult to justify the demonstration approach.

As such, DELCORA will utilize the presumption approach, which is shown in this report to be reasonable in light of the data and analysis as called for in the National CSO Policy.

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Section 1 Introduction

1.1 Background of DELCORA's Facilities

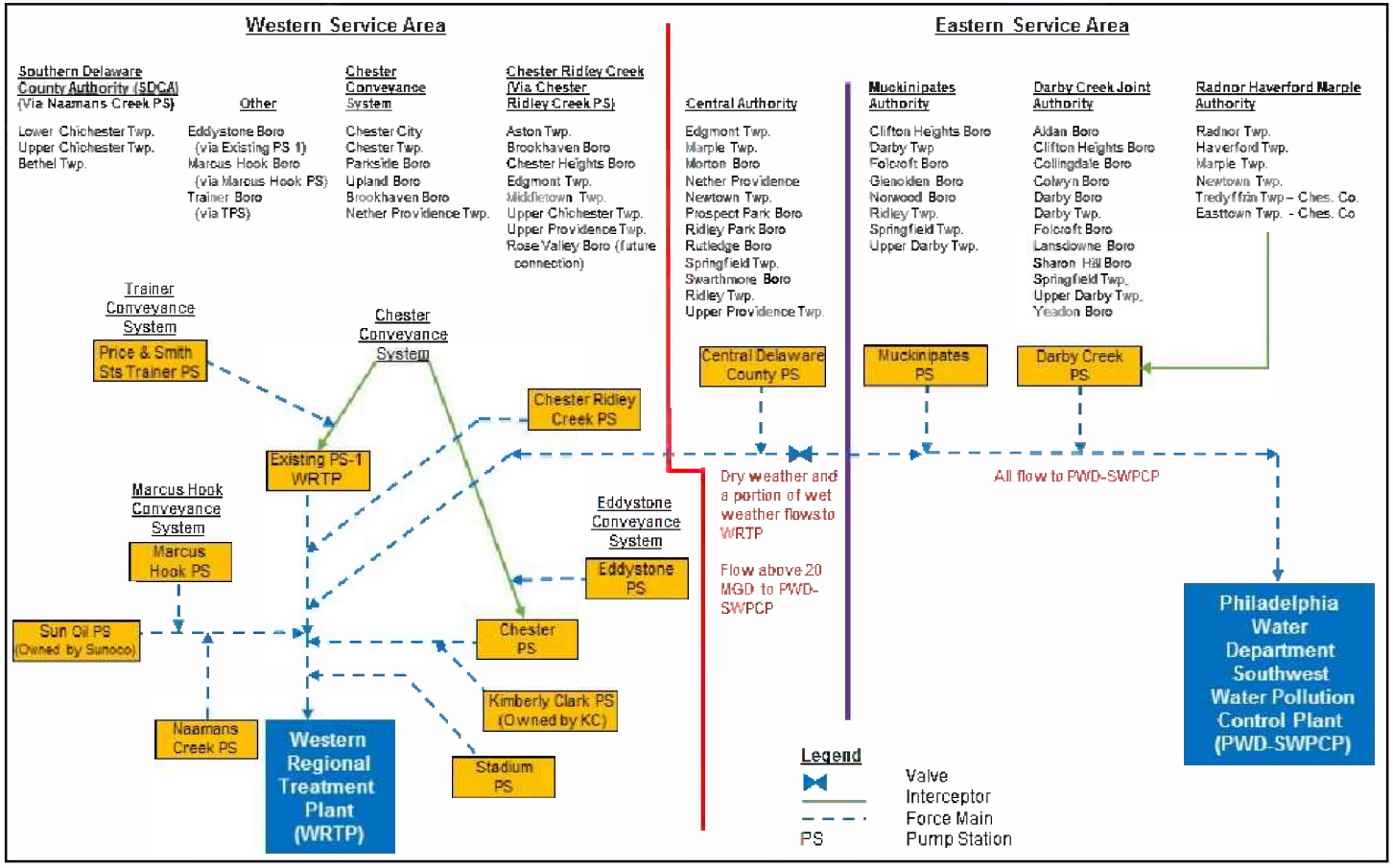
Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA, as shown on Figure 1-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

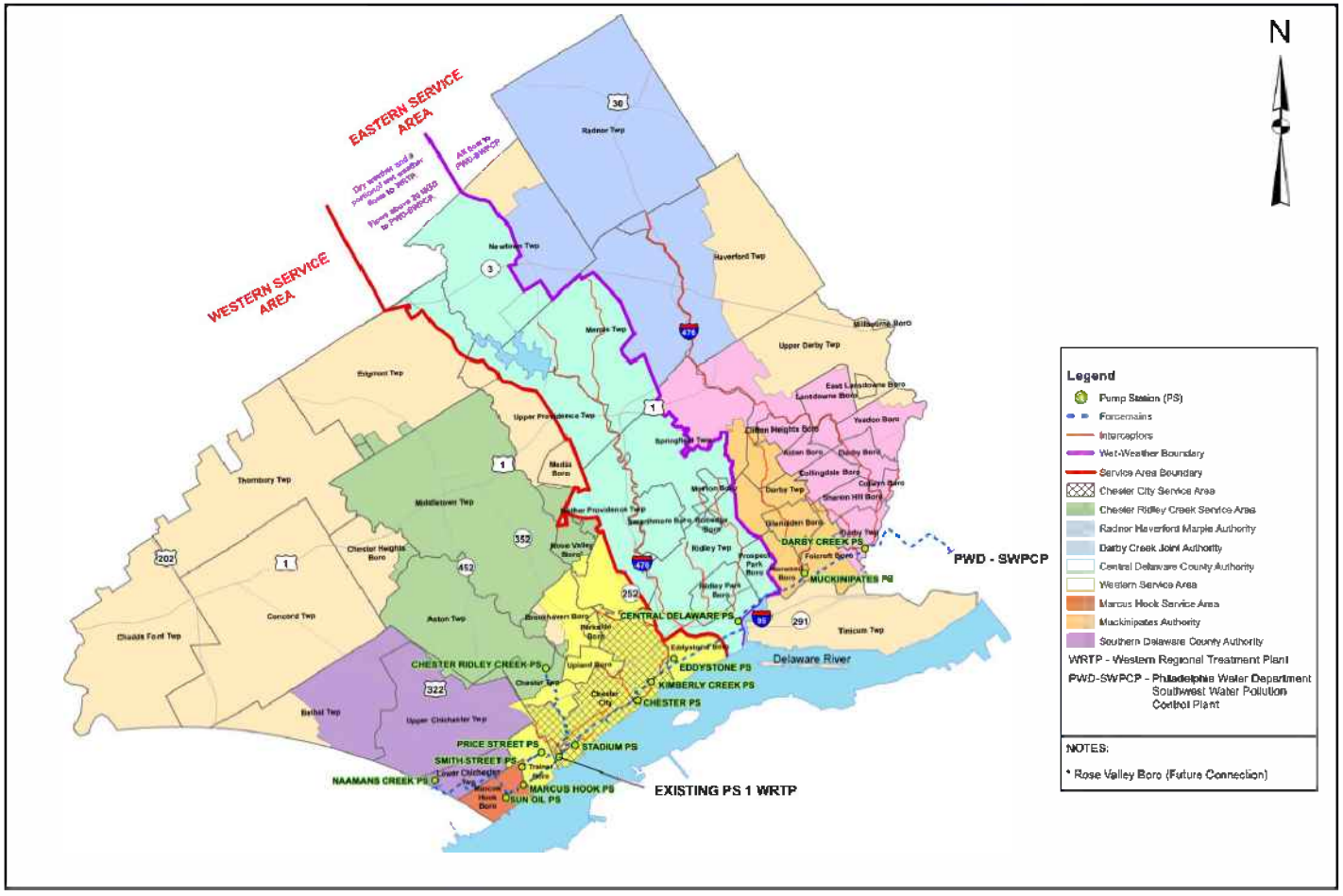
There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four stormwater outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

Figure 1-1: DELCORA's Conveyance System



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN WESTON SOLUTIONS	Figure 1-1 DELCORA'S CONVEYANCE SYSTEM

Figure 1-2: DELCORA's Service Area



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

GREELEY AND HANSEN

Figure 1-2
DELCORA'S SERVICE AREA

Part C – Other Requirements, Section V – Combined Sewer Overflows of the NPDES Permit details DELCORA's responsibilities with respect to the CSO system including reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum to the LTCP until the updated LTCP is approved.

1.2 Consent Decree Requirements

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. The Consent Decree specifies that within sixty (60) days after the approved Water Quality Model Plan is fully implemented according to the schedule included in the Modeling Work Plan, DELCORA shall submit to EPA and PADEP a Water Quality Model Report for review and approval pursuant to Section VI (Review and Approval of Submittals) which shall specifically address each item set forth in Paragraph 15(a)(i)-(vi).

The work plan was first submitted in January 11, 2017 and a revision was submitted in July 31, 2017.

1.3 CSO and Receiving Water System Description

The combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls. The Chester CSO system contains 26 permitted outfalls and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. However, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. Figure 1-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility. Figure 1-3 also provides a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 1-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO. Note that CSO #033 does not appear to overflow during the typical year period. This CSO will be evaluated in the LTCP but, as a practical matter, it does not cause or contribute to WQS being exceeded.

Figure 1-3: Location of Regulators and Combined Sewer Outfalls with Drainage Areas

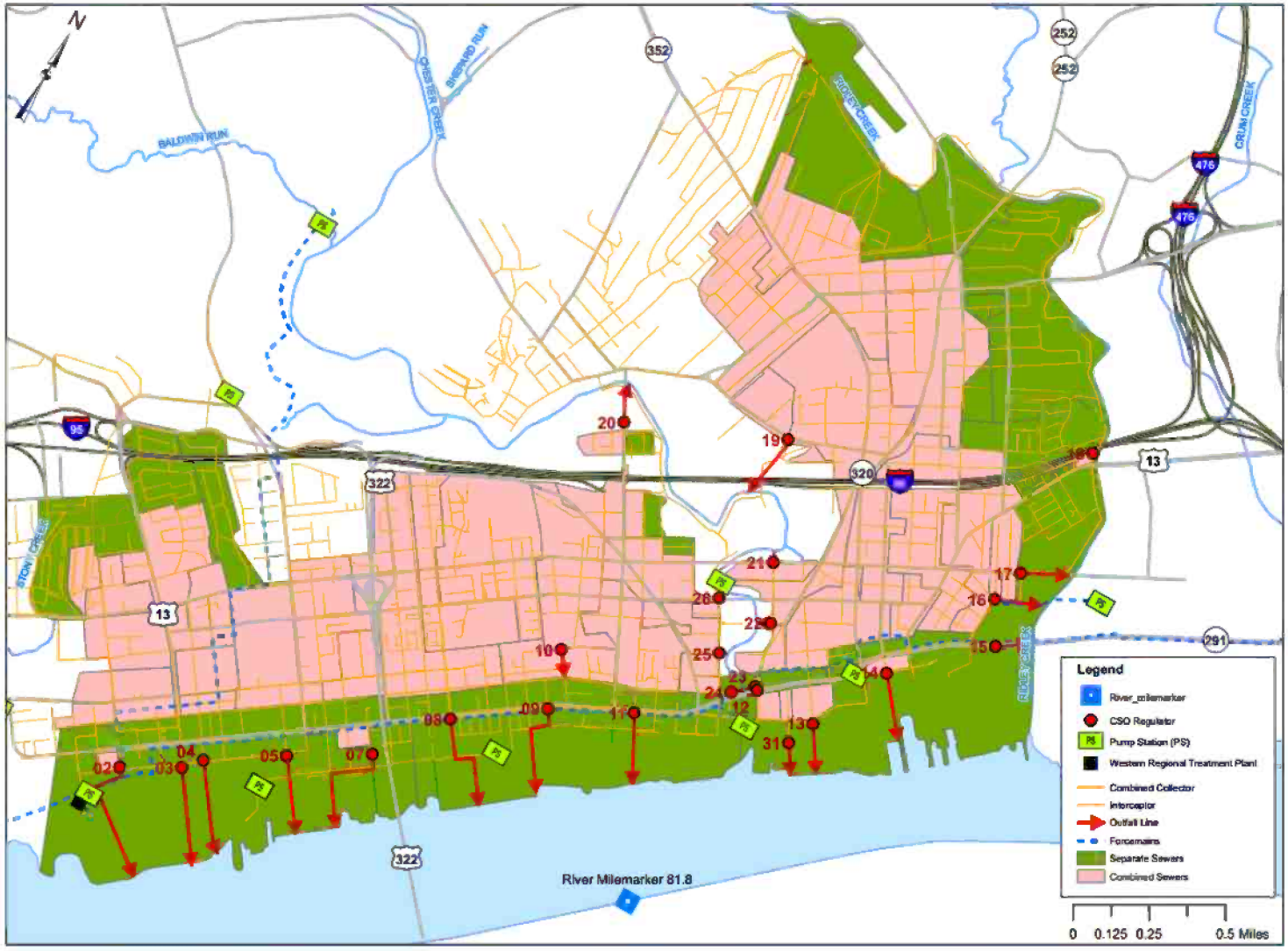
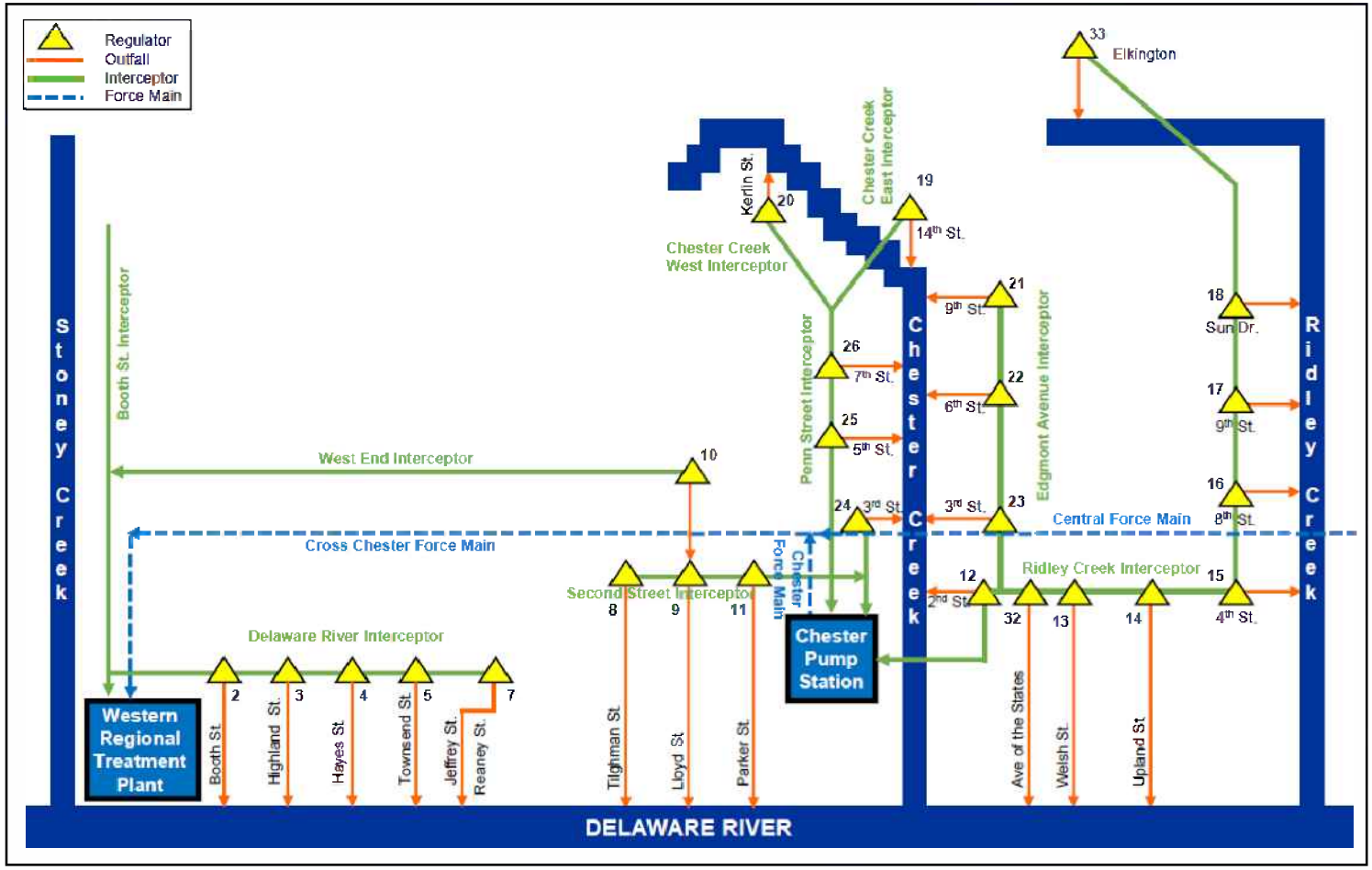


Figure 1-4: Schematic of Chester CSO System



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

GREELEY AND HANSEN

Figure 1-4
SCHEMATIC OF CHESTER CSO SYSTEM

The pollutants of concern (POC) in the receiving waters are described in the "Identification of Sensitive Areas and Pollutants of Concern Report" (DELCORA, 2016a), and include Fecal coliform, *E.coli*, and *Enterococcus*.

DELCORA conducted an extensive wet and dry weather monitoring program between March and June 2017 to better characterize the POC loads within the project area. Site selection and analytical parameters were designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. More information on the DELCORA Water Quality Monitoring Program can be found in Section 4.1.3 as well as in Appendix B.

1.4 Report Purpose and Objectives

This report describes DELCORA's receiving water quality model, which will support the Long Term Control Plan update (LTCPU). Specifically, the report describes the development and calibration of the model, and the initial application of the model to quantify baseline POC water quality conditions in the receiving waters for the typical period. The objective of the water quality modeling was to compute POC concentrations in Chester Creek, Ridley Creek, and the Delaware River, by accounting for all major POC sources within the model domain. Furthermore, the objective of the water quality model is to produce results for the typical period that will serve as the basis for evaluating CSO control alternatives. The primary focus of the water quality model is on the local water conditions, including the tidal zones of Chester and Ridley Creeks, and the Delaware River from roughly river mile 80 near Marcus Hook Creek to river mile 85 near Crum Creek. The intended use of the water quality modeling framework is to evaluate the water quality under typical year conditions and for the LTCP CSO control alternatives.

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Section 2 Water Quality Modeling Software

Three types of models, which comprise the modeling framework, were jointly applied to compute pollutant of concern (POC) concentrations in Chester and Ridley Creeks and the Delaware River:

- A watershed model which simulates flows and POC loads from the Chester and Ridley Creeks watersheds;
- CSO models to simulate flows and POC loads from the DELCORA and Philadelphia Water Department (PWD) combined sewer systems (CSS) to the streams; and,
- A receiving water quality model that computes POC concentrations in Chester and Ridley Creeks and the Delaware River resulting from the various sources of POCs to the streams.

The watershed model framework for this project is the EPA Stormwater Management Model (SWMM), which is supported by the USEPA. SWMM is a dynamic rainfall-runoff simulation model used for single event or continuous simulation of runoff quantity and quality from primarily urban areas (USEPA, 2014). The watershed model is based upon the EPA SWMM, Version 5.1.010, which is consistent with the version used for the CSS model. A variety of enhanced SWMM platforms are available that integrate the EPA SWMM software with user friendly interfaces and GIS capabilities. For this project, PCSWMM, developed by Computational Hydraulics International (CHI), was used.

The DELCORA combined sewer system hydrologic and hydraulic (H&H) model used for this study was developed by Greeley and Hansen (GH) to support DELCORA's Long Term Control Plan Update (LTCPU). The CSS model is based upon the EPA SWMM, Version 5.1, Build 5.1.012 and was applied through the proprietary software InfoSWMM Version 14.5 Update 4, developed by Innovyze (DELCORA, 2017).

A simplified Philadelphia combined sewer system model was developed by LimnoTech to estimate Philadelphia CSO flow and POC load contributions. The reason for including these loads is because large contributions of POCs occur upstream of DELCORA that impact the water quality in the DELCORA project area. The Philadelphia CSS model is also based on the EPA SWMM, Version 5.1.010 model using PCSWMM. Unlike the DELCORA CSS model, it does not represent hydraulics of the Philadelphia combined sewer system; instead it represents the storage capacity of the system and the frequency and magnitude of combined sewer overflows.

The receiving water quality model was developed based on USEPA's EFDC (Environmental Fluid Dynamics Code) modeling framework. This model has been applied to support numerous CSO water quality projects (Lynchburg, VA; Northern Kentucky; Evansville, IN; Cincinnati, OH) and is suitable for representing hydrodynamic and water quality conditions occurring in the Delaware River and its tributaries. EFDC is a state-of-the-art finite difference model that can be used to simulate hydrodynamic and water quality behavior in one, two, or three dimensions in riverine, lacustrine, and estuarine environments (TetraTech, 2007). The model has been applied to hundreds of water bodies across the United States, including in the Delaware Bay and Chesapeake Bay.

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Section 3 Model Configuration and Development

Model configuration and development is the process of configuring a model to represent certain conditions of interest (e.g. combined sewer overflows, or bacteria concentrations) at a particular site. The model development process for DELCORA's water quality modeling framework included definition of 1) important physical and chemical processes, 2) model inputs and assumptions influencing the modeled processes, 3) the spatial extent of model calculations, and 4) the time span of model calculations. This process is described below for each of the components of the modeling framework.

3.1 Watershed Model

3.1.1 Purpose and Description

The purpose of the Chester and Ridley Creek watershed model is to estimate flow conditions in the creeks for periods when USGS flow data for the two creeks are unavailable for the application period. Gage data are available through much of the typical period, except for a long data gap in Ridley Creek (9/22/1995 through 12/31/1996) and some shorter periods at both gages. The watershed model is used to fill in those data gaps, as well as to estimate the flow contribution of the separate storm sewer areas within the DELCORA project area as represented in Figure 1-3.

The watershed model consists of a set of subcatchments representing the hydrology of the system. The subcatchments are connected to a network of stream segments representing the hydraulics of the system. During wet weather events, runoff and associated pollutants are transported from the subcatchments to the stream network, and ultimately discharge to Chester Creek, Ridley Creek, or the Delaware River.

To set up the watershed model in SWMM, processes influencing the system's hydrology and hydraulics were characterized. Several different types of data were used for this characterization. The processes that were modeled and the relevant data that were collected and analyzed for setting up the watershed model are further described below.

3.1.2 Model Processes

The first step in model development is determining what hydraulic and water quality processes should be included. SWMM is capable of modeling six processes: rainfall/runoff, infiltration, snow melt, groundwater, flow routing, and water quality. To meet the objectives of this model three of these processes were used: rainfall/runoff, infiltration, and flow routing. The other three processes were not used or were modified as follows:

- Snow melt: it was assumed that snow melt typically does not generate significant runoff in the DELCORA area, so this process was not included.

- Groundwater: the contribution of groundwater to stream flow was approximated using a base flow time pattern for select model nodes as well as the RTK model for faster interflow response (See Section 3.1.2.3), so explicitly modeling groundwater was not necessary.
- Water quality: water quality was modeled by assigning wet weather and dry weather flow bacteria concentration to the modeled flows. These concentrations were calculated based on the results from the dry and wet weather monitoring program. Explicitly modeling pollutant loads through build-up/wash-off functions was therefore not necessary.

Site-specific watershed data were used to define key inputs and to represent the local relationship between precipitation, runoff, and in-stream flow conditions. These data include area, slope, percent impervious, soil type (infiltration), depression storage, base flow, and Manning's roughness coefficient. General watershed model characteristics for each watershed and the source of information are provided in Table 3-1, and are further explained in the subsections following the table. The modeled hydraulic and runoff response was further refined through the calibration process.

Table 3-1: Watershed Model Characteristics

	Chester Creek	Ridley Creek	Data Source
Annual Precipitation (in)	41.6	41.6	NOAA NCDC (Philadelphia International Airport)[2]
Drainage Area (sq. miles)	65.6	38.2	USGS Streamstats[3]
Imperviousness (%)	13.2	8.5	USGS Streamstats[2]
Average Overland Slope (%)	7.5	7.5	USGS Streamstats[2]
Top Three Land Uses (%)	Residential (45%)	Residential (44%)	Delaware Valley Regional Planning Commission[4]
	Wooded (24%)	Wooded (29%)	
	Agriculture (7%)	Agriculture (13%)	
Dominant Hydrologic Soil Group	HSG B	HSG B	USDA NRCS SSURGO 2016[5]
Average Watershed Yield (MG/mi^2)	10.4	9.2	USGS Gage Data[6]

[2] https://www.ncdc.noaa.gov/cdo-web/
[3] https://streamstats.usgs.gov/ss/
[4] https://www.dvrpc.org/Mapping/Data/
[5] https://websoilsurvey.nrcs.usda.gov/
[6] https://waterdata.usgs.gov

3.1.2.1 Subwatershed Delineations

The watershed model consists of a set of subcatchments representing the drainage area of the Chester Creek and Ridley Creek watershed. For modeling purposes, each tributary's watershed was subdivided into smaller subwatersheds using the hydrologic unit code (HUC) delineations developed by the USGS[7] as the initial basis for the delineation. These HUC 10 subwatersheds were then divided into smaller subcatchments through interpretation of a digital elevation model (DEM) in ArcGIS, and consideration of tributary confluences, flow metering stations, water quality monitoring stations, road planimetric data, and the delineation of the Chester City separate sewer area as well as the combined sewer area. The separate sewer area and combined sewer area were previously delineated by the City of Chester and Greeley & Hansen respectively. Overall, the drainage areas downstream of the USGS gages were divided into smaller subcatchments compared to the upstream areas because more information was available to facilitate the delineations at the subcatchment level. Additionally, the majority of drainage area downstream of the USGS gages also coincides with the focus area of the modeling. The delineation of the two watersheds are shown in Figure 3-1.

3.1.2.2 Meteorology

SWMM requires two meteorological inputs: a precipitation time series to generate runoff, and temperature data to calculate evaporation. Several meteorological stations are located in or near the Ridley and Chester Creek Watershed, as shown in Figure 3-2.

Complete time series for precipitation (hourly and daily), daily minimum and maximum temperatures were available at Philadelphia International Airport from 1948 through current conditions, including the watershed calibration time period of 2006 through 2016. All meteorological data at this station was obtained from NCDC, which is operated by the National Oceanic and Atmospheric Administration (NOAA). The other stations either have incomplete data sets, recordings that do not overlap with the complete calibration period, or the recorded time steps are too coarse (larger time step than hourly). These stations are therefore not suitable for the watershed hydrology calibration.

[7] https://water.usgs.gov/GIS/huc.html

Figure 3-1: Extent of Watershed Model

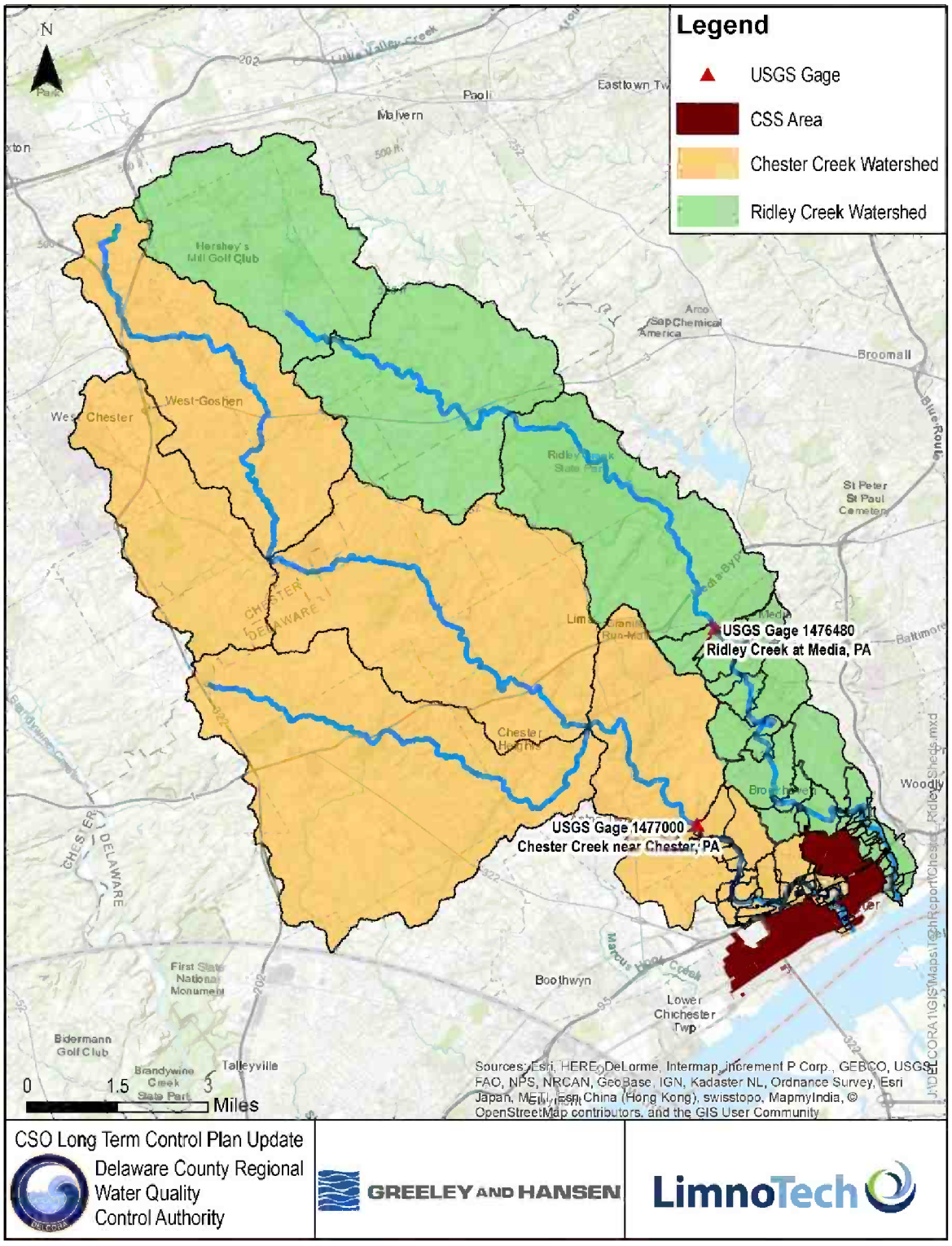
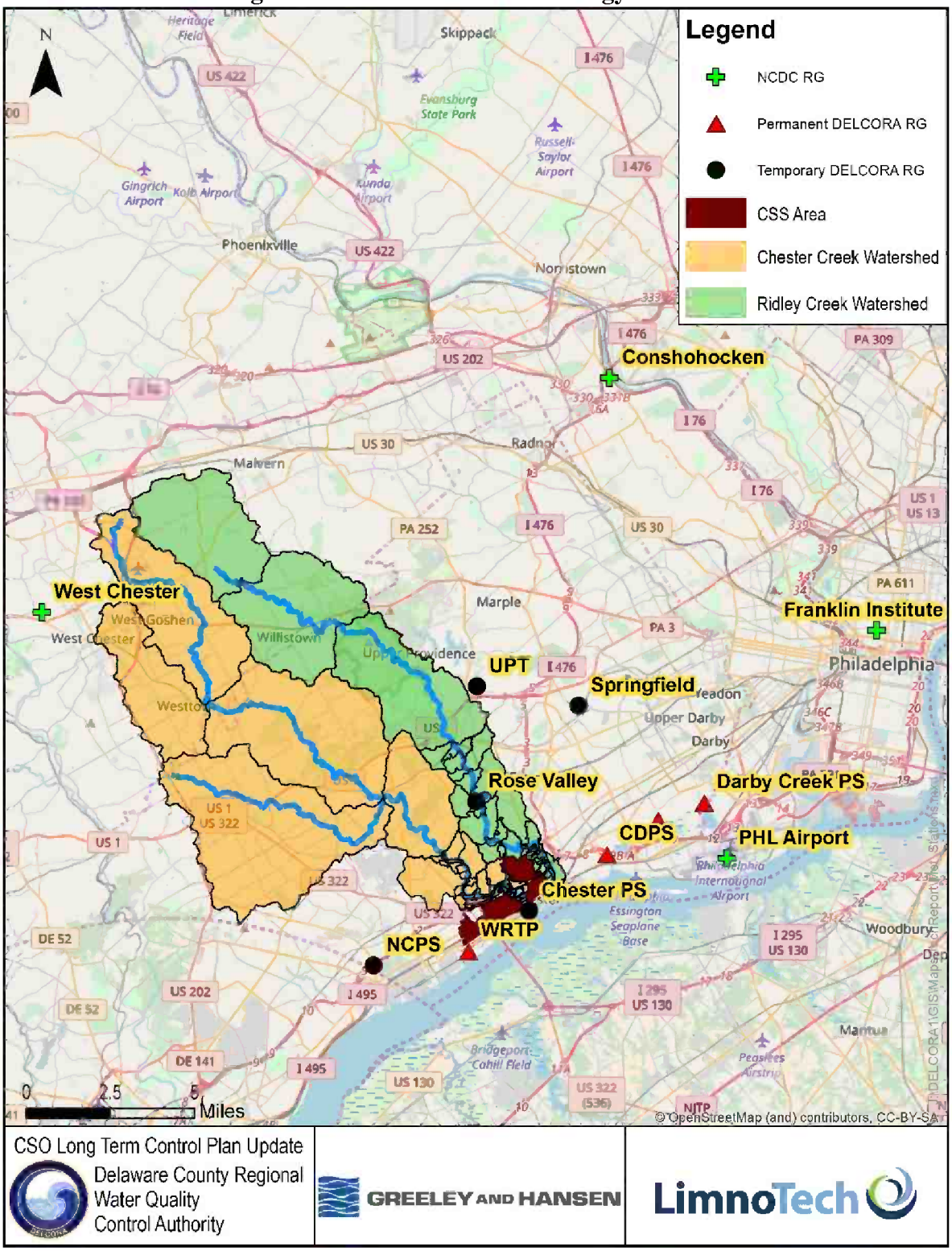
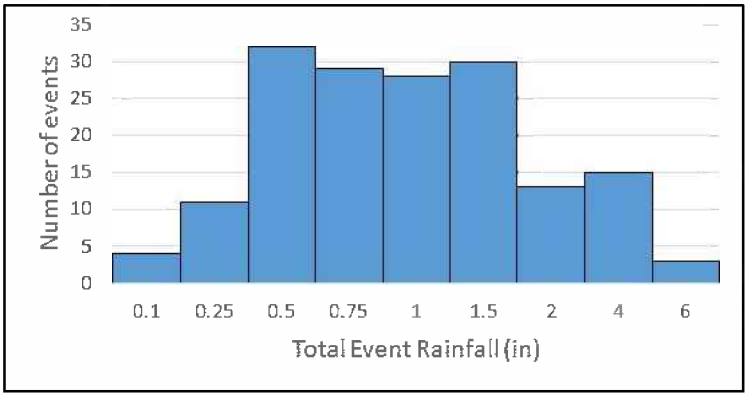


Figure 3-2: Location of Meteorology Stations



The availability of only one gage for the watershed calibration means that the model may be less accurate for rainfall patterns that vary across the watershed. In order to minimize the effect of this spatial variability on the calibration, a set of 165 rainfall events were chosen from the 10-year calibration period when there was consistency between the total rainfall depth at Philadelphia International Airport and the observed flow runoff depth at the Ridley and Chester Creek USGS gages. Two criteria were used to evaluate "consistency" between observed precipitation and flow: (1) precipitation events must increase baseflow by at least 3 times, and (2) the observed flow response occurs within 4 hours of the precipitation event. The selected rainfall events vary in intensity, duration, and overall rainfall depth, as shown in Figure 3-3 below.

Figure 3-3: Watershed Calibration Events: Rainfall Depths



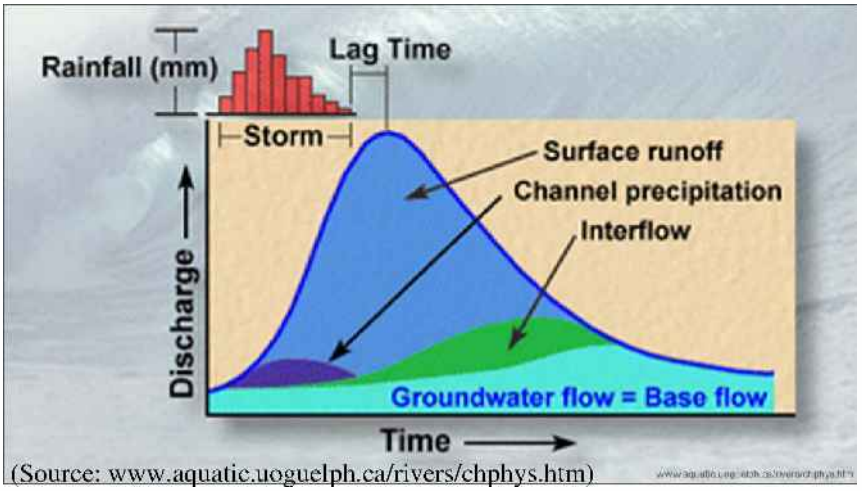
3.1.2.3 Hydrology

The total observed stream discharge relative to a rain event can be separated into different categories of flow, including:

- Channel precipitation: This is flow from rain that falls directly on streams. It represents a very small portion of the total stream flow, but produces an almost instantaneous increase in flow relative to the beginning of a rain event.
- Direct surface runoff: This represents the portion of rain that lands on the ground surface and becomes stormwater runoff. This flow builds up quickly (i.e.: short lag time) relative to the beginning of a rain event, especially in urban areas. Direct runoff can enter streams through overland flow (flow moving over the top of the ground surface) or through a sewer pipe conveyance system.
- Interflow: This is the flow from the portion of rain that infiltrates into the ground and moves laterally through the shallow unsaturated soils towards streams. This flow has a more delayed response compared to surface runoff.
- Groundwater or base flow: This is flow entering the creek from the groundwater table. This flow has a much slower response time to rainfall compared to direct surface runoff and interflow.

A generalized streamflow response to a rainfall event is shown in Figure 3-4 below.

Figure 3-4: Generic Streamflow Hydrograph



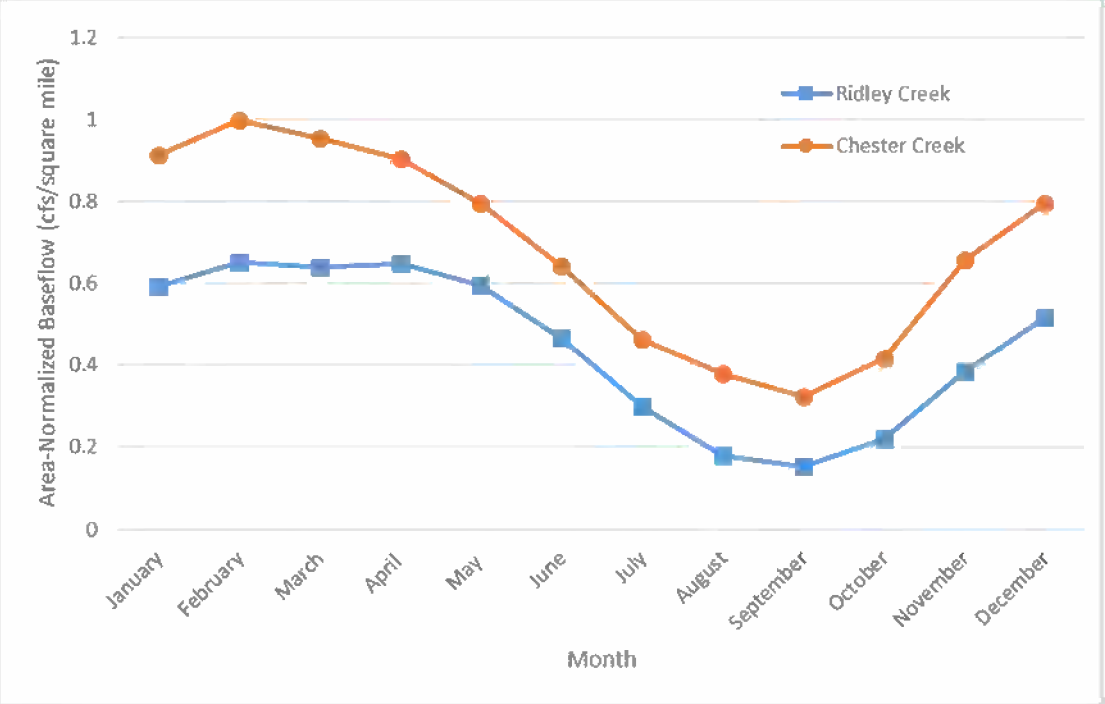
The watershed model simulates the direct surface runoff via the SWMM runoff block using a nonlinear reservoir method. Parameters that influence the surface runoff are explained in the subsections below.

Initial model results and comparisons with observed stream flows at the USGS gages indicated a significant interflow response during wet weather. Interflow was therefore simulated using the RTK approach in the SWMM model since sufficient data for explicit groundwater modeling within SWMM was not available. RTK is an application of the synthetic unit hydrograph method and is based on fitting up to three triangular unit hydrographs to an observed hydrograph to estimate the fast, medium, and slow stream responses (EPA 2008; Lai, 2017).

Surface Runoff and Channel precipitation are represented by one of the three RTK hydrographs that is generally used to represent inflow to sewers. Interflow is represented by the RTK hydrograph that is used to represent short term infiltration. Base flow is represented by the RTK hydrograph that is used to estimate groundwater flow.

Base flow comprises the majority of stream flow during extended periods of dry weather, and can be estimated from measured flow data time series. The flow records from the two USGS gages at Ridley and Chester Creek were used to approximate base flow within each creek. Using 10 years of flow data, monthly 7Q10 flows were calculated using methods from Risley et al (2008). The 7Q10 flows represent flows in a stream during dry periods and can be estimated on a monthly basis to capture the seasonal variability in these dry flows. These values were then normalized to watershed area (in mi^2) and applied to subcatchments that contribute to the streams and creeks that are included in the watershed model (Figure 3-5). Base flow was added to the watershed model as a constant inflow with monthly variations based on the area of the contributing subwatershed.

Figure 3-5: Area-Normalized Base Flow Values for Ridley and Chester Creek



3.1.2.4 Soil infiltration

SWMM offers several methods for soil infiltration (listed in order of increasing complexity): Curve Number, Horton's, and Green-Ampt. The curve number methodology is a fairly coarse representation of soil infiltration and does not allow for time-and-rain variable soil infiltration variations. The Green-Ampt method requires very site-specific knowledge to characterize infiltration parameters, which were not readily available for this project. Therefore, the Horton method was selected as most appropriate for the watershed model. Horton's method uses a set of parameters that defines the maximum infiltration rate, the minimum infiltration rate, the decay rate for transitioning from maximum to minimum infiltration rates, a recovery rate for transitioning from minimum to maximum infiltration rates, and an overall maximum infiltration volume. These parameters are determined based on the hydrologic soil groups that are present in the watershed model extent.

The hydrologic properties of soils influence how quickly and how much precipitation is converted to runoff. In general, soils can be classified by hydrologic soil group (HSG). There are four basic HSGs, called HSG A, HSG B, HSG C, and HSG D. Soils in group A have the lowest runoff potential, while soils in group D have the greatest runoff potential (Mockus et al., 2004). These four basic classifications can then be broken down into dual classifications such as A/D or B/D. Dual classifications represent soils that are classified as group D because of a high water table, causing them to have a high runoff potential. However, if the water table were lowered, these soils would have a lower runoff potential (such as group A or B).

To characterize the soils within the model extent, data were downloaded from the 2016 Soil Survey Geographic (SSURGO) database provided by the National Resources Conservation Service (NRCS). A wide range of HSGs are represented within the SWMM model extent (Table 3-2). In addition to the four standard categories (HSG A through D), several dual classifications are also represented. These dual classifications were assumed to be undrained, and were therefore assigned the same soil properties as HSG D. Any soil types with no official hydrologic soil group classification were also assumed to be mainly poorly drained and would have a high potential for runoff. Therefore, they were assigned the same soil properties as HSG D.

The soil infiltration parameters associated with each HSG were estimated from tables provided in the *User's Guide to SWMM 5* (James et al., 2010). An average minimum and average maximum value from the suggested range was used for the infiltration rate. In the absence of detailed soil data, the decay constant and drying time were assumed to be the same for all soil types within the model extent, and a maximum infiltration volume was not specified.

Table 3-2: Description of Hydrologic Soil Groups within Watershed Model Extent

Hydrologic Soil Group	Description	Ridley Creek		Chester Creek	
		Area (acres)	% of Total	Area (acres)	% of Total
A	Soils with low runoff potential	7.3	19%	7.0	11%
A/D	Soils with high runoff potential unless drained. Otherwise classified as HSG A.	0.0	0%	0.0	0%
B	Soils with moderately low runoff potential	12.6	33%	27.8	42%
B/D	Soils with high runoff potential unless drained. Otherwise classified as HSG B.	2.0	5%	4.1	6%
C	Soils with moderately high runoff potential	12.0	32%	18.8	29%
C/D	Soils with high runoff potential unless drained. Otherwise classified as HSG C.	3.2	8%	6.8	10%
D	Soils with high runoff potential	1.1	3%	1.1	2%
	TOTAL	38.2	100.0%	65.6	100.0%

3.1.2.5 Impervious Area and Slope

Percent impervious area and percent slope strongly influence the amount of precipitation that runs off to the streams. Large amounts of impervious area and/or high slopes can lead to high-volume and "flashy" runoff. To estimate median percent impervious area for each subcatchment, a high-

resolution land cover raster was downloaded from the Chesapeake Conservancy[8]. Percent slope for each subcatchment was estimated using the National Elevation Dataset (NED) (Gesch et al., 2002). The average percent imperviousness for Chester and Ridley creek are 10% and 8.5% respectively.

3.1.2.6 Other Subcatchment Parameters

In addition to the major subcatchment parameters listed in the sections above, there are five additional parameters that were characterized for each subcatchment: Manning's n coefficient for overland flow over pervious and impervious areas, depression storage for pervious and impervious areas, and percent of impervious area with zero depression storage (Table 3-3). These parameters can be used to adjust the shape and the timing of the hydrograph. For simplicity, these parameters were set to constant values for all subcatchments. The values were selected based on literature values from the SWMM5 manual (James et al., 2010).

Table 3-3: Additional SWMM Subcatchment Parameters

Parameter	Value	Description	Source
Manning's n for overland flow over impervious area	0.018	Average value	Mc Cuen et al. (1996)
Manning's n for overland flow over pervious area	0.25	Dense grass	Mc Cuen et al. (1996)
Depression storage for impervious area	0.075	Average value for impervious surfaces	ASCE (1992)
Depression storage for pervious areas	0.15	Average value for lawns	ASCE (1992)
Percent of impervious area with no depression storage	25%	Default value in SWMM	-

3.1.2.7 Hydraulics and Routing

SWMM offers three methods for routing water through the stream network (listed in order of increasing complexity): steady flow, kinematic wave, and dynamic wave. Dynamic wave was selected for the routing portion of the model. The dynamic wave model can account for channel storage, backwater, entrance/exit losses, flow reversal, and pressurized flow. The dynamic wave model allows for more complex flow conditions than the other routing methods, but requires the use of smaller computational time steps, so choosing this method generally increases the model run times. This method was selected because it has the potential to produce more accurate results.

[8] https://chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/.

3.1.2.8 Stream Network

The stream network that makes up Chester and Ridley Creek upstream of Chester City were developed using two sources. Hydrography data were acquired from the National Hydrography Dataset (NHD Plus), which is developed by USEPA Office of Water and the US Geological Survey (USGS)[9]. This dataset includes nationwide spatial information about a variety of waterbodies, including streams, rivers, lakes, and ponds. NHD Plus was modified using a digital elevation model developed from LiDAR mass points. Modifications of the NHD Plus flow lines were made to align with the lowest nearby digital elevation model (DEM) elevation and with aerial photographs. No bathymetric data was available for the stream network upstream of Chester City, so the channels were assumed to be trapezoidal channels with a connected floodplain. The geometry of the channels were first estimated using the available DEM data, and then modified during the hydrology calibration process. In the tidal regions of the two Creeks, bathymetric data was collected through a field survey and was used to specify the channel geometry in the receiving water model. The bathymetric field survey of Chester and Ridley Creek was conducted in March of 2017, and the results are described in Appendix A.

3.1.2.9 Water Quality

To estimate tributary water quality concentrations, modeled tributary flows were separated into base flow and runoff components. Event mean concentrations for each component were then estimated based on sampling data (see Section 4.1), then later refined during the water quality model calibration process, which is described in Section 4.2. These event mean concentrations were then associated with each flow component (i.e. runoff and base flow) to estimate POC loads in the tributaries. This method allowed for time-variable POC concentrations that are consistent with the timing of the wet weather flow response.

3.1.2.10 Linkage to the EFDC Water Quality Model

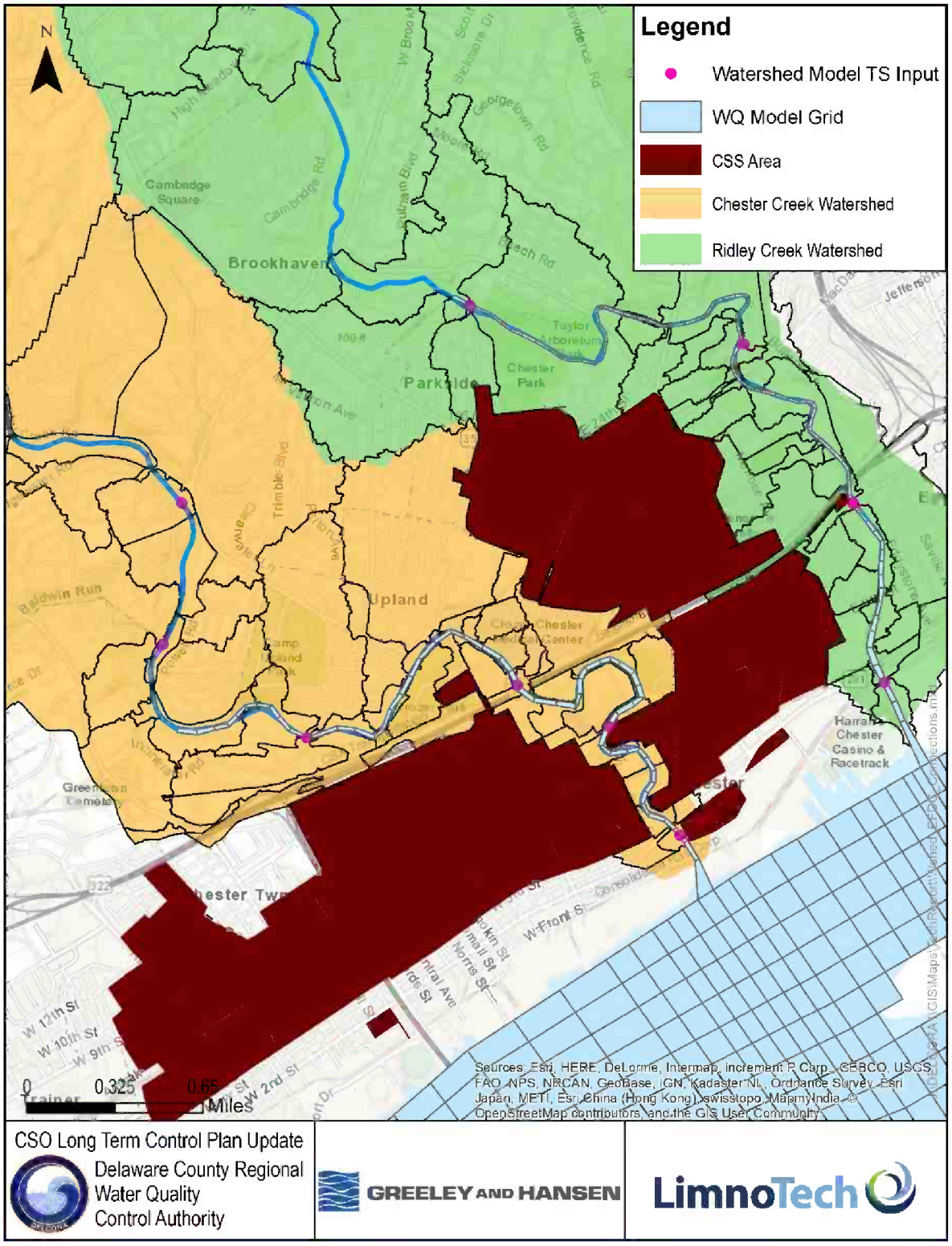
The hydrograph time series (TS) produced by the watershed model were tied into the EFDC at the most appropriate geographic location. These linkages are shown in Figure 3-6.

3.2 DELCORA Combined Sewer System Model Development

The DELCORA combined sewer system (CSS) hydrologic and hydraulic (H&H) model used for this study was developed by Greeley and Hansen (GH) to support the DELCORA Long Term Control Plan Update (LTCPU). This model has been documented in detail in the Sewer System Hydrologic and Hydraulic Model Report (DELCORA, 2017).

[9] https://nhd.usgs.gov/

Figure 3-6: Watershed-Receiving Water Model Connections



3.3 Philadelphia Simplified CSO Model

3.3.1 Purpose and Description

The Philadelphia CSO system is a complex sewer system network managed by the Philadelphia Water Department. It has CSO outfalls located along the Western shore of the Delaware River, the Schuylkill River, Frankford Creek, Pennypack Creek, Tacony Creek, and Cobbs Creek. The bacteria loads from these outfalls contribute to the overall bacteria concentrations in the Delaware River upstream of the DELCORA project area. The Philadelphia CSO model developed for the purpose of this project is a simplified model that approximates the storage volume within the CSO network and magnitude and frequency of Philadelphia CSO discharges and associated POC loads, thereby accounting for Philadelphia CSO POC water quality impacts on the downstream DELCORA service area.

3.3.2 Model Processes

Due to the limited amount of publically available information related to the Philadelphia sewer network, and no publically available calibration data such as metered flows, the Philadelphia CSO model constructed for the purposes of this project is a simplified hydrologic model. It does not explicitly represent the hydraulics of the Philadelphia combined sewer network but rather uses hydrologic functions and parameters available in the SWMM software to approximate the storage volume and flow characteristics within the CSO sewer network, thereby simulating the magnitude (volume) and frequency (timing) of Philadelphia CSO discharges.

Development and calibration of this model relied principally on information from the 2015 and 2016 annual reports of Philadelphia CSO model overflows (PWD, 2015-2016). A summary of information available from these this reports are is shown in Table 3-4. Data from the 2015 annual report was then used to verify the developed model.

Table 3-4: Information Available from the 2016 Philadelphia CSO Model Annual Reports

Receiving Stream	Number of Outfalls (#)	Total Annual Overflow Events (#)	Total Annual Overflow Duration (hours)	Total Annual Overflow Volume (MG)
Cobbs Creek	34	21	46	667
Delaware River	54	33	135	5,025
Frankford Creek	16	39	111	1,000
Pennypack Creek	5	30	165	617
Schuylkill River	41	42	117	2,811
Tacony Creek	15	42	122	2,314

The information presented in the reports helped to constrain model inputs related to the CSS sewersheds, including the total subwatershed area, depression storage, average surface slope, and subwatershed width and length. These parameters were defined for each combined sewer outfall.

Section 4.3 describes how these model inputs were calibrated so that the model accurately computes the volume and frequency of Philadelphia CSOs.

3.4 Receiving Water Model Development

3.4.1 Purpose and Description

The receiving water quality model simulates POC concentrations in the tidal reaches of Chester and Ridley Creeks, as well as in the Delaware River near the DELCORA service area. These modeled POC concentrations will be compared to water quality standards to assess the influence of DELCORA CSO loads on present day water quality compliance. CSO control scenarios will then be simulated within the modeling framework to describe the associated improvements to water quality.

3.4.2 Model Processes

To compute POC concentrations in the receiving waters, the receiving water quality model integrates different known flow and POC contributions, the subsequent transport and mixing of these sources, and the decay of the POCs. Key features represented in the model include upstream Delaware River flows; tributary dry and wet weather flows, tidal conditions, and POC loads from the tributaries, the DELCORA CSOs, and the Philadelphia CSOs. The processes that were modeled and the relevant data that were collected and analyzed for setting up the receiving water quality model are further described below.

Figure 3-7 and Figure 3-8 illustrate the elements related to the development and calibration of the receiving water quality model. These are also further explained in the following subsections.

Figure 3-7: Water Quality Model Extent and Related Features

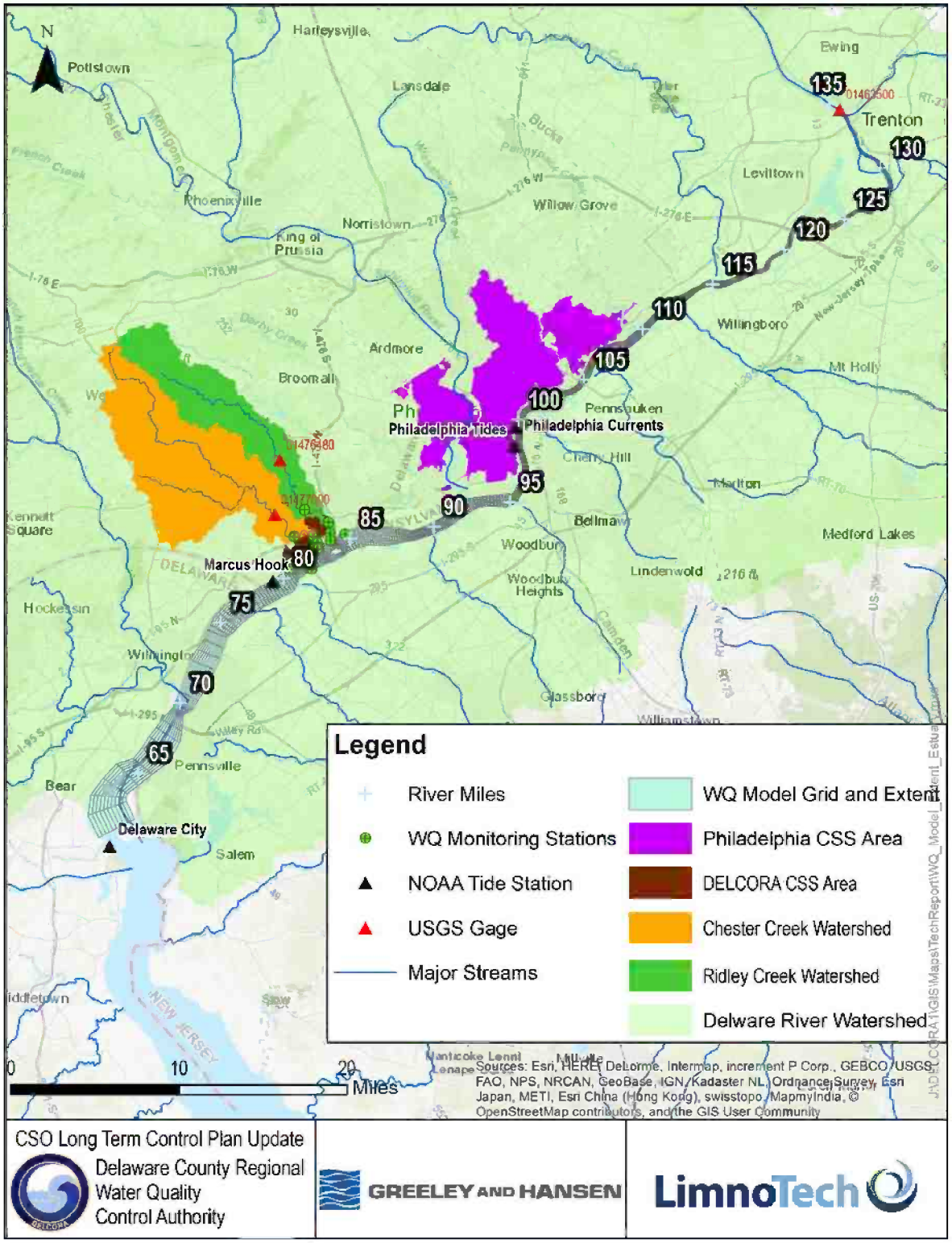
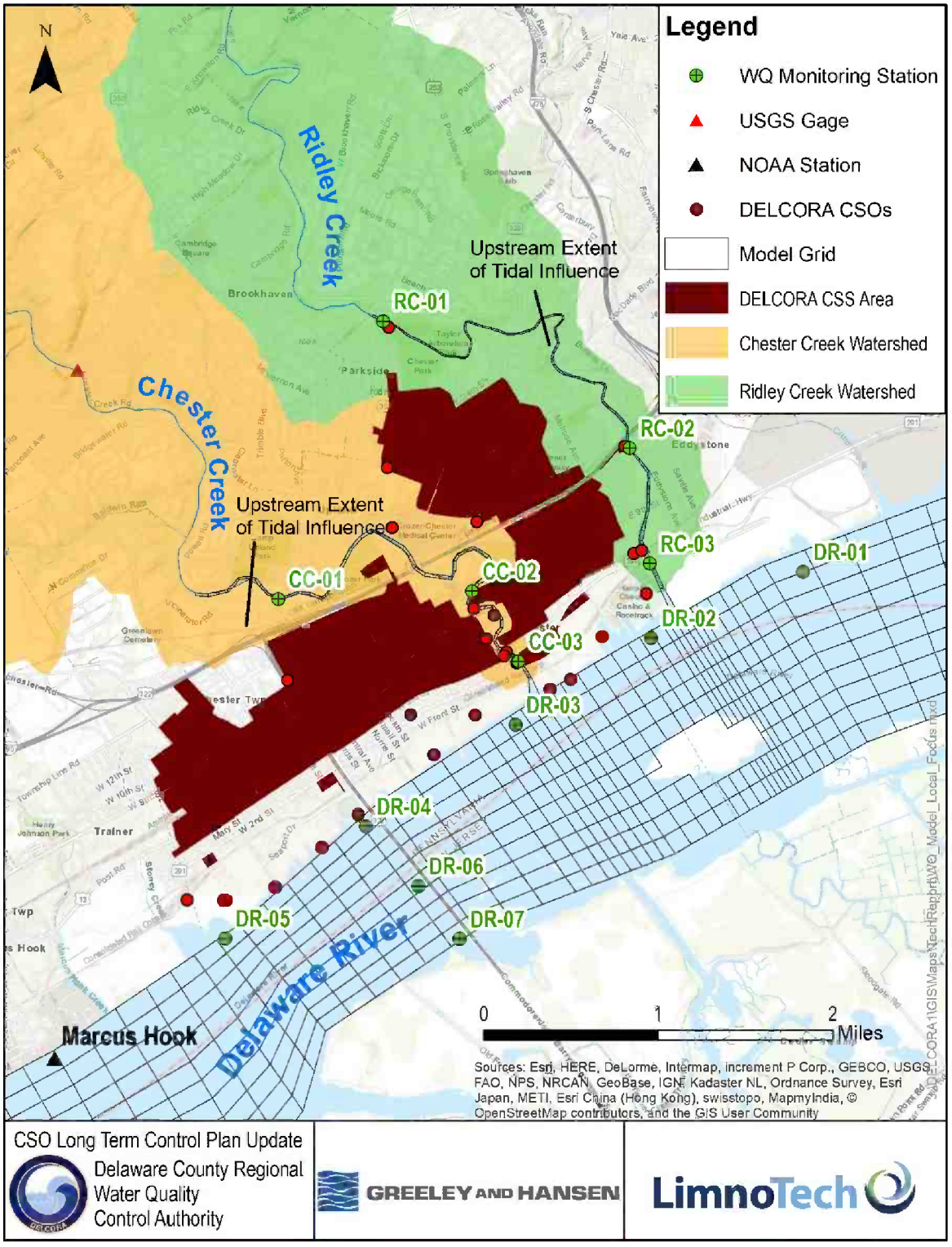


Figure 3-8: Water Quality Model and Related Features near DELCORA System



3.4.2.1 Model Extent and Grid Development

The intended use of the water quality model is to predict the local water quality near the DELCORA combined sewer outfalls. However, the extent of the model is much greater than this localized area in order to appropriately represent the mixing of DELCORA POC sources with background POC sources, and the back-and-forth tidal movement that occurs in the Delaware River. The DELCORA water quality model extends from the head of tide in Trenton, NJ to Delaware City, DE. The upstream limit was chosen because that is the limit of the tidal influence and because there is a USGS flow gage present. The downstream limit was chosen because it is well below the DELCORA CSO discharges and because there is a NOAA tidal station present. Both the USGS flow gage and the NOAA tidal station are used as boundary conditions to the model, as further described in Section 3.4.2.1.

The stream lengths that are represented in the model, along with the average grid cell dimensions are shown in Table 3-5. The model grid has the greatest detail near DELCORA CSOs to describe near-field concentration patterns during periods of CSO discharge, and less detail farther from DELCORA CSOs. Grid cell dimensions in Chester and Ridley Creeks were chosen to be long enough that they would not overly constrain the model time step and short enough that they would follow the sinuous paths of the creeks.

Table 3-5: EFDC Water Quality Model Grid Summary

	Miles of Stream Represented	Average Grid Cell Dimensions (LxWxD)*	Total Number of Cells Used	Average Number of Cells Across Stream Width	Average Number of Layers Through Stream Depth
Delaware River	73	1,000ft x 300ft x 23ft	3,766	10	4
Chester Creek	3.5	320ft x 90ft x 4ft	55	1	1
Ridley Creek	3.5	230ft x 60ft x 2ft	80	1	1

* Cell dimensions vary greatly across the model extent depending on the physical properties of the river.

3.4.2.2 Flow and POC Contributions

The EFDC water quality model includes flows and POC loads from a variety of sources, including:

- DELCORA CSOs, represented by the DELCORA H&H model and entered as flow and bacteria concentration time series at each location where DELCORA CSOs discharge into Ridley Creek, Chester Creek, and the Delaware River.
- Philadelphia CSOs, represented by the simplified Philadelphia CSO model, and entered as flow and bacteria concentration time series at the mouth of the tributaries where CSO discharges occur, or directly to the CSO discharge location along the Delaware River.

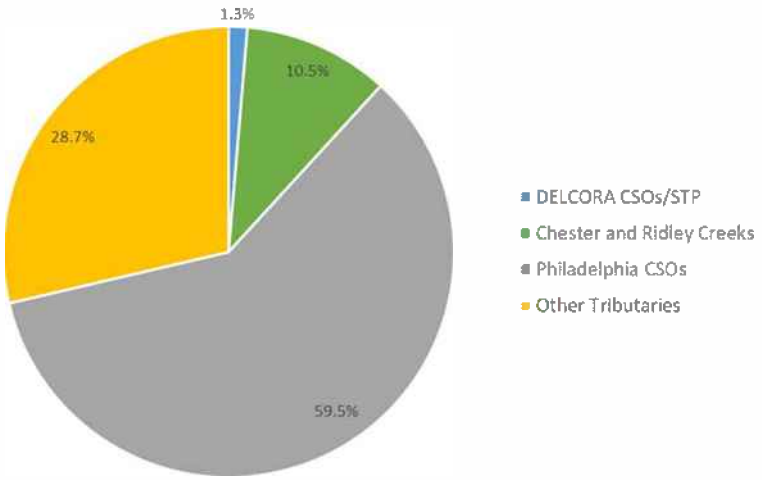
- Ridley and Chester Creek watershed sources, represented by the watershed model or USGS gage data, and entered as flow and bacteria time series at various locations along the two creeks, as explained in Section 3.1.2.9.
- Tributaries along the Delaware River but outside of the DELCORA project area, including, for examples, the Schuylkill River and Darby Creek. These are entered as flow and bacteria time series at the confluence of the tributaries and the Delaware River. The contributions from these tributaries were based on available USGS flow data. Average drainage area ratios were used for the ungaged portions of tributaries, including some tributaries which are entirely ungaged. Bacteria concentrations were estimated as they were for Ridley and Chester Creeks; by separating base flow and runoff and associating EMCs with each flow component, as explained in Section 3.1.2.9.

The respective percent contribution of modeled bacteria load from the different sources are shown in the figure below. The principle loads include the following:

- DELCORA CSO/STP: 1.3% of total load
- Chester and Ridley Creek above the CSO area: 10.5% of total load
- Philadelphia CSO: 59.5% of total load
- Other tributary loads: 28.7% of total load

These modeled bacteria loads were calculated by summing up the total flow contributions from each of the four major sources during both wet and dry weather conditions for the 3-year "Typical Year" application period. These volumes were multiplied by the respective EMC values to calculate the 3-year modeled load and relative percent contribution from each source. It should be noted that the relative contribution from the "Other Tributaries" source is the least constrained by actual monitoring data and is likely much higher in reality than what is shown in the figure. This load has little impact on the water quality and the calibration results near the DELCORA focus area.

Figure 3-9: Percent of Bacteria Load by Source



3.4.2.3 Hydrodynamic Processes

To quantify rates of transport and mixing, the receiving water model represents tidal hydrodynamics in the lower reaches of the creeks and in the Delaware River estuary. The main processes that effect river hydrodynamics include tidal phasing and amplitude, river velocities, flow contributions from tributaries along the Delaware River, and sediment bed resistance (roughness). To simulate the loss of POCs within the receiving water, a first-order, in-stream net decay rate was applied within the model.

Two boundary conditions are used to specify the hydrodynamic and water quality conditions at the upstream and downstream ends of the water quality model. At the upstream end of the model, near Trenton, NJ, flow from USGS gage #01463500 was used to specify the flow coming into the system. At the downstream end of the model, near Delaware City, DE, the Reedy Point NOAA gage #8551910 was used to specify the tidal water surface elevation. Constant bacteria concentrations of 10 #/100 mL were assumed at the upstream and downstream model boundaries, and model tests showed that the boundary conditions had a negligible influence on concentrations near the project area due to the long distances between the boundaries and the project area, and due to bacterial decay. Table 3-6 below summarizes the primary water quality model inputs and supporting data sources.

Table 3-6: Receiving Water Quality Model Inputs and Data Sources

Model Input	Data Source	Notes
Delaware River Bathymetry	NOAA bathymetric soundings	Used most contemporary data available for each reach of the Delaware River
Chester and Ridley Creek Bathymetry	LimnoTech bathymetric soundings	Survey conducted in 2017 (See appendix A)
Tributary Flow Rates	USGS gaged flow data	Used drainage area ratios to estimate flows in ungaged areas
Water Surface Elevations	NOAA 6-minute tidal water level data	Used NOAA gages within the model extent
Water Temperature	USGS daily water temperature data	Delaware River at Chester station (#01477050) Delaware River at Reedy Island Jetty (#1482800)
Meteorological Inputs (e.g. atmospheric pressure)	NOAA hourly meteorological data	Philadelphia International Airport
Upstream Boundary Condition	USGS gaged flow data	Delaware River at Trenton (#01463500)
Downstream Boundary Condition	NOAA 6-minute tidal water level data	Reedy Point station (#8551910)

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Section 4 Model Calibration

Model calibration is described in USEPA guidance (USEPA, 1994) as the "process of adjusting model parameters within physically defensible ranges until the resulting predictions give the best possible fit to the observed data." Model parameters and assumptions were initially defined to the extent possible based on site specific data. However, if site-specific data were not available, model parameters and assumptions were initially defined based on literature values. The calibration process fine-tuned these parameters, within reasonable bounds, to improve model calculations.

4.1 Site Specific Calibration Data

Site specific data used for calibrating the various models include USGS flow data, NOAA tide data, wet and dry weather monitoring within the DELCORA project area, and Delaware River Basin Commission (DRBC) monitoring data. These datasets are explained in further detail in the sections below. Water quality data was organized in a Microsoft (MS) Access database system to ensure consistency in naming and unit conventions, and for ease of extracting information for calibration purposes.

4.1.1 USGS Data

USGS flow data were used to calibrate the watershed model. The information is available through the USGS[10]. Two stations were used for calibration: Ridley Creek gage (#01476480) and Chester Creek gage (#01477000). The time period of 2006 to 2016 was used for watershed calibration, flow data from 2017 was used for the receiving water quality modeling calibration, and the time period of 1994-1996 was used for the typical period application. Availability of gage data during the typical period is variable, with a long period of data missing in Ridley Creek (9/22/1995 through 12/31/1996) and a few multi-day periods missing at both gages during the three year period. A third station at Trenton, NJ (#01463500) was used to specify the upstream boundary condition for the Delaware River portion of the water quality model. The locations of the USGS gages are shown in Figure 3-7.

4.1.2 NOAA Tide Data

Tide data representing tidal phasing (timing), amplitude (variations in water surface elevation), and current velocity (water speed and direction) were used to calibrate the hydrodynamic component of the water quality model. This information is available through NOAA[11]. Two tidal stations were used for calibration: the Philadelphia station (#8545240) and the Marcus Hook (#8540433) station. A third station at Reedy Point (#8551910) was used to specify the downstream boundary condition for the Delaware River portion of the water quality model. NOAA data from

[10] https://waterdata.usgs.gov/nwis
[11] https://tidesandcurrents.noaa.gov/

2017 was used to calibrate the hydrodynamics of the water quality model. The locations of the NOAA gages are shown in Figure 3-7.

4.1.3 DELCORA Wet and Dry Weather Monitoring Program

DELCORA conducted an extensive wet and dry weather monitoring program between March and June of 2017. Water quality data from this monitoring program was used to calibrate the water quality component of the water quality model and to set initial values for the dry weather, stormwater, and CSO POC event mean concentrations (EMCs). Monitoring was undertaken at thirteen (13) in-stream locations (seven on the Delaware River, three on Ridley Creek, and three on Chester Creek), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) stormwater locations in the City of Chester municipal separate storm sewer system, as shown in Figure 3-7 and in more detail in Figure 4-1.

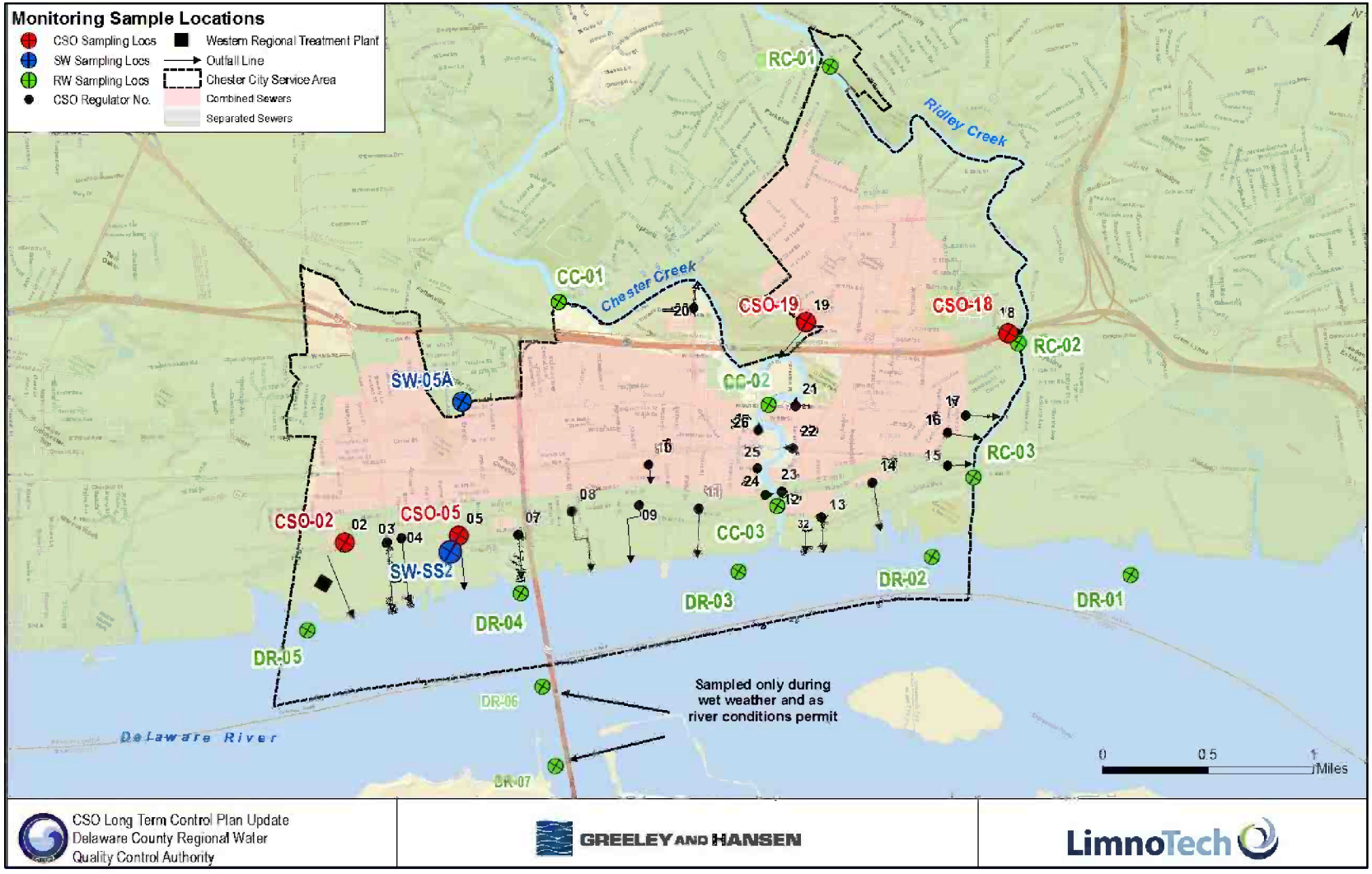
Monitoring locations were selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters are designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The POCs sampled were Fecal coliform, *E.coli*, and *Enterococcus*.

Water quality monitoring and sampling was conducted as follows:

- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area were sampled for water quality for (3) dry weather events. The mid-stream and far-shore Delaware River locations were not sampled during the dry weather surveys because the water quality in the river is found to be relatively uniform laterally due to the lack of active sources during dry weather. These dry weather events were distributed across the sampling season, which was from March through June of 2017. Grab samples and *in situ* measurements were collected at each location during each event.
- All thirteen (13) in-stream locations were sampled for water quality using grab samples and *in situ* monitoring for three (3) discrete wet weather events.
- Up to four (4) CSO and two (2) stormwater outfall locations were sampled for water quality for the same three (3) discrete wet weather. Samples for all outfalls were collected as grab samples.

The sampling events were planned and distributed across the sampling season, which was from March through June 2017.

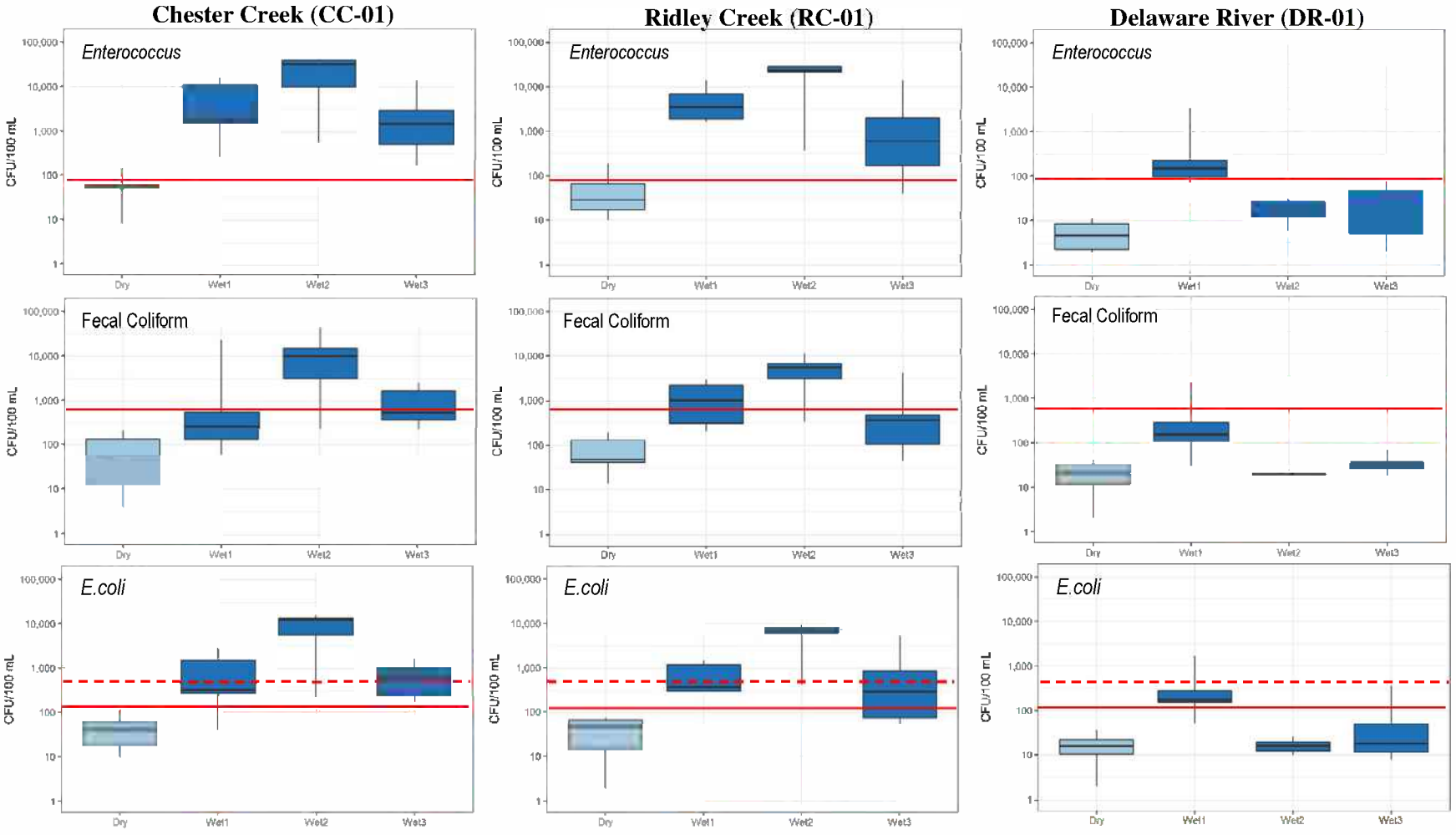
Figure 4-1: Receiving Water, Combined Sewer (CSO), and Stormwater (SW) Monitoring Locations



Detailed information on the results and observations from the DELCORA Water Quality Monitoring Program can be found in Appendix B. Some general observations are summarized below and shown in Figure 4-2.

- Dry weather POC concentrations at the most upstream locations (RC-01, CC-01, DR-01) in the creeks tended to be similar to each other;
- Dry weather concentrations at the most upstream locations (RC-01, CC-01) were mostly, but not always, below numeric thresholds used for water quality standard (WQS) criteria in the tributaries, and were well below WQS numeric thresholds in the Delaware River (DR-01);
- An increase in dry weather POC concentration from upstream to downstream was observed in each of the tributaries, suggesting there may be significant but currently unknown bacteria sources impacting these tributaries during dry weather. This occurs between sampling stations RC-01 and RC-02 in Ridley Creek and between CC-01 and CC-02 in Chester Creek, and is most pronounced for Fecal Coliform and *E.coli*;
- Wet weather concentrations at the most upstream monitoring locations in Chester Creek (CC-01) and Ridley Creek (RC-01) often exceed the monthly geometric mean WQS criteria for the three POCs. These stations are located upstream of the tidal influence, and the exceedances indicate that upstream areas of Ridley and Chester Creeks do not currently meet WQS (Figure 4-2). These data furthermore indicate the practical impossibility of meeting WQS through downstream CSO control.
- Wet weather concentrations at the most upstream monitoring location in the Delaware River sometimes also exceed numeric thresholds used for the monthly geometric mean water quality standard criteria, but less frequently as compared to the creeks. The E.coli statistical threshold value WQS was exceeded once under wet weather conditions during the sampling periods.
- The time series profiles in the Chester Creek and Ridley Creek waterbodies indicate that DELCORA's CSO discharges and Chester's stormwater discharges are not the only sources impacting these tributaries during wet weather. Upstream sources also contribute to high bacteria concentrations during wet weather events.

Figure 4-2: Sampling Results at Most Upstream Sampling Locations in the Creeks and the Delaware River



STV WQS (E.coli: 410 CFU/100ml (proposed); Fecal Coliform and Enterococcus: no STV standard)
Monthly Geometric Mean WQS (E.coli: 126#/100ml (proposed); Fecal Coliform: 770#/100ml; Enterococcus: 88#/100ml)

4.1.4 DRBC Monitoring Data

The Delaware River Basin Commission conducts regular monitoring of bacteria through its "Delaware Estuary Boat Run" program[12]. Ambient samples are collected monthly along the navigational channel from the head of tide at Trenton, N.J. to the mouth of the Delaware Bay. Samples are collected at 22 stations, once monthly from April to October. Data collected in 2012 were used to validate the water quality component of the water quality model, especially outside of the DELCORA project area, to evaluate the accuracy of modeled POC loads from the Philadelphia CSOs and the Schuylkill River, which are estimated to be the largest POC loads to the estuary. The locations of the DRBC monitoring locations are shown in Figure 3-7.

4.2 Watershed Model Calibration

The modeled hydraulic and runoff response was refined through the calibration process. In this process, the percent impervious, Manning's roughness, RTK interflow and base flow parameters were adjusted within defensible (literature) ranges so that modeled runoff volumes and peak flows were consistent with the observed flow data. Runoff response was calibrated using 165 wet weather events from 2006 to 2016. The rainfall events were chosen to represent a range of different intensities, duration, and rainfall depth. Moreover, these events were chosen when there was consistency between the total rainfall depth at Philadelphia International Airport and observed flow at the Ridley and Chester Creek USGS gages. Two criteria were used to evaluate "consistency" between observed precipitation and flow: (1) precipitation events must increase baseflow by at least 3 times, and (2) the observed flow response occurs within 4 hours of the precipitation event. Calibrating to this subset of events helps minimize the effect of issues with spatial variability of rainfall.

Calibration was evaluated both on total runoff volume, peak flow rates, and timing of the flow response. Various types of plots were used to help assess the calibration, including 1-to-1 plots, event-based time-series hydrographs, and bar charts. To evaluate the overall reasonableness of the watershed calibration, a weight of evidence approach (USEPA, 2015b; Donigian, 2002) was applied using several evaluation metrics, including:

1. Goodness of fit based on correlation coefficients for a wide range of calibration events;
2. Visual checks on continuous time series hydrograph data; and
3. Long term annual performance.

The performance of the model was first evaluated using 1-to-1 plots for comparisons of wet weather event flow volume and peak flows. This is illustrated in Figure 4-3. Both the correlation coefficient (R^2) and the Integral Square Error (ISE) can be used as measures of goodness-of-fit between observed and modeled hydrographs (Sarma, 1969). Overall, the watershed model performed satisfactorily for the total event volume and for the peak flow rates, as shown in the

[12] http://www.state.nj.us/drbc/quality/datum/boat-run.html#3

table below. The slope of each trend line is nearly 1, indicating that the modeled runoff response is unbiased.

Table 4-1: Watershed Model Performance Metrics

	Ridley Creek		Chester Creek	
	R^2	ISE	R^2	ISE
Total Event Volume	0.778 (Good)	5.6 (Very Good)	0.778 (Good)	4.61 (Very Good)
Peak Flow Rate	0.61 (Fair)	8.84 (Good)	0.605 (Fair)	7.2 (Good)

In addition to 1-to-1 plots, a visual check of flow time series (hydrographs) was conducted for the time period of March through May of 2017, when wet weather water quality sampling was conducted. Figure 4-4 and Figure 4-5 compare the observed and modeled flow hydrographs for Chester and Ridley Creeks respectively. The modeled response to the rainfall at the Philadelphia Airport closely tracks the gaged response observed at the two USGS gages. The timing of the peaks occur as expected relative to the occurrence of the rainfall event and to the observed data, providing confidence that the routing parameters used were adequately calibrated. The hydrograph figures also support the previous conclusion that overall, the model predicts volume well, but slightly over predicts peak flow rates. The hydrographs show that the model tends to under predict the effect of baseflow and interflow, despite using the SWMM RTK function.

The hydrograph figures show that there was a notable discrepancy between the observed data and modeled results for the event labeled as "Wet Weather Event 3". This event and other specific wet weather events like this where the modeled runoff volume differed significantly from the observed runoff volume were reviewed more closely. Based upon this review, it was concluded that notable deviation between modeled and observed runoff volumes can occur when rainfall is not uniform over the watershed (e.g. when rainfall is concentrated in a small portion of the watershed) due to the fact that a single rain gage (Philadelphia Airport) is used in the watershed model to represent rainfall conditions over the entire watershed.

In the case of Wet Weather Event 3, the rainfall was concentrated in the vicinity of the City of Chester and areas east of the Delaware River (Figure 4-6). So while the observed rain at the Philadelphia Airport is significant (0.51 inches), very little rainfall fell in the upstream areas of the Ridley and Chester watersheds (less than 0.1 inches), and consequently, very little wet weather flow was observed at the two USGS flow gages (consistent with what would be expected from a small (<0.1-inch) rainfall event) whereas the model predicted more flow (consistent with what would be expected from a 0.5-inch storm).

While the limited number of rainfall gages is a constraint on the accuracy of the watershed model for a single wet weather event, on a long term basis (such as the three year typical hydrologic period) the model provides reasonably accurate estimates of creek flow, as demonstrated in Figure 4-3 on the previous page. In other words, even if an individual event was modeled too high or too low, on a long term basis, the model produces a typical response to rainfall conditions and yearly modeled creek flows during dry weather and wet weather are consistent with the observed data.

Figure 4-3: 1 to 1 Watershed Model Wet Weather Calibration Plots

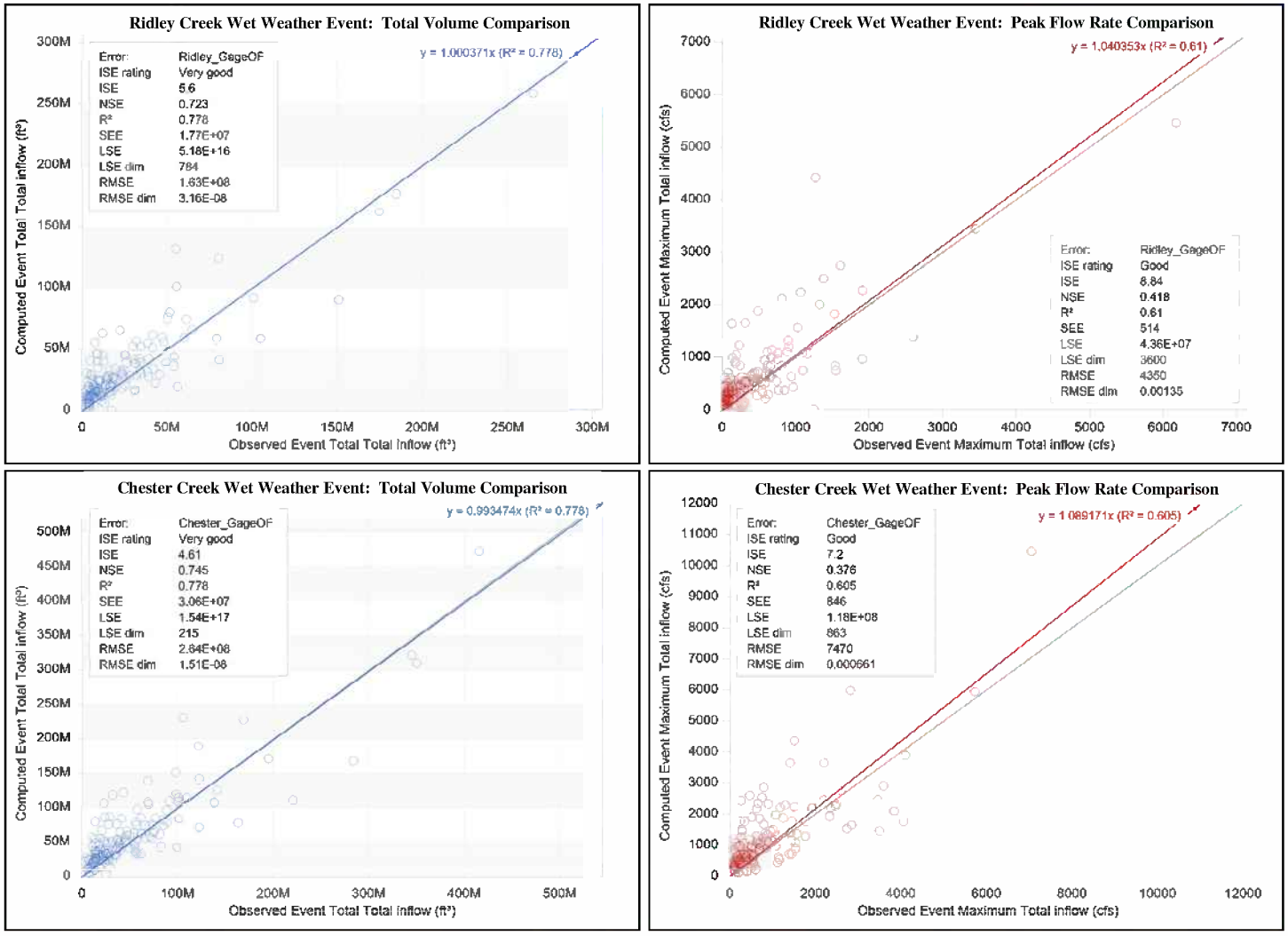


Figure 4-4: Chester Creek - Comparison of Modeled vs. Observed Flow Hydrograph

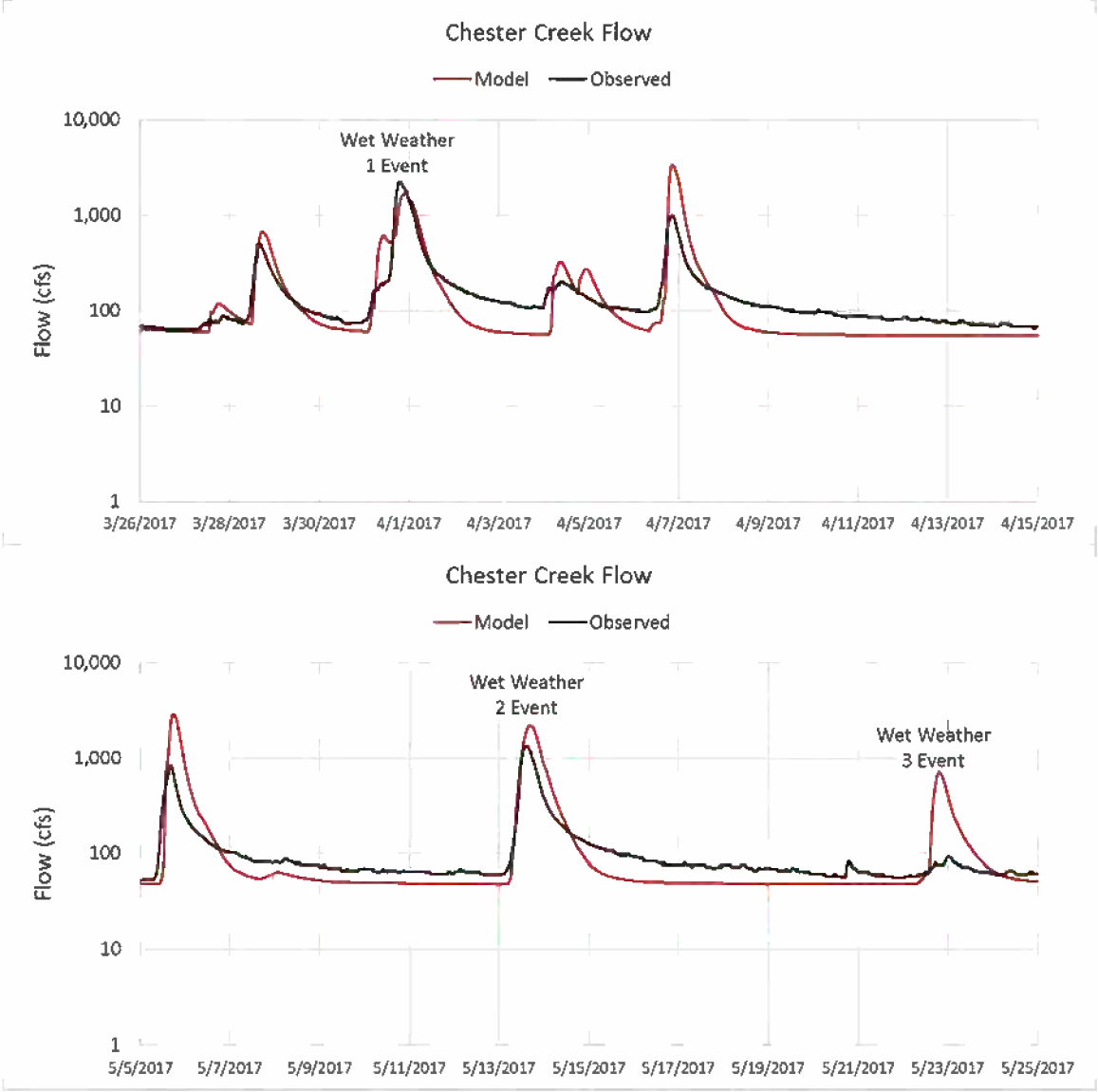
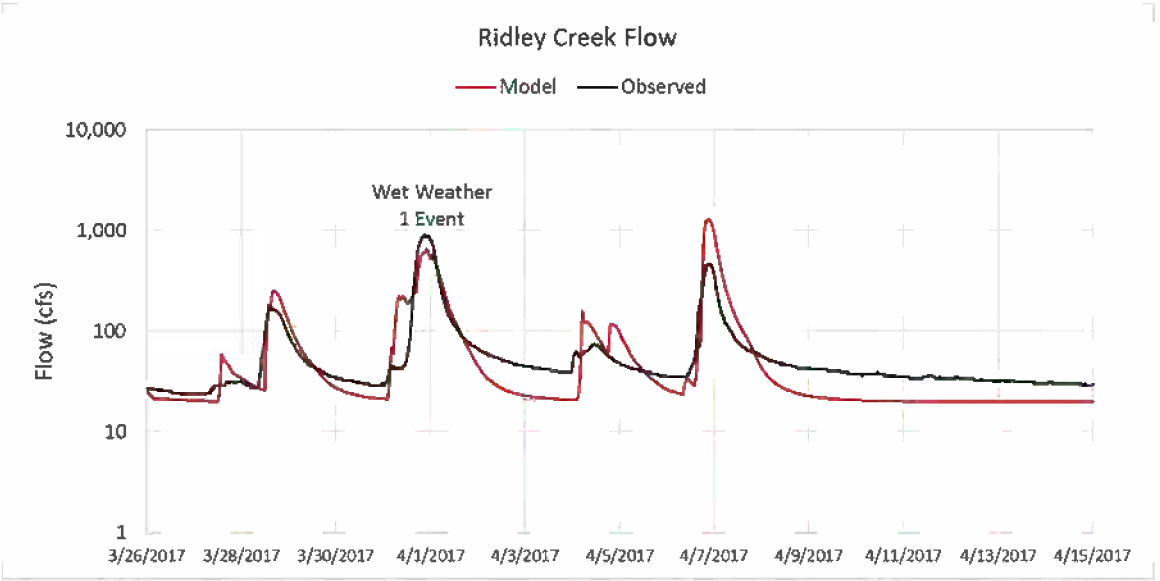


Figure 4-5: Ridley Creek - Comparison of Modeled vs. Observed Flow Hydrograph



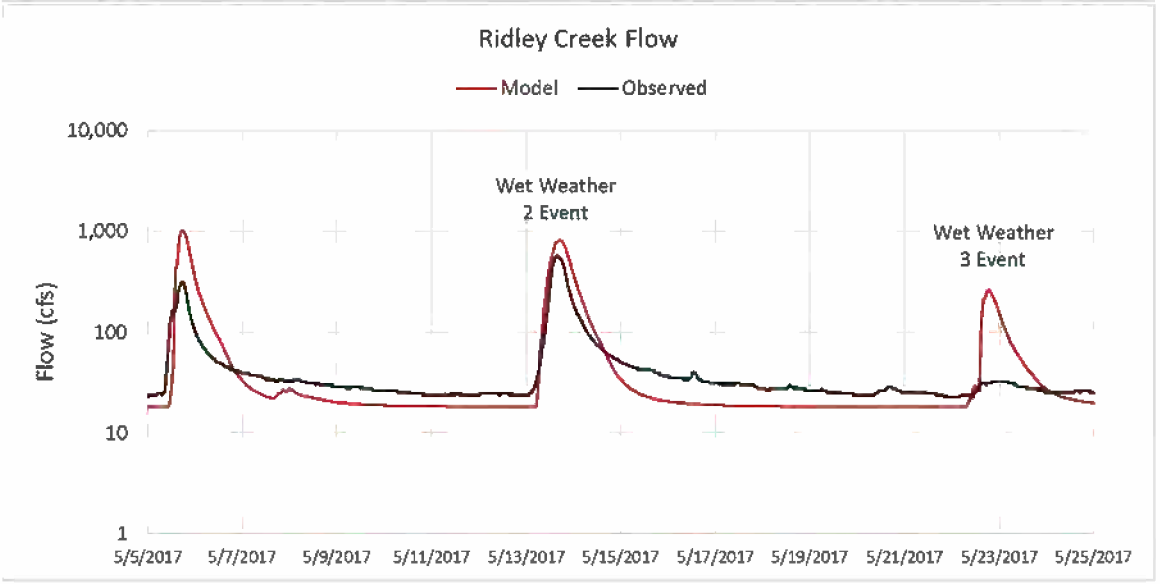
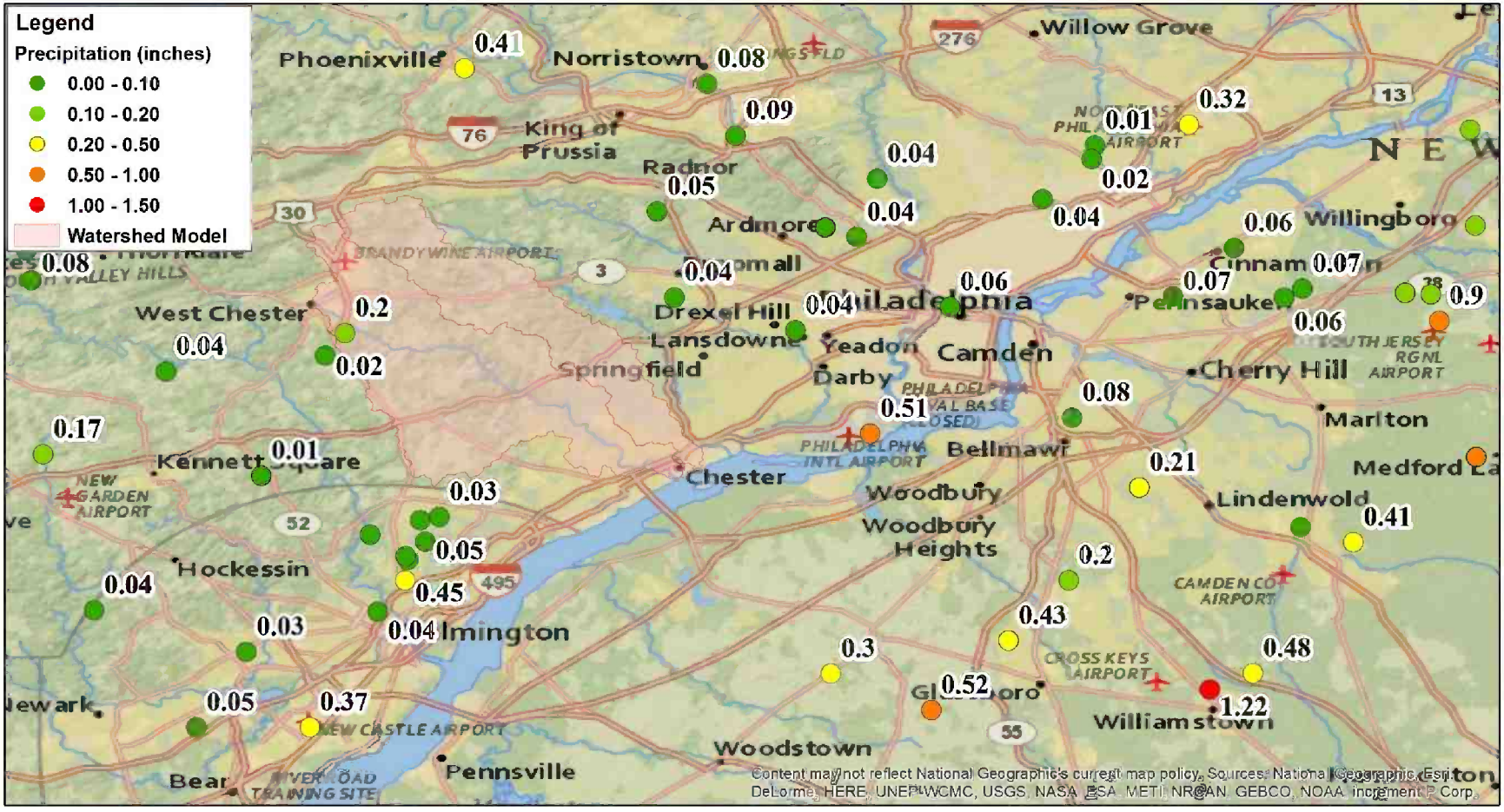


Figure 4-6: Rainfall Distribution for Wet Weather Event 3 (May 22, 2017)



In addition to evaluating the performance of the watershed model on an event basis, the overall annual performance was evaluated. This analysis accounts for contributions from base flow, interflow, and runoff, and compares the model performance against observed flow volume at the USGS gages. The results are shown in the table below and in Figure 4-7.

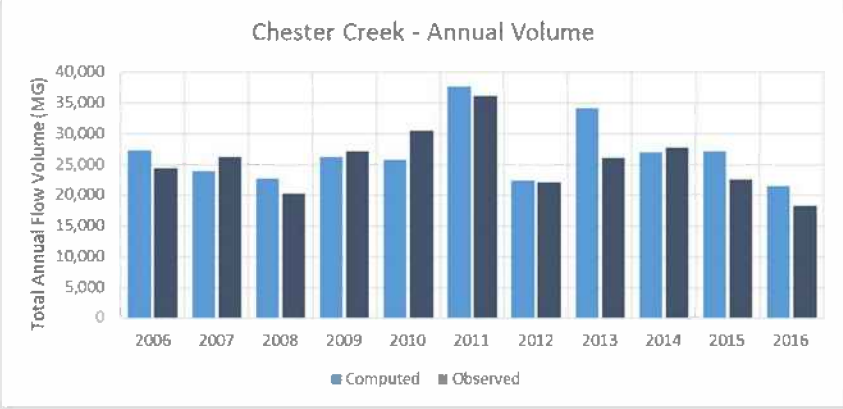
Table 4-2: Watershed Model Overall Annual Performance

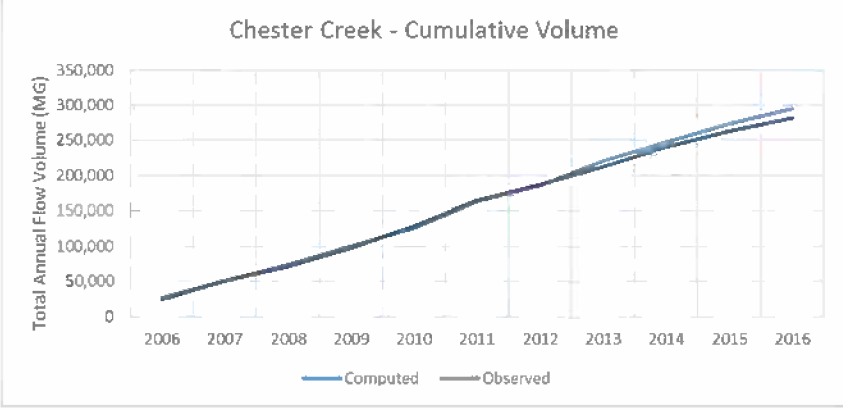
	Chester Creek			Ridley Creek		
Year	Modeled Volume (MG)	Observed* Volume (MG)	Percent Difference	Modeled Volume (MG)	Observed* Volume (MG)	Percent Difference
2006	27,324	24,340	12%	13,093	10,865	21%
2007	23,999	26,172	-8%	11,086	12,005	-8%
2008	22,674	20,278	12%	10,460	8,101	29%
2009	26,255	27,175	-3%	12,486	11,540	8%
2010	25,762	30,512	-16%	12,234	13,539	-10%
2011	37,727	36,184	4%	18,844	16,794	12%
2012	22,375	22,068	1%	10,297	9,390	10%
2013	34,210	26,094	31%	16,981	11,234	51%
2014	26,980	27,722	-3%	12,890	12,093	7%
2015	27,108	22,639	20%	12,948	8,513	52%
2016	21,487	18,226	18%	9,845	7,555	30%

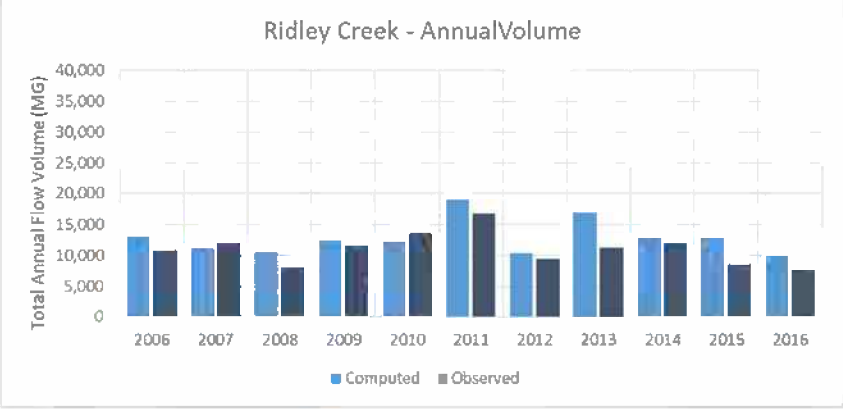
*Missing gage data periods were interpolated using the average flow over the whole time series.

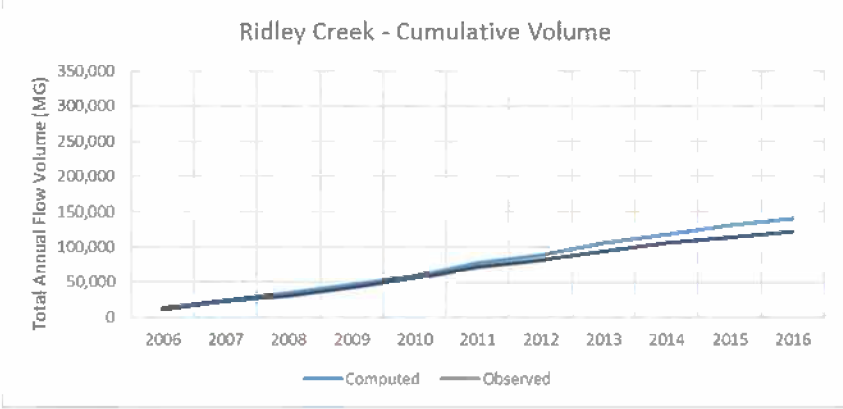
This table shows that the model response is variable from year to year, sometimes over predicting and sometimes under predicting total volume. Our understanding is that these over- and under-predictions are largely driven by rainfall variations over the watershed that are not represented in the watershed model because of lack of limited precipitation data over the entire watersheds. In other words, if the total rainfall observed at the Philadelphia Airport is larger than what was observed in the upper portions of the watershed, then the model would likely over predict total flow volume compared to the observed total flow volume. Conversely, if the total rainfall observed at the Philadelphia Airport is smaller than what was observed in the upper portions of the watershed, then the model would likely under predict total volume compared to the observed total volume. For example, in 2010, less rain was recorded at the Philly Airport than at the West Chester Rain Gage, which is located north of the Chester Creek Watershed, and the model accordingly under predicted total volume in that year. And in 2013, more rain was recorded at the Philly Airport than at the West Chester Rain gage, and the model over predicted volume in that year.

Figure 4-7: Comparison of Modeled vs. Observed Annual Flow Volume and Cumulative Flow Volume









This pattern was observed for some but not all of the years, suggesting that other factors may contribute too. One of those factors may be that there was missing flow data at the two USGS gages during the calibration period. The missing data was replaced by the average flow for the purpose of this specific evaluation, but that may have also led to some over or under prediction in the observed flow volumes. Due to the uncertainty related to rainfall and flow data, this evaluation was not used to fine-tune the calibration because it would compromise the calibration of the individual calibration events and hydrographs.

Taking into account the results from the 1-to-1 plots that showed satisfactory correlation coefficients (see Table 4-1 and Figure 4-3) and the visual checks of the flow time series that confirmed satisfactory responsiveness of the model to rainfall data, the watershed model was deemed sufficiently calibrated, consistent with observed data, and reliable to be applied for the purpose of predicting flows when observed data are not available during the typical year period. As explained in Section 4.1.1, availability of gage data during the typical period is variable, with a long period of data missing in Ridley Creek (9/22/1995 through 12/31/1996) and a few shorter periods (of a few days at a time) missing at both gages during the three year period.

To estimate tributary water quality concentrations, modeled tributary flows were separated into dry and wet weather flow components based on the methodology described in Section 3.1.2.3. Dry weather is the sum of base flow and interflow, while wet weather is represented by the direct runoff and channel precipitation. Statistical reference concentrations for the POC event mean concentrations were initially estimated based on the sampling data obtained from the DELCORA Wet and Dry Weather Monitoring Program (See section 4.1.3). These reference concentrations are shown in Table 4-3. It was somewhat surprising that the *enterococcus* results tended to be higher than the fecal coliform and *E.coli* data. However, there is very little data in the literature for *enterococcus* so it was difficult to assess whether these results are unusual. The fecal coliform concentrations however, are within the range of urban storm water bacteria concentrations reported in the literature (EPA 2004). It should also be noted that, as previously shown in Section 4.1.3, the monitoring data shows that wet weather concentration at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek often exceed the applicable monthly geometric mean or STV WQS concentration for all three POCs.

Table 4-3: Reference POC Concentrations Used to Develop EMCs for Modeled Flows

	Enterococcus (#/100 mL)			Fecal Coliform (#/100 mL)			*E.coli* (#/100 mL)		
	25th %ile	75th %ile	Geo-mean	25th %ile	75th %ile	Geo-mean	25th %ile	75th %ile	Geo-mean
Dry Weather Flow	19	65	39	22	180	40	13	69	28
Wet Weather Flow	8,500	59,500	31,784	799	22,750	4,516	668	18,750	3,042

The POC concentration assumptions were further refined during the water quality model calibration process, which is described in Section 4.5.2. Event mean concentrations were applied to each dry and wet weather flow component to estimate POC loads in the tributaries. This method allows for time-variable POC concentrations that are consistent with the timing of the wet weather flow responses. The final EMCs were determined based on the results of the receiving water model calibration, as explained in Section 4.5. The selected dry weather EMC (30 #/100 mL) is consistent with the geometric mean of the observed data. It was also not varied by POC because the dry weather sampling data were variable but had similar central tendencies. The final calibrated EMC values used in the watershed model are shown in the table below.

Table 4-4: Calibrated POC EMC values for Ridley and Chester Creek

Model Input	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E.coli* (#/100 mL)
Dry Weather Flow	30	30	30
Wet Weather Flow	20,000	8,000	4,000

4.3 DELCORA Combined Sewer System Model

DELCORA CSO flows were obtained from the calibrated DELCORA CSS H&H Model. The calibration and application of the CSS H&H model is discussed in detail in the H&H model report (DELCORA, 2016).

To model the POC loads from the CSO system, Statistical reference concentrations for the POC event mean concentrations were initially estimated based on the sampling data obtained from the DELCORA Wet and Dry Weather Monitoring Program (See section 4.1.3). These reference concentrations are shown in Table 4-5. Measured concentrations were within the range of CSO bacteria concentrations reported in the literature (EPA, 2004) but tended to be lower than the median concentrations measured in other communities. Several potential explanations for this include: 1) the highly industrialized nature of the DELCORA service area may result in a smaller bacteria load via runoff to the combined system than communities with less industrial land; 2) DELCORA may have a relatively high percentage of stormwater in the combined system.

The data presented a challenge in that the *E.coli* values are generally higher than the fecal coliform values, which is not physically possible since *E.coli* is a subset of fecal coliform. These data were therefore used as initial estimates, but then further refined and adjusted during the water quality model calibration process so as to reflect both the physical constraints (i.e.: *E.coli* EMCs that are smaller than Fecal Coliform EMCs) and the observed ranges.

Table 4-5: Reference POC Concentrations Used to Develop EMCs for the Modeled DELCORA CSOs

	Enterococcus (#/100 mL)			Fecal Coliform (#/100 mL)			*E.coli* (#/100 mL)		
	25th %ile	75th %ile	Geo-mean	25th %ile	75th %ile	Geo-mean	25th %ile	75th %ile	Geo-mean
CSO Concen-tration	42,250	191,750	81,510	53,000	157,000	95,310	66,000	265,500	129,920

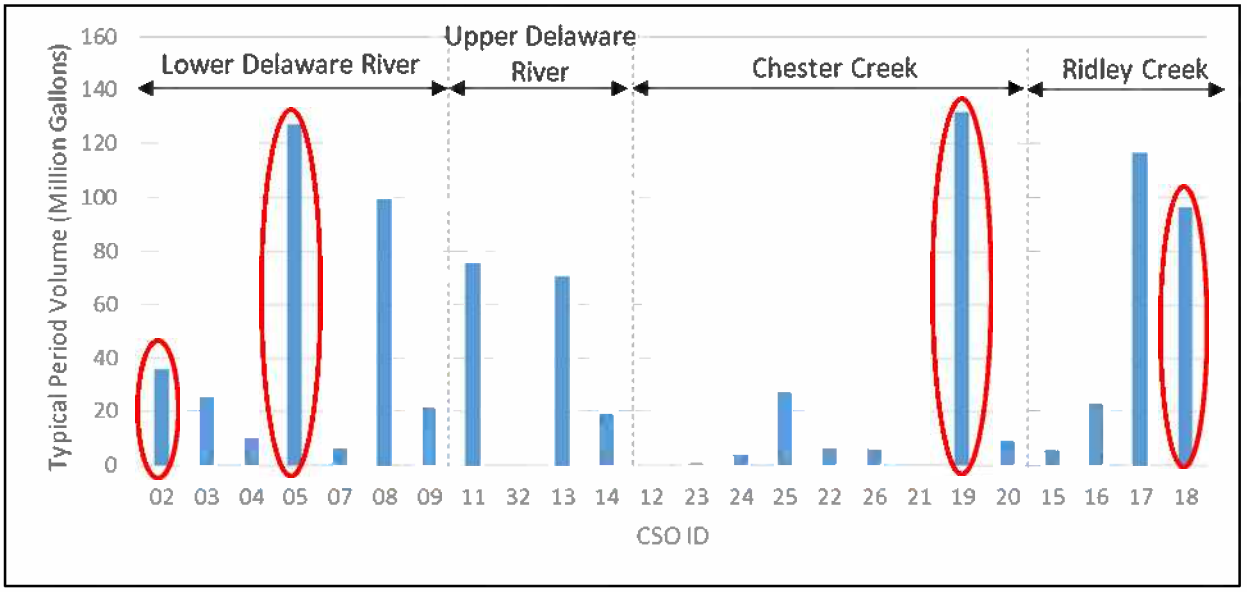
The water quality model was ultimately calibrated using the CSO EMCs shown in Table 4-6 below.

Table 4-6: Calibrated POC EMC Values for the DELCORA CSOs

Model Input	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E.coli* (#/100 mL)
CSO EMC	125,000	150,000	125,000

Figure 4-8 illustrates the distribution of CSO volumes among the various outfalls by receiving water. The CSOs that were part of the wet weather monitoring program are circled in red.

Figure 4-8: CSO Volumes for Typical Period (1994-1996)



POC loads associated with DELCORA CSOs are estimated by multiplying modeled CSO flow rates by POC EMC concentrations.

4.4 Philadelphia Simplified CSO Model

Calibration of this SWMM model relied principally on information from annual reports of Philadelphia CSO model overflows (PWD, 2017). Tables from these reports, which describe the annual overflow volume, number of overflow events, and total overflow duration per CSO, helped to constrain model inputs related to the combined sewersheds, including the total impervious area, depression storage, average surface slope, and sewershed width and length.

Model parameters described above were first calibrated to reported overflow volumes and frequencies from the 2016 annual CSO reports, then validated using the 2015 annual CSO reports. Modeled and reported overflow volumes and frequencies were in close agreement for the 165 CSO locations in both 2015 and 2016, as shown in Figure 4-9 and Figure 4-10. However, at one overflow location, identified as "F_FRFG," the reported overflow changed significantly between 2015 (1,250 million gallons) and 2016 (<1 million gallons), indicating that some change occurred in the Philadelphia sewer system that eliminated overflows at that discharge location. The SWMM model was configured for the 2016 condition for the water quality calibration. Overall, the model provides reliable estimates of Philadelphia CSO overflow volume and frequency of discharge.

The process for calibration of the model was as follows:

1. Gather CSO information from the Philadelphia CSO Annual Reports[13], including total annual overflow volumes, number of overflow events, and overflow event durations.
2. Develop annual rainfall event statistics, including total rainfall depth and duration for Philadelphia Airport rain gage.
3. Rank the developed rainfall events by total depth and distribute the reported overflow volume over the reported number of overflow events for each CSO. This method assumes that overflows occur during the highest volume rainfall events and that the overflow volume is proportional to the total rainfall depth.
4. Parameterize the SWMM runoff model relying principally on the total assumed rainfall depth which cause overflows, and the reported overflow characteristics (volume, number of overflows and duration).
5. Use the SWMM runoff model to compute the hourly CSO response for each rainfall event and CSO location.
    a. Assume 100% impervious sewersheds and calculate necessary sewershed area for each CSO by dividing the reported annual overflow volume by the assumed total rainfall depth causing overflow.
    b. Set depression storage input equivalent to largest rainfall depth that does not result in an overflow. Further, a constant evaporation rate was used to deplete the depression storage between rainfall events.

[13] http://www.phillywatersheds.org/what_were_doing/documents_and_data/CSO_SW_AnnualReports

c. Adjust sewershed width-to-length ratio, which influences runoff dynamics, for consistency with reported number of overflow events and reported overflow duration.

4.5 Receiving Water Model Calibration

The receiving water model calibration was comprised of two components: calibration of the hydrodynamic calculations (water movement), and calibration of the water quality calculations. These are explained in the following sections.

4.5.1 Hydrodynamic Model Calibration

Calibration of tidal hydrodynamics occurred first. Modeled tidal propagation is principally influenced by sediment bed resistance which varies due to changes in sediment grain size and bed forms. Model inputs related to bed resistance (roughness) were calibrated for consistency with NOAA tidal data at multiple stations near DELCORA CSOs, including the Marcus Hook Station (only water level measured) and Philadelphia Station (water level and currents measured). Modeled and observed water levels were compared for the 2017 water quality sampling period (March through June 2017). The model's representation of changes in tidal phasing and amplitude along the Delaware River estuary, which influence rates of pollutant transport and mixing, were refined during the calibration process.

Figure 4-11 and Figure 4-12 illustrate the hydrodynamic model performance relative to observations. These figures show good agreement between modeled and observed water levels and sufficient agreement between modeled and observed current velocities. Modeled current velocities tend to be low relative to observed current velocities, which is likely due to differences in scale between the observations and the model output. Model output represent average velocities over approximately a 200 foot width and 1,400 foot length, while the observations represent velocities at a much smaller scale (i.e. tens of feet laterally and vertically). Consistency between modeled and observed water levels is a strong indication that at larger spatial scales (i.e. the scale of the model grid and larger scales), the model accurately computes tidal current velocities.

Figure 4-9: Philadelphia CSOs – Comparison of Modeled and Reported Overflow Volumes

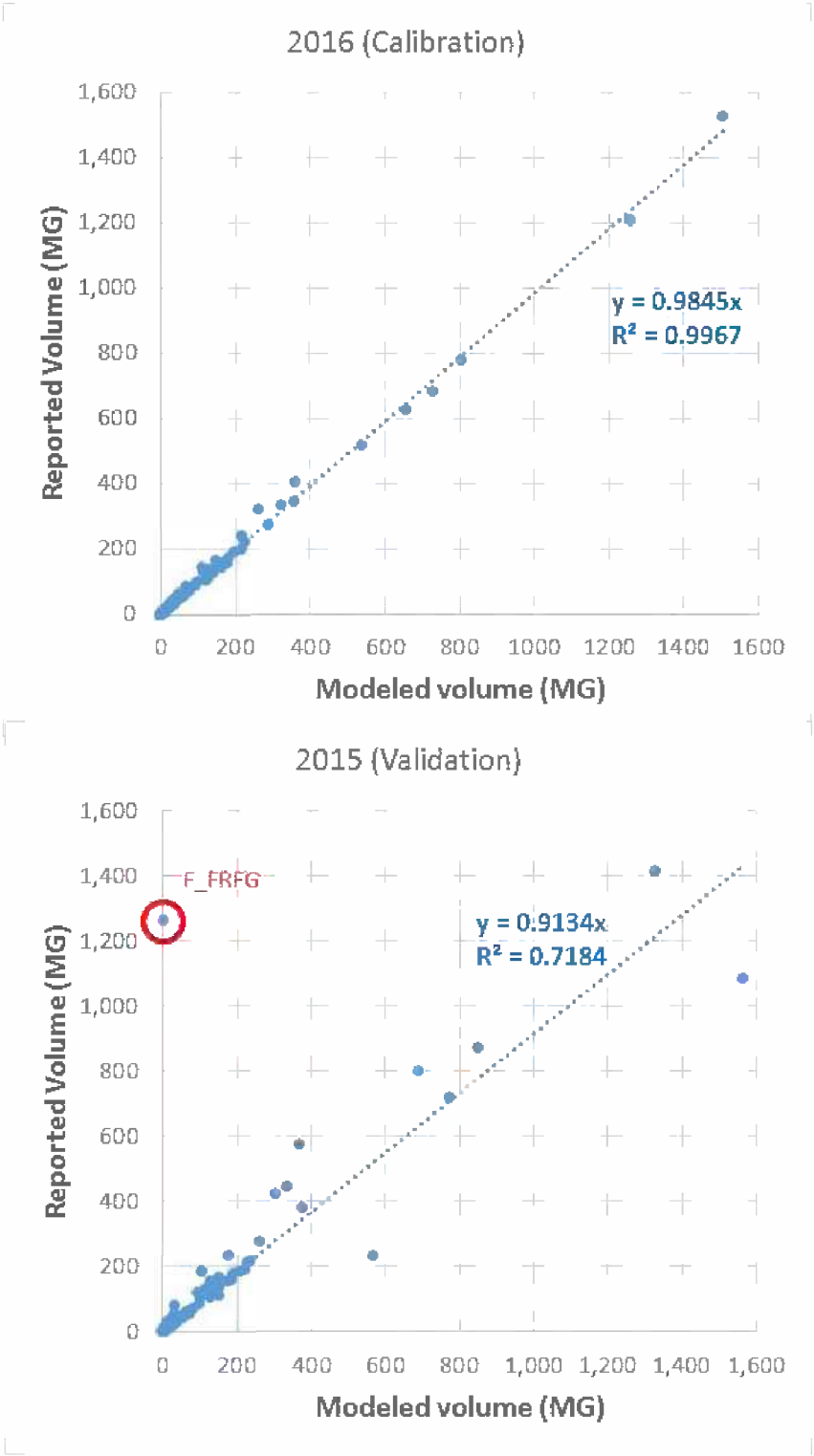


Figure 4-10: Philadelphia CSOs – Comparison of Modeled and Reported Overflow Events

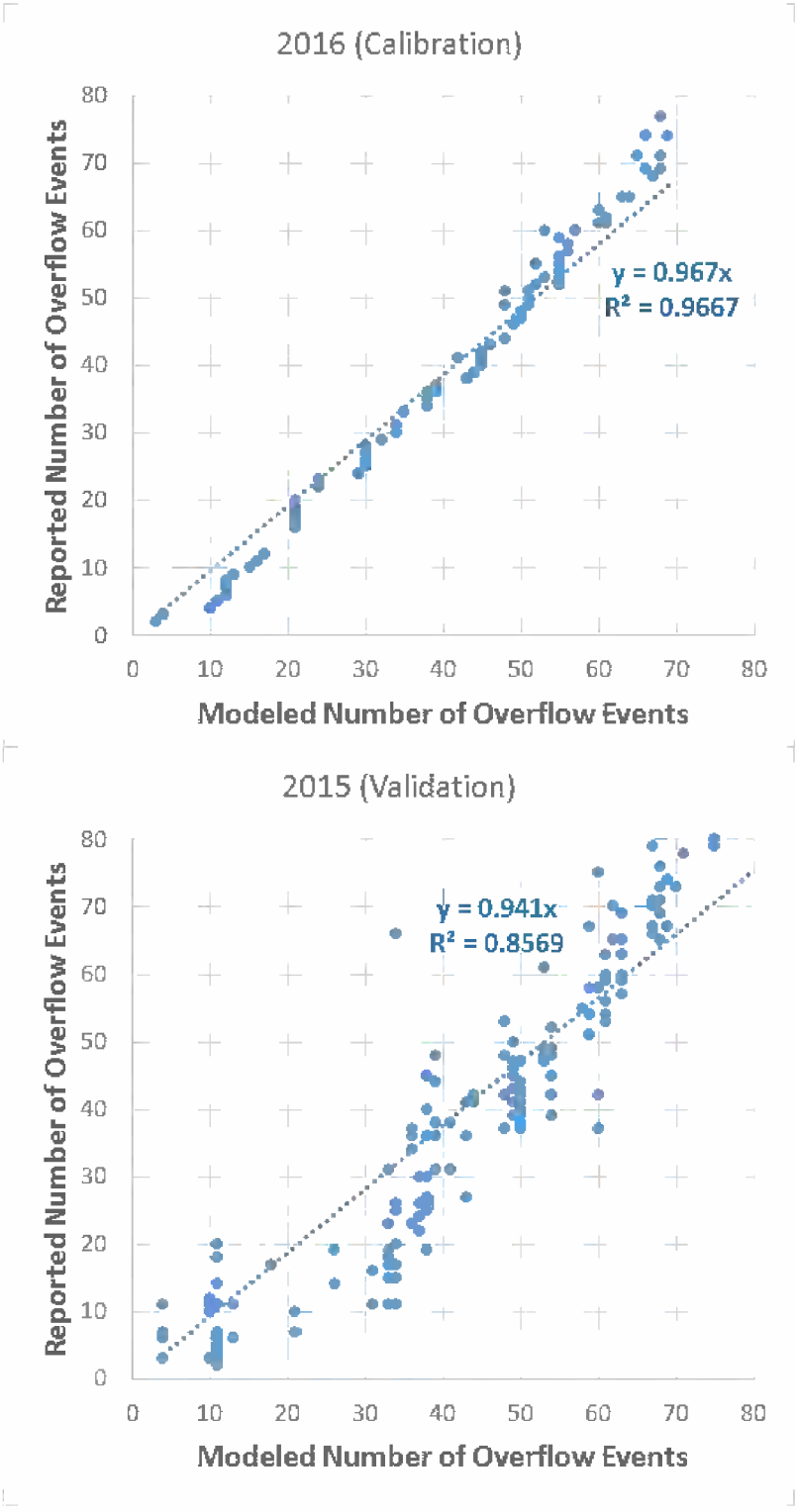


Figure 4-11: Delaware River – Comparison of Modeled and Observed Water Levels

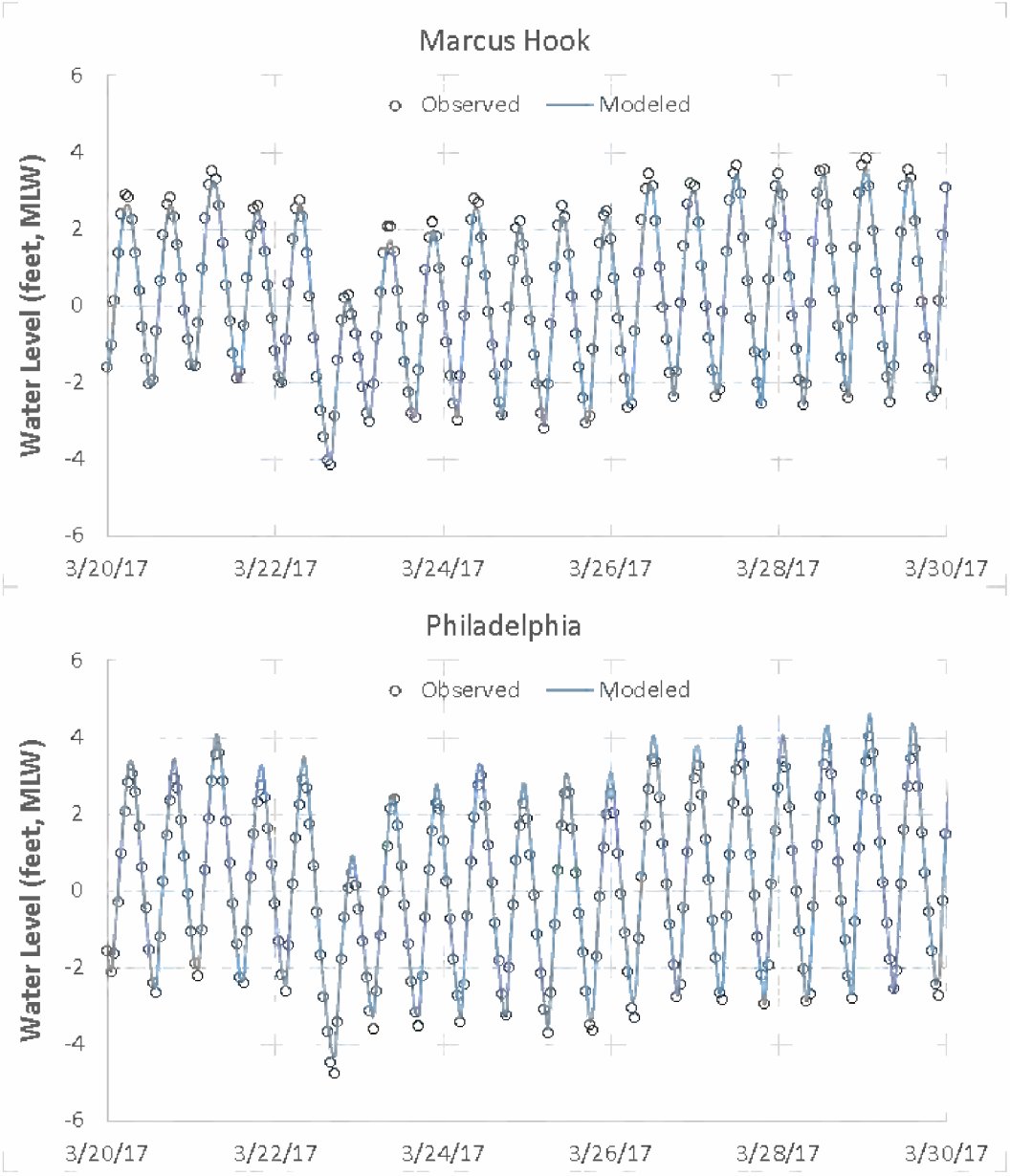
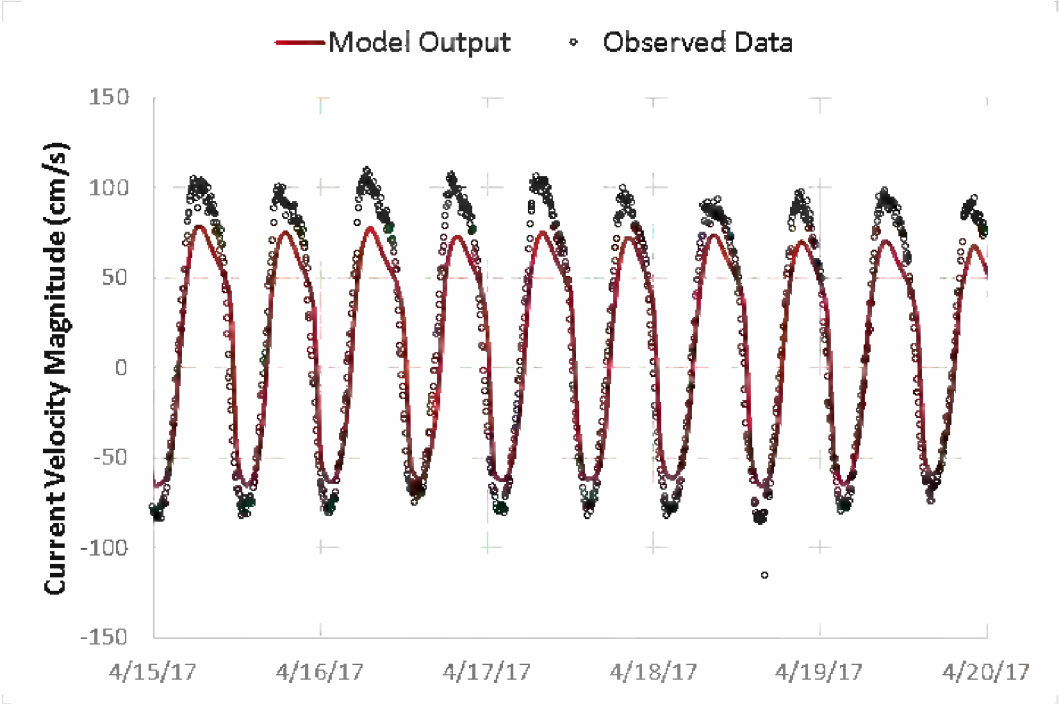


Figure 4-12: Delaware River – Comparison of Modeled and Observed Velocities at NOAA Philadelphia Currents Station



4.5.2 Water Quality Calibration and Validation

4.5.2.1 Approach

The water quality model component was calibrated to sampling data collected in 2017 by DELCORA (see section 4.1.3) and validated to water quality data collected in 2012 by the Delaware River Basin Commission (DRBC). The intent of the calibration is to refine initial POC load (EMC and flow) estimates and the assumed first-order, in-stream POC net decay rate. The POC loads control the amount, the timing, and the intensity of the bacteria loads from the various sources to the receiving water. The decay rate then controls how quickly bacteria decays (decreases in concentration due to the net effects of multiple bacterial processes) over time. The calibration approach was to adjust POC load and decay rate values, evaluate changes in model results against the entire calibration dataset, and identify the model values that were most consistent with the central tendencies of the dataset by stream.

The central tendencies are evaluated through the use of event-based pollutographs and 1-to-1 plots. The pollutographs were evaluated using visual checks for individual events at relevant water quality stations. These visual checks include an evaluation for goodness of fit with respect to the modeled vs observed concentrations, and the time-response of the POC concentrations. The 1-to-1 plots were evaluated with respect to how closely the modeled data could replicate the observed

data within a certain range to account for the typical variability observed with bacteria data. The intent of the water quality calibration was to find the overall best fit across all of the different sampling events and all the relevant monitoring stations, with more emphasis placed on the water quality stations within the DELCORA CSO area. This approach invariably leads to calibration results that are better at some locations or for some events than others. Using different POC load assumptions may improve results for some stations and events, but may diminish results for other stations and events. Model assumptions were refined to obtain the best fit across all of the stations.

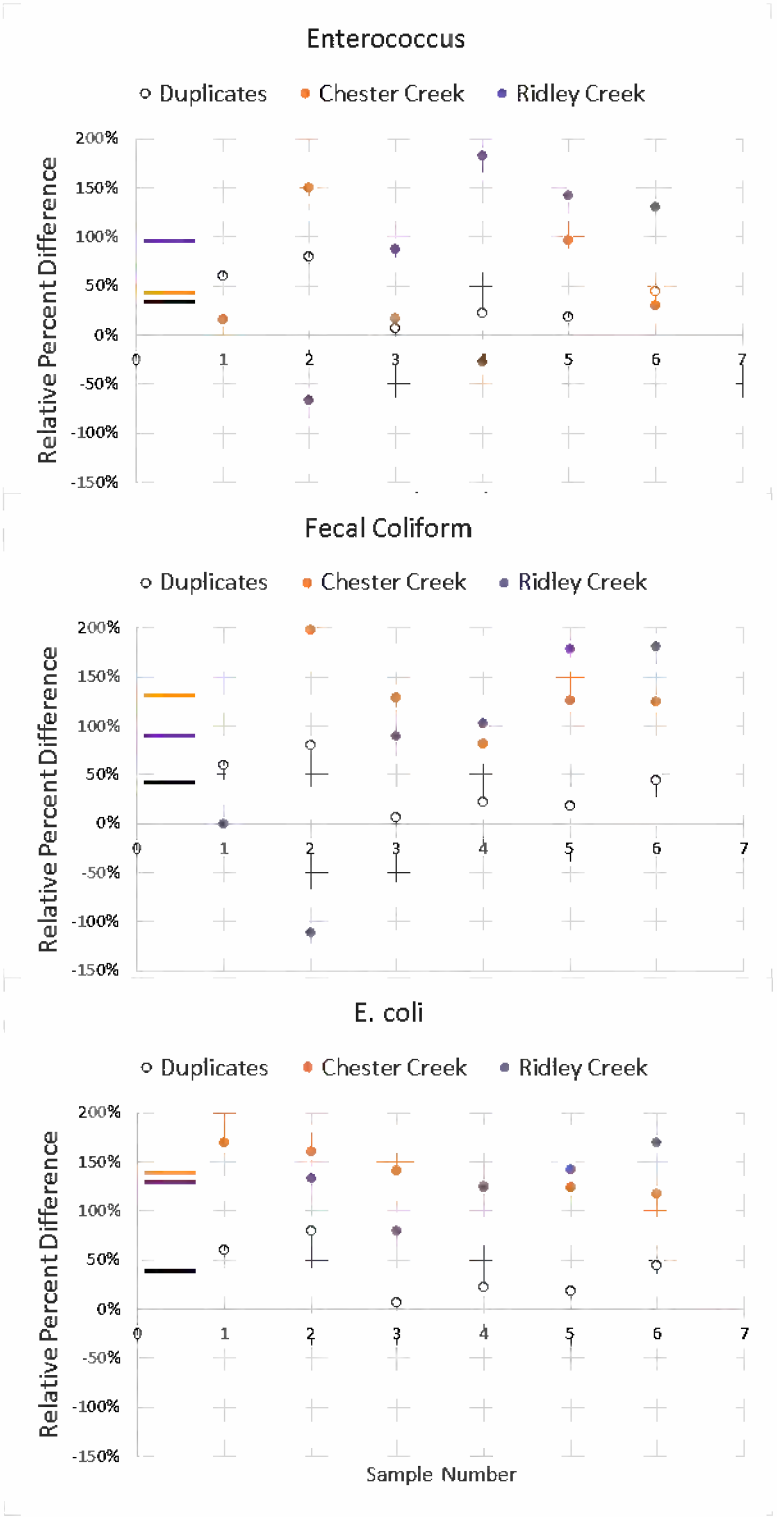
The approach focused first on establishing the appropriate dry weather model values, followed by the wet weather model values. Based on this approach, the decay rate was calibrated to 1.0 per day (1/day), dry weather flow POC concentrations were set to 30 #/100 mL, and wet weather POC EMCs for the tributaries and CSOs were calibrated to the values listed in the table below.

Table 4-7: Model Inputs for POC EMC Concentrations

Model Input	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E.coli* (#/100 mL)
Background Tributary Runoff POC Concentration	20,000	8,000	4,000
DELCORA and Philadelphia CSOs POC Concentration	125,000	150,000	125,000

As discussed in Section 4.1.3, the results from DELCORA's monitoring program showed an increase in POC concentration from upstream to downstream in each of the tributaries, indicating there may be bacteria sources entering these tributaries during dry weather. Dry weather POC concentrations generally appreciably increase from the most upstream sampling stations (RC-01 and CC-01) to the next downstream sampling stations (RC-02 and CC-02), as illustrated in the figure on the next page. This figure shows the relative percent difference in concentrations from the upstream to downstream sampling locations. When the relative difference is positive, it indicates an increase in concentration from upstream to downstream. While small (+/- 50%) changes could be due to the typical variability observed in sampling data, larger increases (>50%) could be indicative of a bacteria source entering the tributary somewhere between CC-01 and CC-02, and between RC-01 and RC-02. These unknown sources were included in the water quality model and were calibrated for consistency with the central tendency of the dry weather POC data at stations RC-02 and CC-02. The final calibrated loads of the unknown sources ranged from 1.1e6 to 9.1e6 cfu/s depending on POC and stream. Such a source was not included in the model of *Enterococcus* in Chester Creek because no consistent *Enterococcus* concentration increase was observed in the sampling data.

Figure 4-13. Difference in POC Concentration in Upstream vs Downstream Station



Horizontal bars represent mean relative percent difference of paired observations

4.5.2.2 Calibration and Validation Results

The results from the dry weather calibration is shown in Figure 4-14 and Figure 4-15 for Fecal Coliform for dry weather event 2. Model results are shown with the red line and observed data are shown using the gray squares. The figure also shows how the model performs for 50% higher and 50% lower POC load assumptions. Showing the +/- 50% results helps demonstrate that the model represents the central tendencies of the observed water quality data. Generally speaking, the model reasonably predicts dry weather Fecal Coliform concentrations for dry weather event 2, over predicts for dry weather event 1 and under predicts for dry weather event 3. Performance for the other POCS is shown in the table below. A complete set of figures for model calibration for all dry weather events and all POCs can be found in Appendix C.

Table 4-8: Assessment of Dry Weather Events Water Quality Calibration

		Enterococcus	Fecal Coliform	*E.coli*
Dry Weather Event 1	Ridley	Biased High	Biased High	Biased High
	Chester	Biased High	Biased Low	Reasonable fit
	Delaware	Biased High	Biased High	Biased High
Dry Weather Event 2	Ridley	Reasonable fit	Reasonable fit	Reasonable fit
	Chester	Reasonable fit	Reasonable fit	Reasonable fit
	Delaware	Biased High	Reasonable fit	Reasonable fit
Dry Weather Event 3	Ridley	Reasonable fit	Biased Low	Reasonable fit
	Chester	Reasonable fit	Biased Low	Reasonable fit
	Delaware	Reasonable fit	Reasonable fit	Reasonable fit

After calibrating the model to the dry weather events, attention turned to calibrating the wet weather events. Figure 4-16 illustrates the water quality model calibration for fecal coliform during the first wet weather event at select stations in the tributaries and the Delaware River, along with sensitivity tests that show how the model performs for 50% higher and 50% lower POC load assumptions. The objective of the in-stream calibration is to provide the overall best fit across all stations, thus providing consistency with the central tendency along the length of the modeled river. Modeled POC concentrations are consistent with the range of observed concentrations from the DELCORA monitoring program and the model performance is reasonable compared to the observed data. Performance for the other POCS is shown in the table below. A complete set of figures for model calibration for all wet weather events and all POCs can be found in Appendix C.

Table 4-9: Assessment of Wet Weather Events Water Quality Calibration

		Enterococcus	Fecal Coliform	*E.coli*
Wet Weather Event 1	Ridley	Reasonable fit	Biased High	Biased High
	Chester	Reasonable fit	Reasonable fit	Reasonable fit
	Delaware	Biased High	Biased High	Reasonable fit
Wet Weather Event 2	Ridley	Biased Low	Biased Low	Reasonable fit
	Chester	Biased Low	Biased Low	Reasonable fit
	Delaware	Reasonable fit	Reasonable fit	Reasonable fit
Wet Weather Event 3	Ridley	Reasonable fit	Reasonable fit	Reasonable fit
	Chester	Reasonable fit	Biased Low	Biased Low
	Delaware	Reasonable fit	Biased High	Reasonable fit

Following calibration of the dry and wet weather events using the data from the DELCORA Monitoring Program, the water quality model was subsequently validated to water quality data collected in 2012 by the Delaware River Basin Commission (DRBC). Seven samples per location were taken between April and November of 2012 in the Delaware River from Trenton to the mouth of the Delaware River. These data are primarily useful for evaluating accuracy of modeled POC loads from the Philadelphia CSOs and the Schuylkill River, which are estimated to be the largest POC loads to the estuary. Figure 4-17 illustrates the water quality model validation for fecal coliform at stations near Delaware County, starting at river mile 87.9 which is upstream of the DELCORA CSO area. Modeled POC concentrations are consistent with the range and timing of observed concentrations in the DRBC data, and the model performance is reasonable compared to the observed data. Modeled results are also consistent with the observed pattern of higher concentrations near Philadelphia and lower concentrations near DELCORA. A complete set of figures for all POCs and stations used for model validation can be found in Appendix C.

Figure 4-14. Fecal Coliform Dry Weather Calibration at Ridley and Chester Creek (Dry Weather Event #2, 5/10/17)

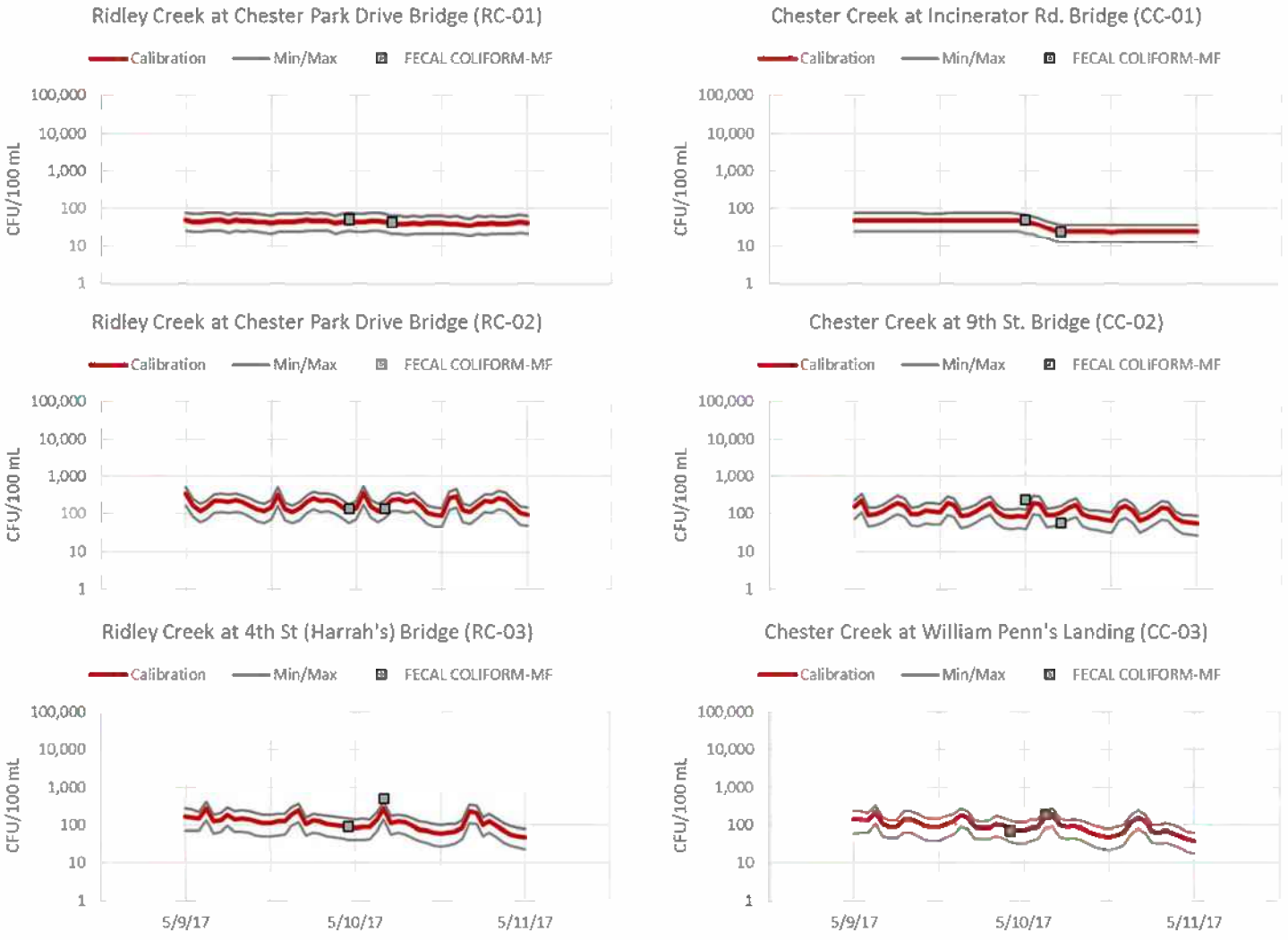


Figure 4-15. Fecal Coliform Dry Weather Calibration at Delaware River Stations (Dry Weather Event #2, 5/10/17)

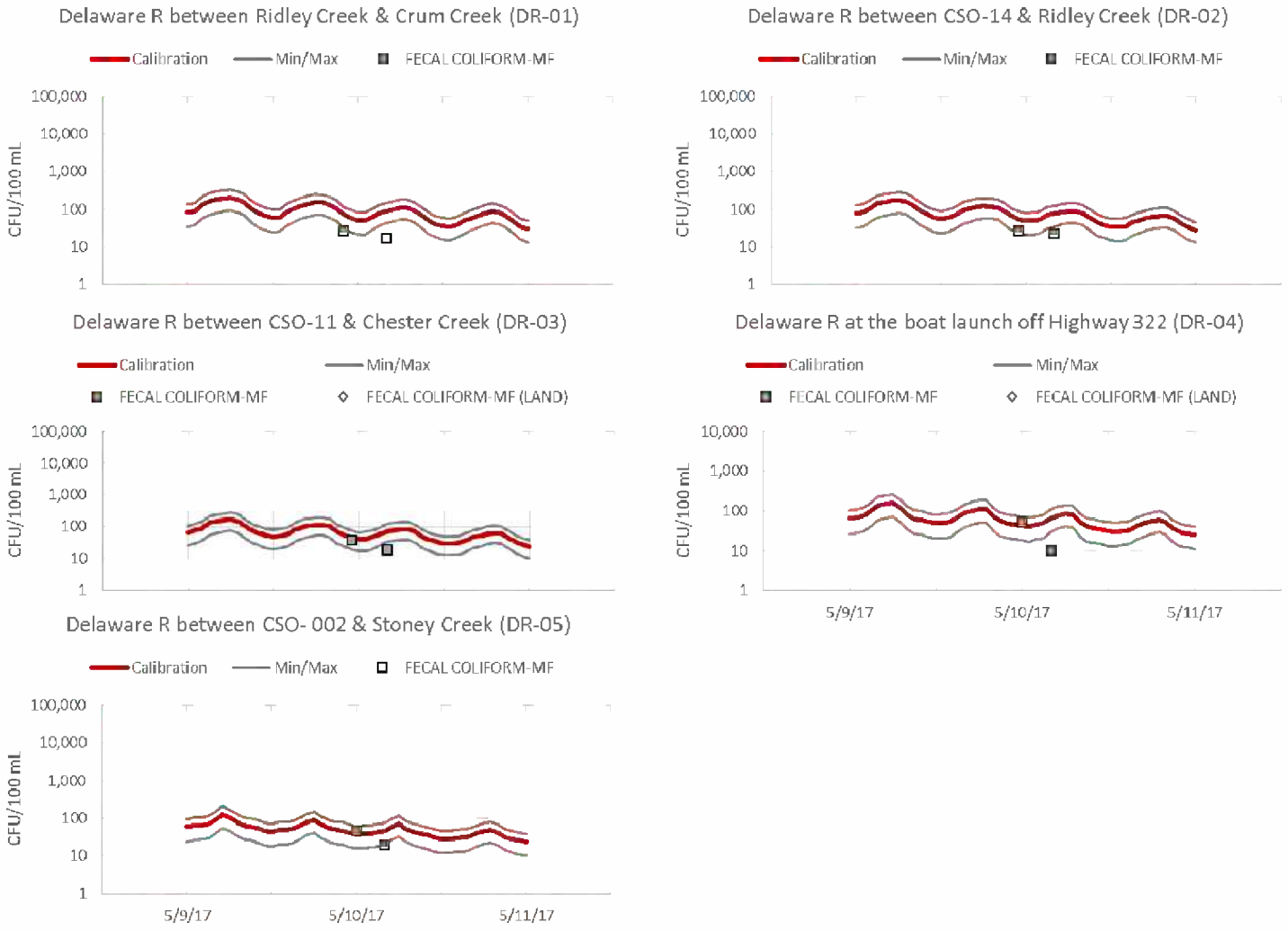


Figure 4-16. Fecal Coliform Calibration at Ridley Creek, Chester Creek, and Delaware River Stations (Wet Weather Event #1, 3/30/17-4/1/17)

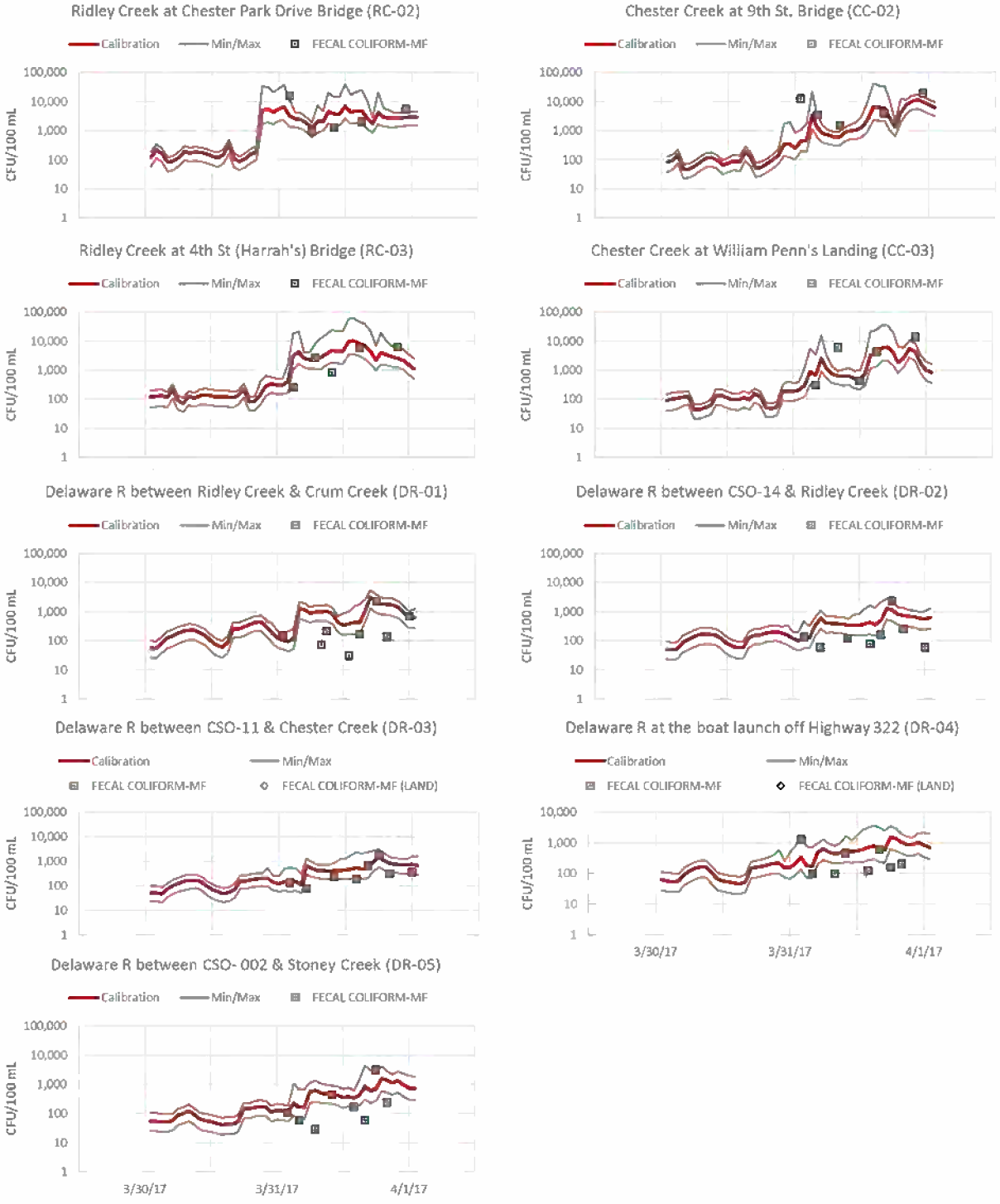
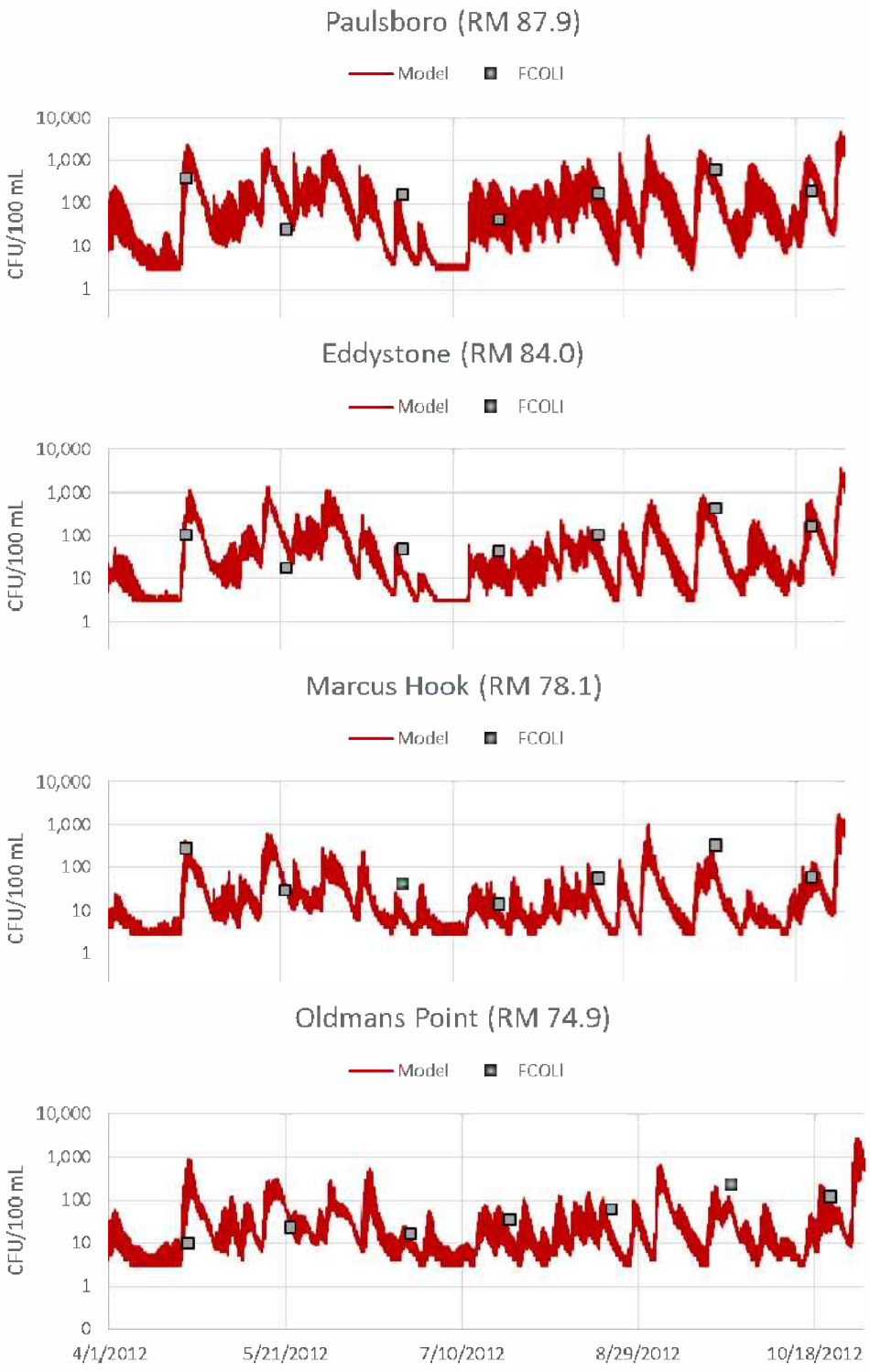


Figure 4-17: Fecal Coliform Model Validation Results near Delaware County



One-to-one plots were also used to assess model performance relative to all observed data at all stations. This is shown in Figure 4-18, Figure 4-19, and Figure 4-20 for the three POCs. These figures pair observed POC concentrations with their associated modeled concentrations for both wet and dry weather events. To account for the natural variability that can occur when sampling POCs, two additional sets of lines were added to the 1-to-1 plot to represent confidence intervals. The first set of dashed lines represent a two times (2x) confidence interval representing the variability in monitoring data results associated with field-collection efforts. The second set of dotted lines represents a ten-time (10x) confidence interval which represents the possible variability in monitoring data results associated with the combination of field and laboratory factors. This confidence interval is based on best professional judgement and variability with field and analytical duplicate results. The majority of points on the one-to-one plots fall within the 10x confidence interval for all stations, however the creek predictions are biased slightly low whereas the Delaware River has an overall reasonable fit, as shown in the table below. Overall, even if an individual event was modeled too high or too low, on a long term basis, the model produces a fairly typical response to POC loads that follow the central tendencies observed.

Table 4-10: Assessment of Overall Water Quality Calibration and Validation

	Enterococcus	Fecal Coliform	*E.coli*
Creeks Calibration	Biased Slightly Low	Biased Slightly Low	Biased Slightly Low
Delaware Calibration	Reasonable fit	Biased Slightly High	Biased Slightly High
Delaware Validation	Reasonable fit	Reasonable fit	Reasonable fit

4.6 Overall Calibration Observations

A water quality modeling framework has been developed and calibrated, and is ready for application to compute POC concentrations in the tidal portions of Chester and Ridley Creeks and in the Delaware River adjacent to DELCORA, for the typical year period. Each model within the framework was developed and calibrated using the best available data, and found to be reasonably consistent with the central tendencies of the observed data and therefore reliable to be applied for the Long Term Control Plan Update.

Figure 4-18: *Enterococcus* Model Calibration and Validation Summary

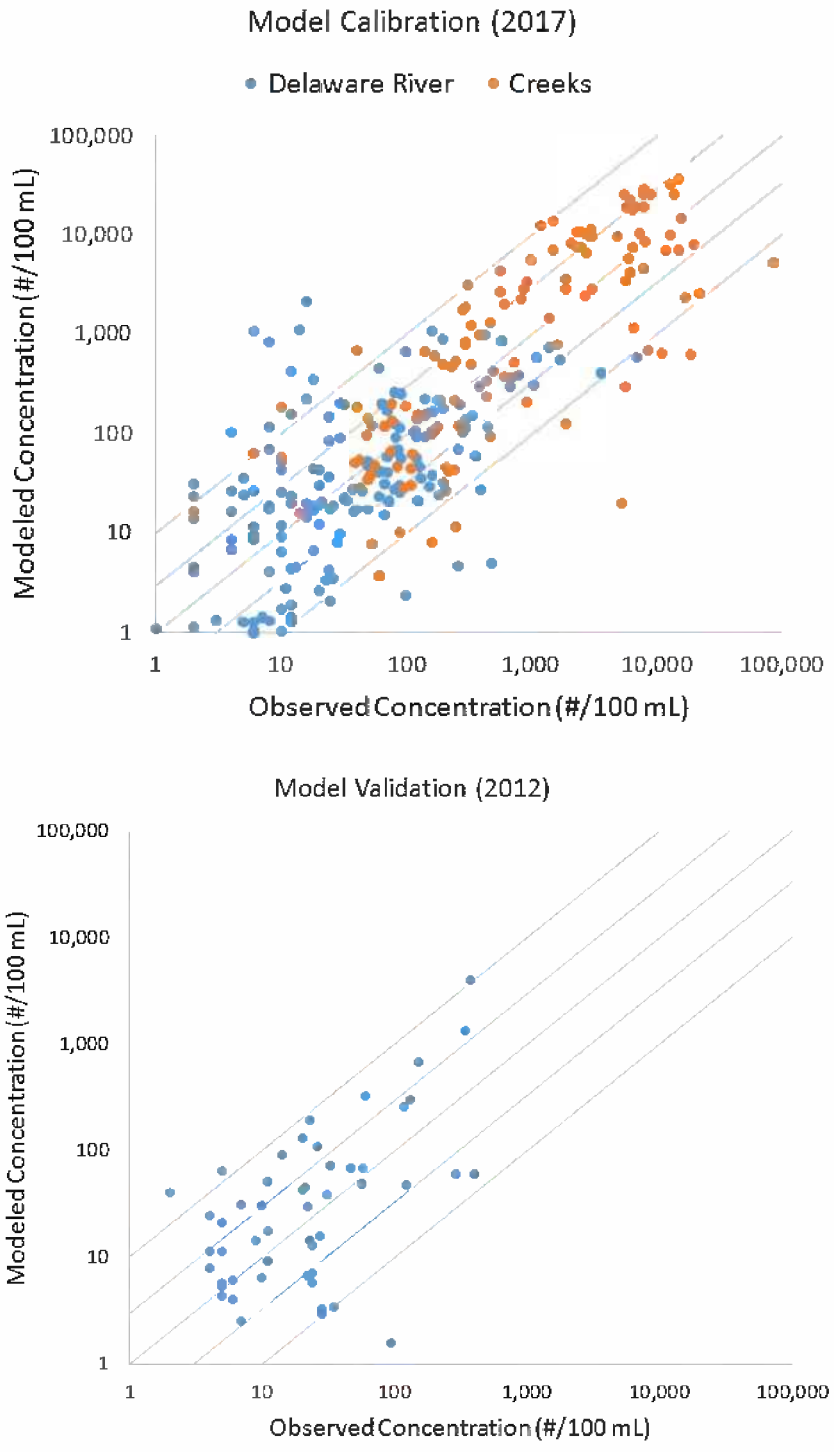


Figure 4-19: Fecal Coliform Model Calibration and Validation Summary

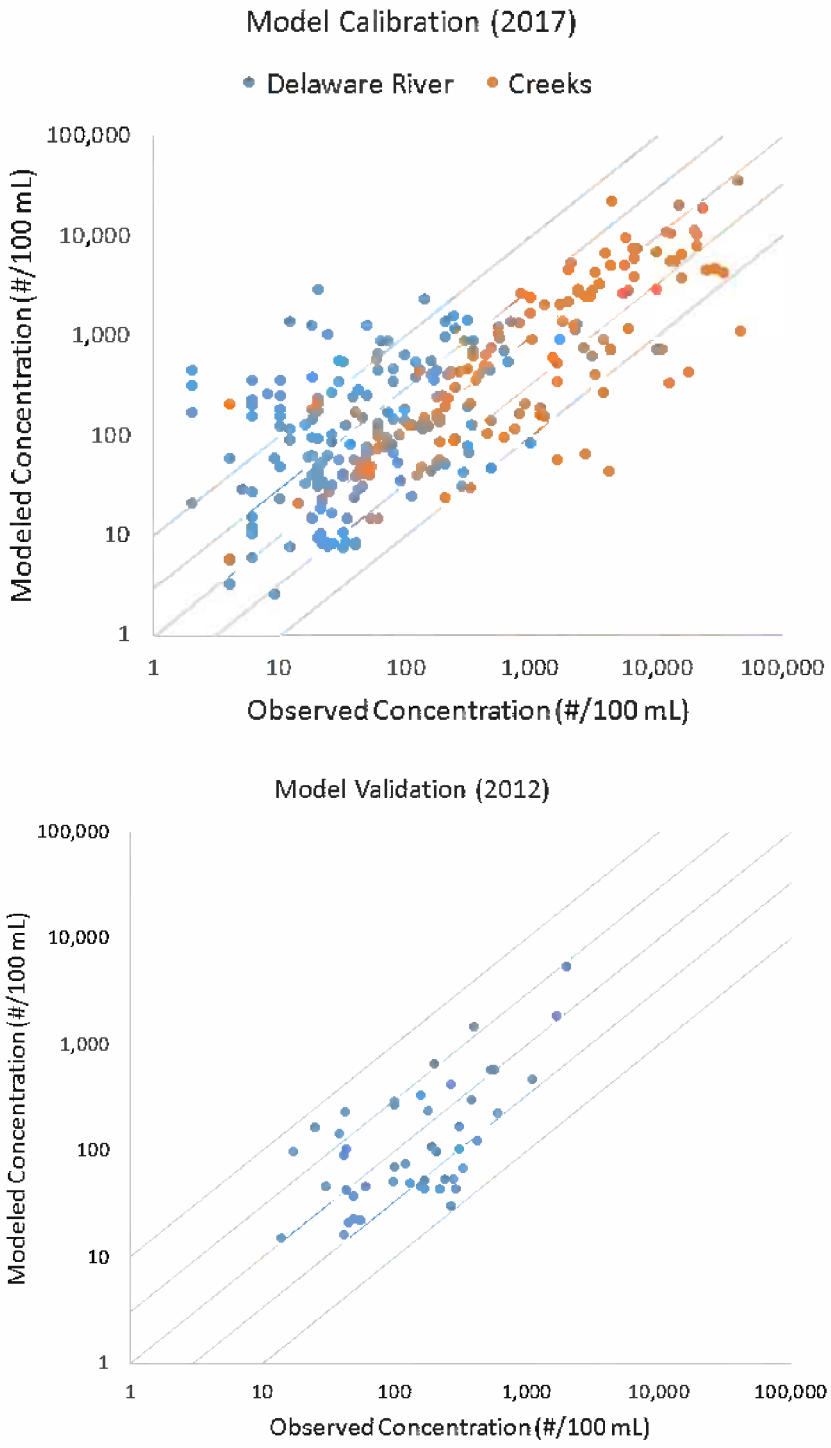
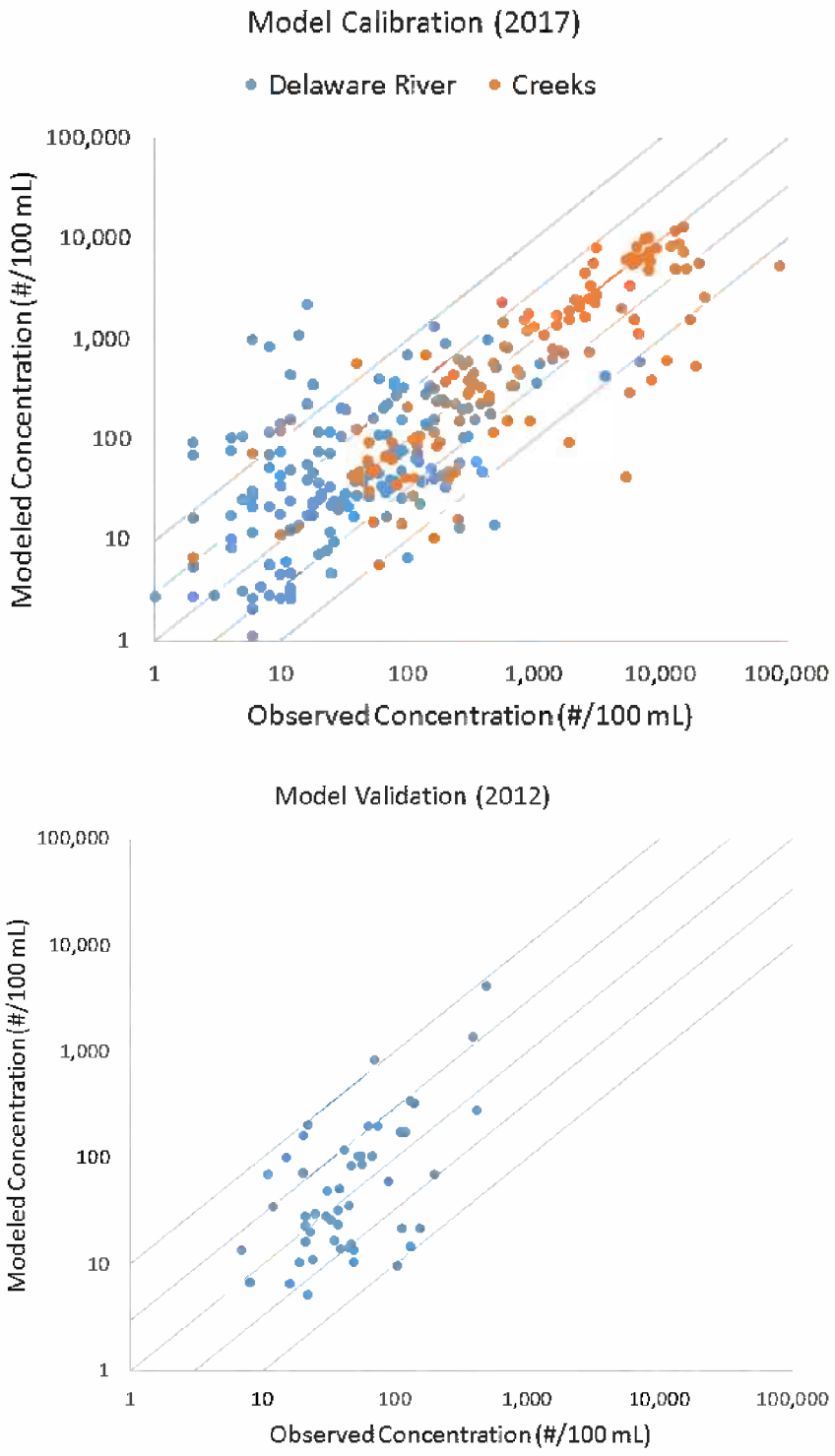


Figure 4-20: *E.coli* Model Calibration and Validation Summary



Section 5 Water Quality Model Application to Evaluate Typical Year Condition

5.1 Typical year simulation description

The purpose of the DELCORA water quality model is to compute water quality concentrations for a baseline scenario and potential future control scenarios, and to quantify the water quality benefits of potential future infrastructure projects. The baseline conditions represent the in-stream water quality conditions using the most recent and appropriate data to represent current watershed, tributary, and CSO loads, including the existing DELCORA combined sewer system configuration and operation. The water quality model was applied for the typical year hydrologic period of 1994-1996. This period was identified as being representative of longer-term hydrologic conditions, and includes one relatively dry year, a relatively wet year, and an average year (DELCORA, 2016b).

5.2 Relevant Water Quality Standards

Modeled POC concentrations were compared to the currently applicable and potential future water quality standards. The standards vary by POC and by stream segment, and are summarized in the table below (Table 5-1). The Upper Delaware River and the tidal zones of Chester and Ridley Creek currently have secondary contact WQS whereas the Lower Delaware River currently has primary contact WQS for bacteria. The boundary between the Upper and Lower Delaware River occurs at river mile 81.8, which is just downstream of Chester Creek and CSO-11 (Figure 5-1). Generally, the modeling work indicated that the *enterococcus* standards are the most stringent (relative to current concentrations) among the three POCs.

Table 5-1: Water Quality Thresholds for Comparisons with Model Results

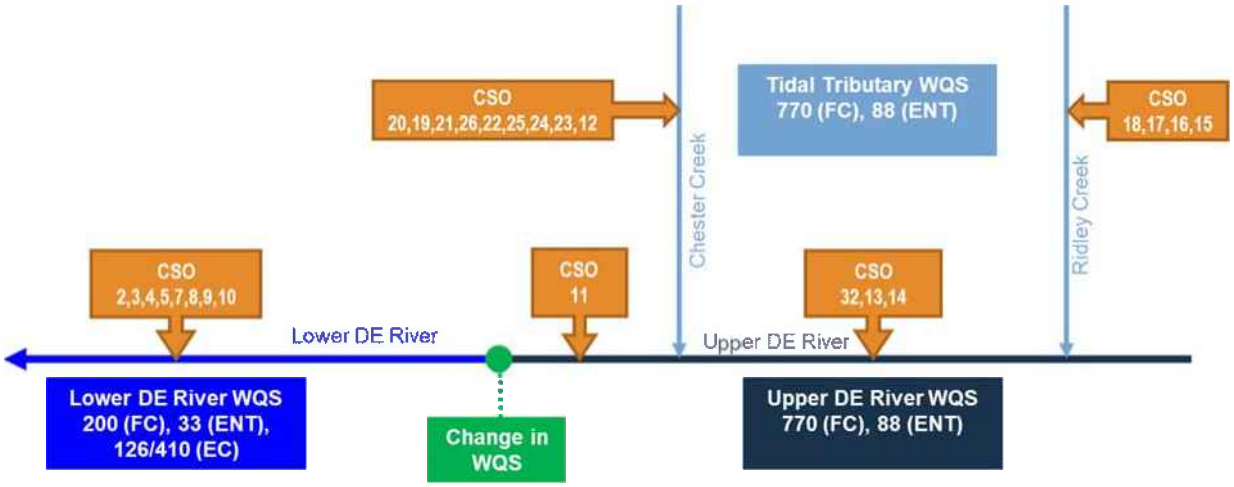
Segment	*Enterococcus* (#/100 mL)	Fecal Coliform (#/100 mL)	*E.coli*[1] (#/100 mL)
Upper Delaware River and Tidal Zones of Creeks	Monthly Geomean: 88 #/100 mL	Monthly Geomean: 770 #/100 mL	n/a
Lower Delaware River	Monthly Geomean: 33 #/100 mL	Monthly Geomean: 200 #/100 mL	Monthly Geomean: 126 #/100 mL Statistical Threshold Value: 410 #/100 mL

1. *E.coli* (EC) standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.M. 81.8, during recreational months only (May 1 - September 30).

E.coli standards similar to the Lower Delaware River are also proposed for the non-tidal tributaries, which are located upstream of DELCORA's CSO discharges. Outfall CSO-033 is located in the non-tidal portion of Ridley Creek, but this outfall does not appear to overflow during

the typical year period. CSO-033 will be evaluated in the LTCP but, as a practical matter, it does not cause or contribute to WQS being exceeded.

Figure 5-1: Schematic of Applicable POC Water Quality Standards

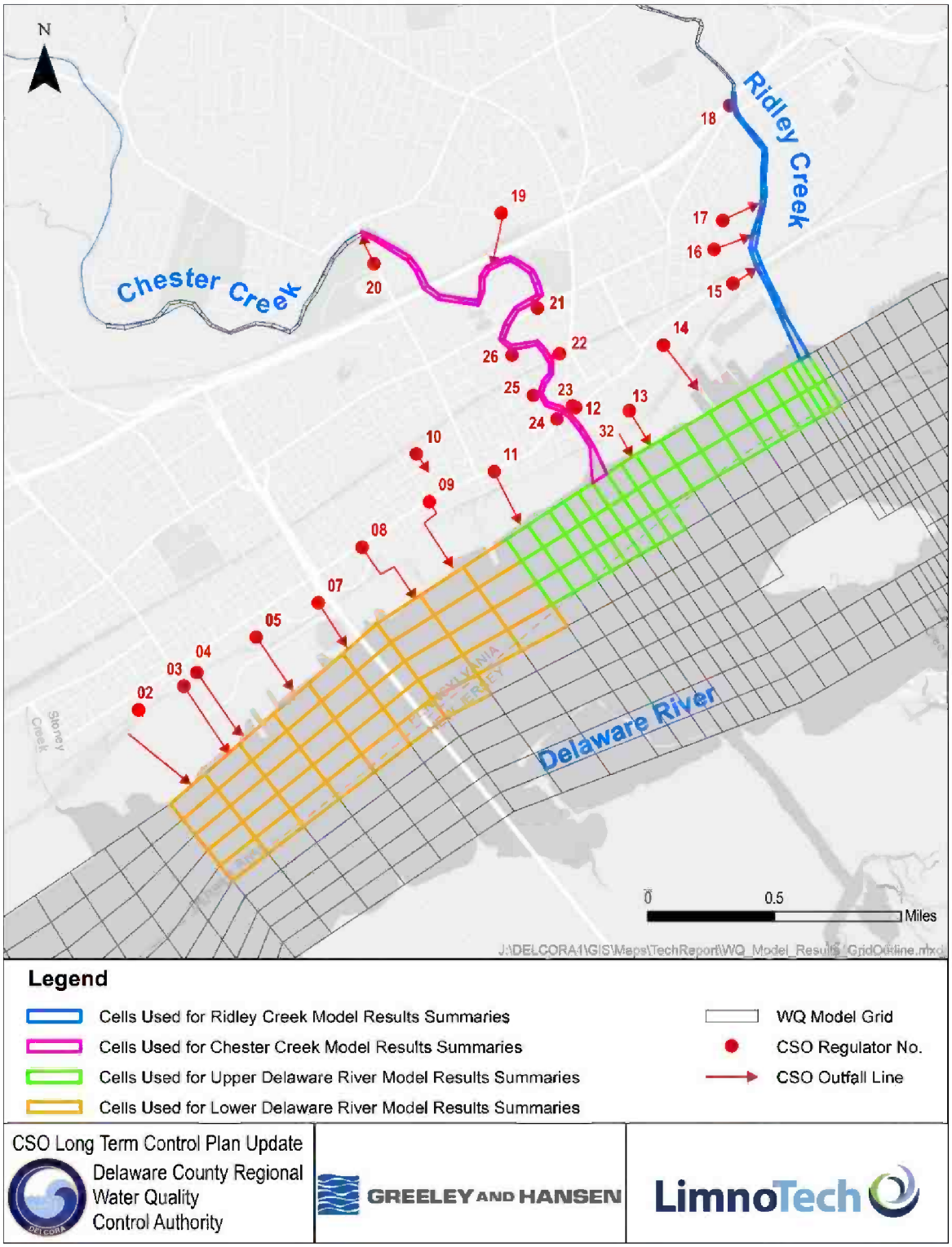


The model has been configured to separately track the in-stream concentration associated with background sources from the in-stream concentration associated with DELCORA sources (CSO and WWTP). This separate accounting will allow for background and non-background sources to be reduced independently from each other. Non-background sources include the DELCORA CSOs and DELCORA STP.

5.3 Typical year simulation results

Model results were summarized for comparison with the applicable water quality standards, which include monthly geometric mean (GM) and statistical threshold value (STV) standards. Model results were summarized over the stream reaches that receive CSO discharges, and that occur within Pennsylvania water as shown in Figure 5-2 below. Monthly geometric mean concentrations and exceedances of the STV standard are computed from hourly model output within each of the selected model grid cells. Model results for the typical year are presented in the sections below.

Figure 5-2: Model Grid Cells Used for Presenting Model Results



5.3.1 Ridley and Chester Creek Observations

Excursions above the *Enterococcus* monthly geomean water quality standards occur in the tidal zone of Ridley Creek almost every single month of the simulation period, and about one third of the time in Chester Creek. No excursions above the Fecal Coliform monthly geomean WQS are observed in either creek. The tidal zone of these creeks do not have a current or proposed *E.coli* WQS.

The excursions are largely due to background sources. As shown in Section 4.1.3, the water quality monitoring data shows that wet weather concentration at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek often exceed the monthly geometric mean and STV WQS concentration for the three POCs. DELCORA CSOs have a relatively smaller impact (less than 10%, on average) on monthly geometric mean concentrations than background sources, because they are intermittent discharges that are only active for short time periods within a monthly geometric mean evaluation period. The assimilative capacity of Ridley Creek is less than in Chester Creek due to its smaller stream flows, so DELCORA CSOs have a larger relative impact on in-stream water quality in Ridley Creek versus Chester Creek. Table 5-2 below shows the number of months where water quality standards are exceeded for each of the three POCs in the creeks. Results are shown for all sources (background and CSOs) and for CSO-only sources. This table shows that CSOs by themselves do not cause water quality violations in the Creeks and are not precluding the attainment of WQS.

5.3.2 Delaware River Observations

Occasional (less than 10%) excursions above the *Enterococcus* monthly geomean water quality standards occur in the Upper Delaware River within the DELCORA LTCPU focus area. No excursions above the Fecal Coliform monthly geomean WQS are observed for the Upper Delaware River. The Upper Delaware River does not have a current or proposed *E.coli* WQS.

Occasional (less than 10%) excursions above all three POC monthly geomean and STV water quality standards occur in the Lower Delaware River within the DELCORA LTCPU focus area. Excursions are somewhat more frequent in the Lower Delaware River than in the Upper Delaware due to the significantly lower water quality standard in the Lower Delaware. Background concentrations near DELCORA are similar in both zones because upstream background sources have a large influence on concentrations in both the upper and lower segments. DELCORA CSOs have a greater impact on the Lower Delaware zone than the Upper Delaware zone because more CSO volume discharges to the Lower Delaware. However, the DELCORA contribution to monthly geometric mean concentrations is generally low (less than 7%, on average) relative to background sources. As shown in Section 4.1.3, the water quality monitoring data shows that wet weather exceedances are observed in the most upstream monitoring location for the Delaware River (DR-01).

Table 5-2 shows the number of months where water quality standards are exceeded for each of the three POCs in the Upper and Lower Delaware River. Results are shown for all sources (background and CSOs) and for CSO-only sources. This tables shows that CSOs by themselves do not cause

water quality violations in the upper or lower Delaware River and are not precluding the attainment of WQS.

Table 5-2: Number of Months Exceeding the Monthly Geomean Water Quality Standard

	Enterococcus Monthly Geomean	Fecal Coliform Monthly Geomean	*E.coli*[1] Monthly Geomean	*E.coli*[1] STV
Ridley Creek				
All Sources	35/36	27/36	n/a	n/a
CSO only	0/36	0/36	n/a	n/a
Chester Creek				
All Sources	14/36	0/36	n/a	n/a
CSO only	0/36	0/36	n/a	n/a
Upper Delaware				
All Sources	2/36	0/36	n/a	n/a
CSO only	0/36	0/36	n/a	n/a
Lower Delaware				
All Sources	5/36	2/36	2/36	12/36
CSO only	0/36	0/36	0/36	0/36

1. No *E.coli* standard currently exists or has been proposed for the tidal portions of Ridley and Chester Creeks or for the upper Delaware River, therefore results for these segments are marked as "n/a" in this table.

5.4 Intended Application of the Water Quality Model

The water quality model is deemed adequate to evaluate compliance with the WQS and the degree to which DELCORA CSOs contribute to non-attainment of WQS. The water quality model will be used to help assess the water quality benefits of potential infrastructure projects considered for the LTCPU (i.e.: CSO alternative scenarios). These CSO alternatives will be simulated by the DELCORA hydrologic and hydraulic (H&H) model (i.e. CSS model) and then evaluated with the receiving water quality model. Resulting changes to in-stream POC concentrations will be compared to the applicable water quality standards as well as to the concentrations observed under the baseline conditions. Water quality model output will be used to summarize the predicted reduction to in-stream POC concentrations.

Two major observations can be made from the water quality modeling application results. One is that background sources dominate the modeled POC concentrations (and by extension, DELCORA CSO loads are small compared to background loads), and the second is that the

DELCORA CSOs by themselves do not cause non-attainment, or preclude the attainment, of WQS. Moreover, the modeling results show that regardless of additional CSO controls, even complete separation, water quality standards would still be exceeded under current conditions because background sources typically prevent compliance with WQS. The modeling results are supported by the water quality data results from the wet weather sampling program, which shows that wet weather concentrations at the most upstream monitoring locations (located upstream of CSO influence) in Chester Creek and Ridley Creek (and to a lesser extent in the Delaware River) often exceed the monthly geometric mean and STV WQS concentration for the three POCs. These monitoring and modeling data taken together indicate the upstream bacteria loads result in a practical impossibility of meeting Water Quality standards in the tidal waters through CSO control. While the Consent Decree addresses the issue of background sources by requiring CSO controls to also be assessed assuming that background sources are reduced to 75% of the applicable WQS, it is not clear that imposing CSO controls under these conditions is reasonable given that there is no current plan for reducing background loads in Chester and Ridley Creeks. The CSO Policy states that "*where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation and a load allocation, or other means should be used to apportion pollutant loads*". Such apportionment of loads does not currently exist for Ridley and Chester Creeks for bacteria.

As stated previously, the intended use of the water quality modeling framework is to evaluate CSO control alternatives with respect to applicable water quality standards and demonstrate that alternatives selected for the LTCPU program will meet the water quality-based requirements of the Clean Water Act and Consent Decree. The water quality model is adequate to assess presumption levels of control to show that the CSOs after controls are in place do or do not preclude the attainment of water quality standards. The model framework could also be used to assess the demonstration approach, however, as explained in this report, the modeling shows that CSOs alone do not cause WQS violation and do not preclude the attainment of WQS, and background loads are currently causing WQS violations upstream of the CSOs and the CSO influence. Without a State plan for estimating the cost and practicality for controlling the background load upstream of DELCORA's CSO area, it is difficult to justify the demonstration approach.

As such, DELCORA will utilize the presumption approach, which is shown in this report to be reasonable in light of the data and analysis as called for in the National CSO Policy.

5.4.1 Interpretation of Section 19.b.iv of the Consent Decree

The typical year simulation results show that background sources prevent compliance with the applicable water quality results during some months, and the CSOs are not precluding the attainment of WQS. DELCORA's consent decree requires that if DELCORA uses the demonstration approach and background sources prevent compliance with water quality standards, then DELCORA must also run its water quality model assuming that background sources have

been controlled to 75% of the applicable water quality standards (EPA, 2015). More specifically, section 19.b.iv of the DELCORA Consent Decree states that "*If background sources currently prevent compliance with the water quality standards, DELCORA shall also assess the impact of each size of the CSO controls assuming background pollutant levels are reduced such that in-stream concentrations upstream of the CSO Outfalls are no more than seventy-five (75) percent of the applicable water quality standard.*"

"*Background sources*" are generally understood to be the sources that would not be controlled through the LTCPU, and includes watershed sources of intermittent POCs (e.g. from washoff of POCs from wildlife and pets due to rainfall) as well as continuous sources (e.g. failing septic tanks, etc.), and CSOs from other communities. In other words, background sources are all sources accounted for in the model except for DELCORA CSOs and the DELCORA WWTP. Based on our interpretation of this consent decree language, we could reduce background sources to 75% of the water quality standard during months when there is an excursion above the water quality standard and background sources exceed 75% of the water quality standard.

The Consent Decree states that simulations be conducted with background sources set to seventy-five percent of the water quality standards "*upstream of the CSO outfalls*". However the water quality standard upstream of the outfalls (i.e. in the Upper Delaware) is higher than the standard in the Lower Delaware. So if background sources are reduced to seventy-five percent of the Upper Delaware standard, then the Lower Delaware background concentration would still exceed the Lower Delaware standard (i.e. 75% of the *Enterococcus* Upper Delaware River WQS is 66 #/100ml, which is higher than the Lower Delaware River WQS of 33#/100ml).

The assumed intent of this Consent Decree requirement is to provide some assimilative capacity in the river such that the water quality benefits of potential DELCORA LTCPU infrastructure projects can be more readily identified. With that understanding, the proposed approach to reducing background sources is to separately evaluate CSO controls in the Lower and Upper Delaware zones. First, background sources would be controlled to 75% of the Upper Delaware and Tidal Tributary standard, and control scenarios would be evaluated for CSOs discharging directly to the Upper Delaware and to Chester and Ridley Creeks (which discharge to the Upper Delaware). Second, background sources would be controlled to 75% of the Lower Delaware standard, which would require a larger reduction in background sources, and control scenarios would be evaluated for CSOs discharging directly to the Lower Delaware.

The model has been configured to separately track the in-stream concentration associated with background sources from the in-stream concentration associated with DELCORA sources (CSO and WWTP). This separate accounting will allow for background sources to be reduced independently from non-background sources. Using the time series output from the model, the background sources will be scaled back in the tributaries and in the Upper Delaware River to 75% of the Tidal Tributaries & Upper Delaware River WQS using scaling factors that are specific to each water segment and each month such that background sources are at 75% of the applicable water quality standard for months when non-compliance can be demonstrated.

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APPENDIX A
Bathymetry Survey of Ridley and Chester Creeks

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Memorandum

From:	Cullen O'Brien, LimnoTech	**Date:**	4/30/2017
		Project:	DELCORA
To:	Carrie Turner, LimnoTech Anouk Savineau, Limnotech	**CC:**	Click here to enter text.

SUBJECT: Bathymetric Survey of Chester and Ridley Creeks

This memo summaries field work activities conducted by LimnoTech the week of March 27, 2017. An elevation (bathymetric) survey was completed in support of water quality model development on the lower portions of Chester and Ridley Creeks. The creeks are located in the city of Chester, Pennsylvania and are tidally influenced tributaries to the Delaware River. The field crew was made up of LimnoTech employees Cullen O'Brien and Robert Betz.

Survey methods consisted of acquiring cross sectional bank and bed elevation data. Reaches surveyed included the lower 2.75 miles of Chester Creek and 3.25 miles of Ridley Creek to their discharge into the Delaware River. The most upstream transect location corresponds to the most upstream water quality sampling location included in the 2017 wet and dry weather monitoring program conducted by Weston, Greeley and Hansen, and LimnoTech. Transects were collected on ¼-mile interval spacing. Access to the creeks on the upper portions, generally greater than 1 mile upstream, was by wading where the bottom was shallow and firm. The portions below 1 mile were too deep and soft to be accessed on foot and a john boat with tagline was utilized.

Survey position and elevation was collected using Real Time Kinematic-Global Positioning System RTK-GPS techniques. This technique utilizes satellite positioning with real-time corrections for accurate georeferencing spatial locations and reference information to convert measured depths to elevations. GPS equipment consisted of a Trimble GeoXH centimeter edition with external Hurricane antenna. Real-time position corrections were accessed through cellular connection with the Pennsylvania Virtual Reference Station (VRS) network, ensuring high accuracy position data. Each creek cross section was surveyed at approximately five locations across the bed, water surface, bank toe, and bank top. Access to the entire upland bank at transect locations was not always possible; so the closest points safely accessed to the bank toe were surveyed. Elevation measurements collected from the boat were completed by marking the location at the water surface and subsequently measuring the water depth.

Quality control for horizontal and vertical position was verified with a local National Geodetic Survey (NGS) benchmark. A benchmark is an established survey monument with a known lateral and longitudinal (X, Y) position and elevation (Z) position that is stable. An approximate error estimate of +/- 0.5 feet in the vertical and less than 0.5 feet for horizontal position was observed at some transects, but the majority of locations surveyed were considerably more accurate. The observed errors are due to applying GPS technology in a challenging environment with overhead obstructions such as tree cover, buildings, and local thunderstorms that can dilute or interfere with the GPS signal.

The map below (Figure 1) shows the transect locations where elevation measurements were collected.

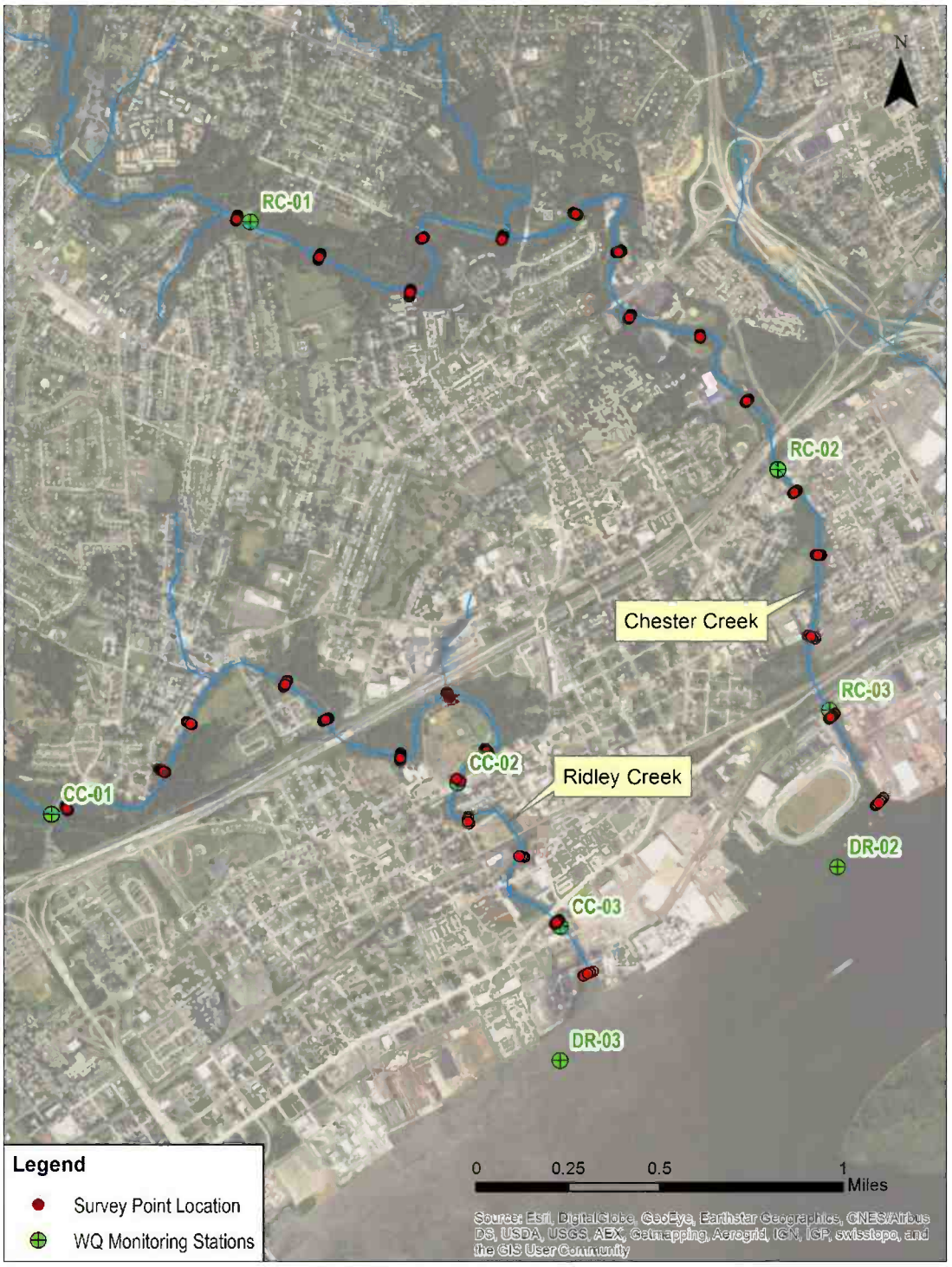

Figure 1: Locations of Creek Elevation Measurements in Chester and Ridley Creeks

Elevation measurements from this survey were compared with similar elevation data from a 1977 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) of the creeks (FEMA, 2015). Though the FEMA study was completed several decades ago, it serves as a useful check on the accuracy and sufficiency of the bathymetric survey data. Figures 1 and 2 compare the LimnoTech survey data with the FEMA data.

A few characteristics of these figures are relevant to the water quality modeling of the creeks. In Chester Creek, the LimnoTech bed elevations are substantially higher (about five to ten feet) than FEMA elevations. Higher contemporary creek elevations influence both the degree of tidal exchange in the lower reaches of the creeks, and travel times of upland runoff and base flow to the Delaware River.

To check for potential bias in the LimnoTech measurements, the LimnoTech measurements of water surface elevation were compared to similar data maintained by NOAA at a nearby tide gage (Philadelphia gage, #8545240). These measurements of water surface elevation agreed well (within two inches) which is a strong indication that the LimnoTech creek bed elevations are not biased high.

Higher creek bed elevations near the Chester Creek mouth are an indication that soft sediments have accumulated there since the 1970s. The highest observed peak flow in Chester Creek occurred a few years before the FEMA survey (in 1971, peak flow of 21,000 cfs) while recent peak flows have been significantly lower (average peak flow of 4,000 cfs in the last ten years) (USGS, 2017). Lower contemporary peak flows may have allowed for the accumulation of soft sediments in the lower reaches of Chester Creek.

Another significant observation from the LimnoTech data is that a pipe crossing near river mile 1.0 in Chester Creek created a high point in the creek bed profile. This high point acts to slightly reduce upstream water currents during lower flow conditions. This would tend to lengthen travel times of bacteria.

In Ridley Creek the LimnoTech data show a more constant bed slope between river miles 2.0 and 3.5 than the FEMA data. This is because low head dams existed in the 1970s near river miles 2.0 and 3.0, but are no longer in place. These dams previously acted to accumulate sediments in their shallow upstream pools, but when the dams were no longer present these accumulated sediments were likely washed away downstream.

These comparisons between the LimnoTech survey data, the historical FEMA data, and the NOAA tide gage, show consistency and provide confidence in the data collected. These comparison also help to identify locations where the creek bed has changed in the last several decades in ways that would influence creek hydraulics and pollutant transport.

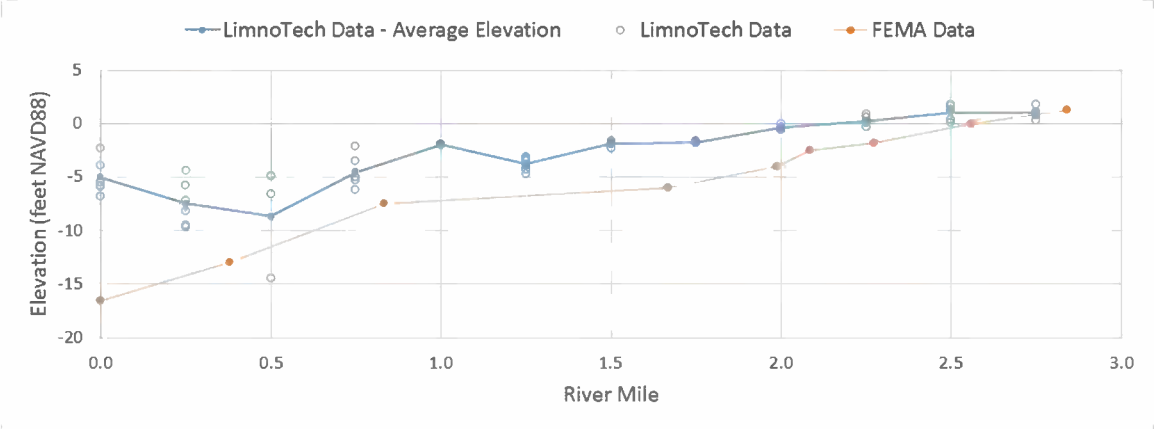

Figure 2: Comparison of Chester Creek bed elevation measurements

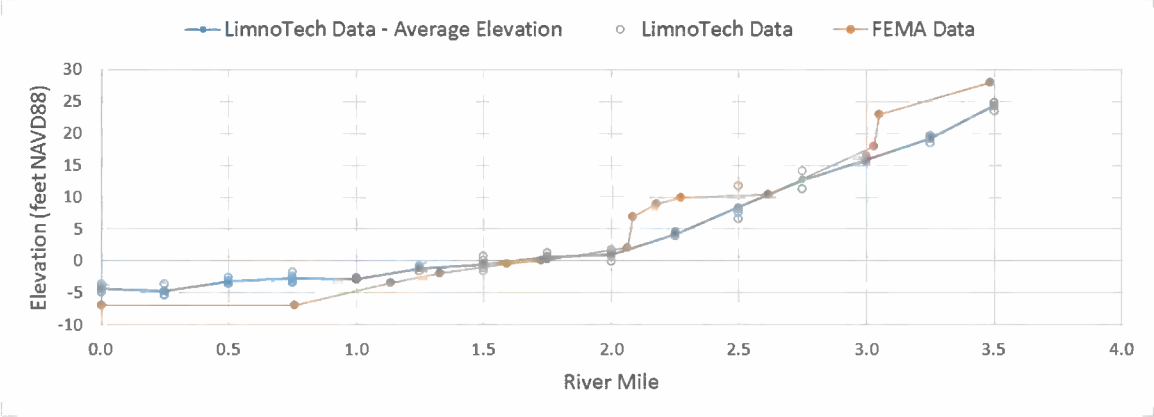

Figure 3: Comparison of Ridley Creek bed elevation measurements

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FEMA, 2015. Flood Insurance Study: Delaware County, Pennsylvania. Volume 1 of 2. Revised September 2, 2015. Flood Insurance Study Number 42045CV001B.

USGS, 2017. Peak Streamflow for Pennsylvania: USGS 01477000 Chester Creek near Chester, PA. Website accessed on April 25, 2017 at: https://nwis.waterdata.usgs.gov/pa/nwis/peak/?site_no=01477000&agency_cd=USGS

APPENDIX B
DELCORA Water Quality Sampling Report

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Water Quality Sampling Report

October 2017

GREELEY AND HANSEN

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

1.1 Background of DELCORA's Facilities

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA, as shown on Figure 1-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer regulated outfalls controlling storm overflows. The location of Chester City's service area is illustrated on Figure 1-2.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western Service Area discharges to DELCORA's Western Regional Treatment Plant (WRTP). The Eastern Service Area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP.

1.2 CSO and Receiving Water System Description

The Chester Combined Sewer Overflow (CSO) system contains 26 permitted outfalls and they discharge to three receiving water bodies: the Delaware River, Chester Creek, and Ridley Creek. However, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. Figure 1-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility. Figure 1-3 also provides a sewer characterization and illustrates the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 1-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

1.3 NPDES Permit Requirements

There are a total of 26 combined sewer overflow outfalls listed with 25 discharge points (Outfall #009 and #010 both discharge at Outfall #009) in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

Part C - Other Requirements, Section V - Combined Sewer Overflows of the NPDES Permit details DELCORA's responsibilities with respect to the CSO system including reporting, continued implementation of and continued compliance with the Nine Minimum Controls (NMC), and implementation of the existing Long-Term Control Plan (LTCP) dated April 1999 and the July 2008 addendum to the LTCP until the updated LTCP is approved.

1.4 Consent Decree Requirements

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated LTCP to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraph V.A.15 (Water Quality Model Plan) requires that within ninety (90) days after EPA reviews and approves the Alternatives Evaluation Approach, DELCORA shall submit to EPA and PADEP a Water Quality Model Plan for review and approval.

The Alternatives Evaluation Approach Report was approved by US EPA on October 13, 2016. The "Demonstration Approach" was selected for each CSO, receiving streams based on the methodology outlined in the Alternatives Evaluation Report.

1.5 Water Quality Sampling Program Purpose and Objectives

The "Demonstration Approach" requires that a Water Quality Model be developed for each receiving stream. The Water Quality Modeling effort will require calibration and validation of the model and therefore Water Quality Sampling is required. The Water Quality Sampling Program will gather data required for this effort. The three water bodies that receive overflows from DELCORA's CSS include the Delaware River, Chester Creek and Ridley Creek.

1.6 Water Quality Sampling Report Purpose and Objectives

The purpose and objective of the Water Quality Sampling Report is to provide a detailed description of the water quality sampling task undertaken to gather field data as required to build and calibrate the Water Quality Model in accordance with the Water Quality Monitoring and Modeling Work plan (Greeley and Hansen / Limnotech, Revised July 2017). The data gathered through sampling efforts on the Creeks, River, Combined Sewer Outfalls (CSO) and Stormwater (SW) locations has been analyzed and is discussed at length in this report. The report also provides a summary of the sampling activities for each

Dry and Wet weather sampling event along with laboratory testing results and in-situ field data collected on-site for each sampling event.

Figure 1-1: DELCORA'S Conveyance Systems

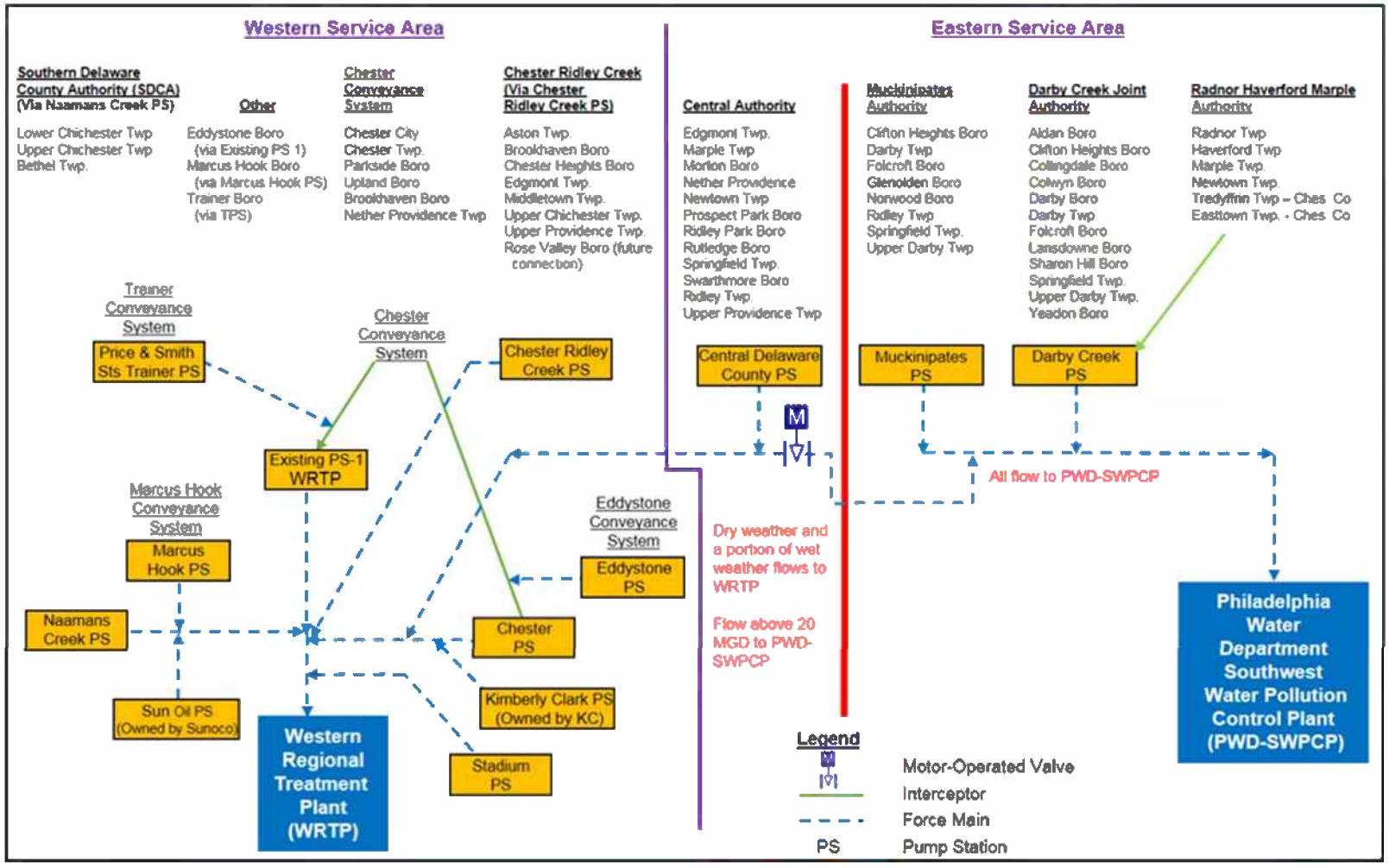


Figure 1-2: DELCORA's Service Area

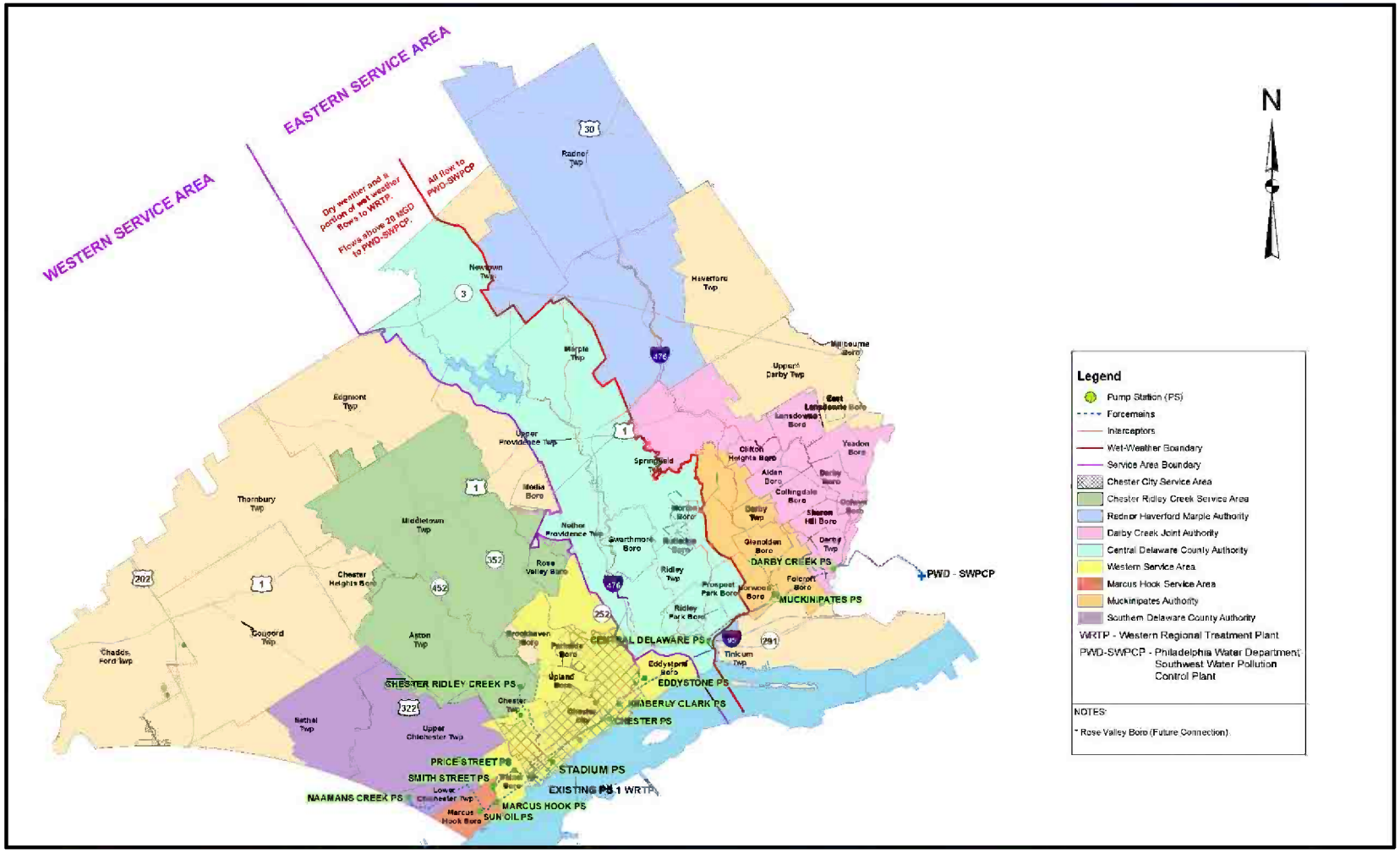


Figure 1-3: Location of Regulators and Combined Sewer Outfalls with Drainage Areas

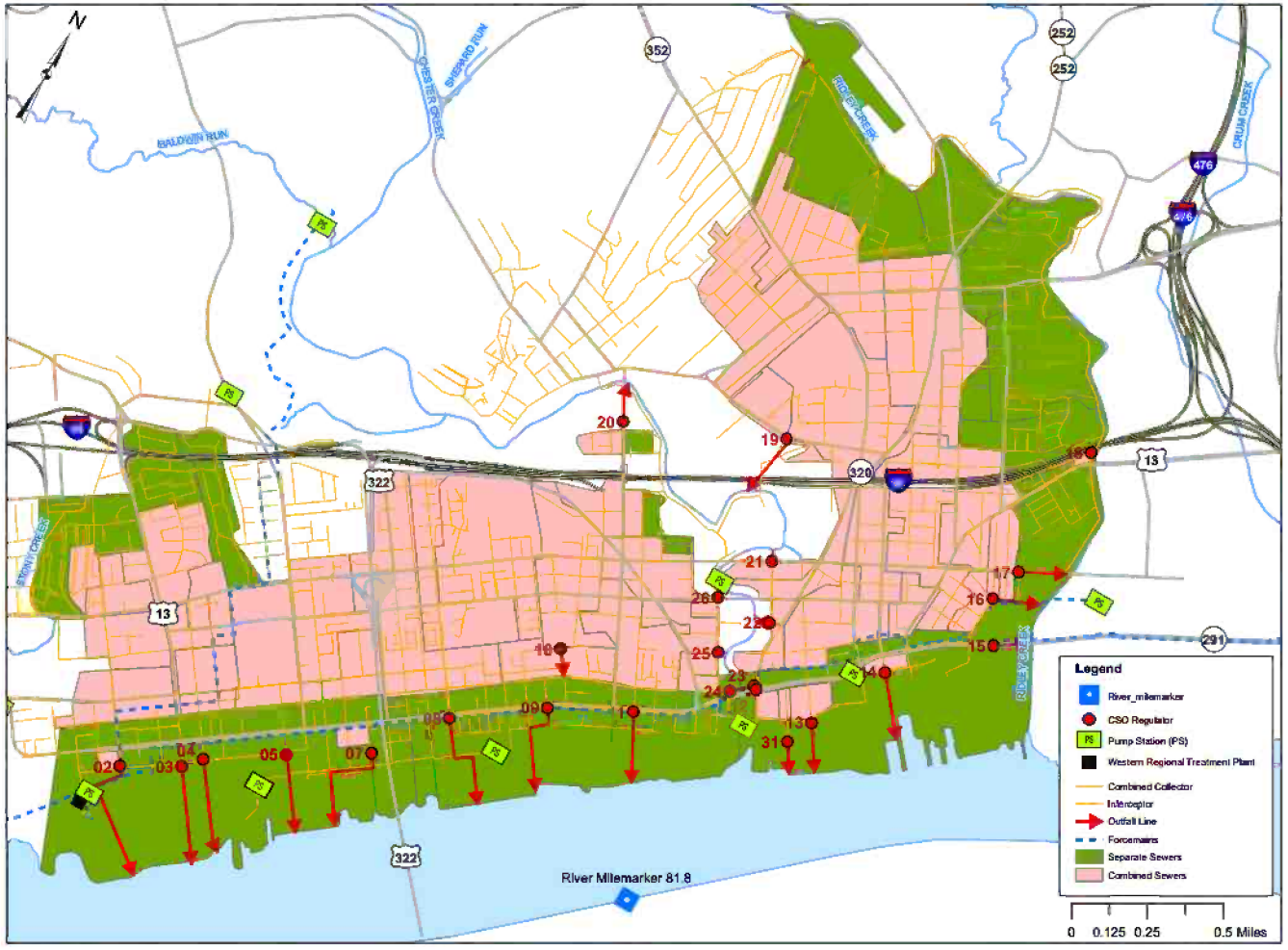
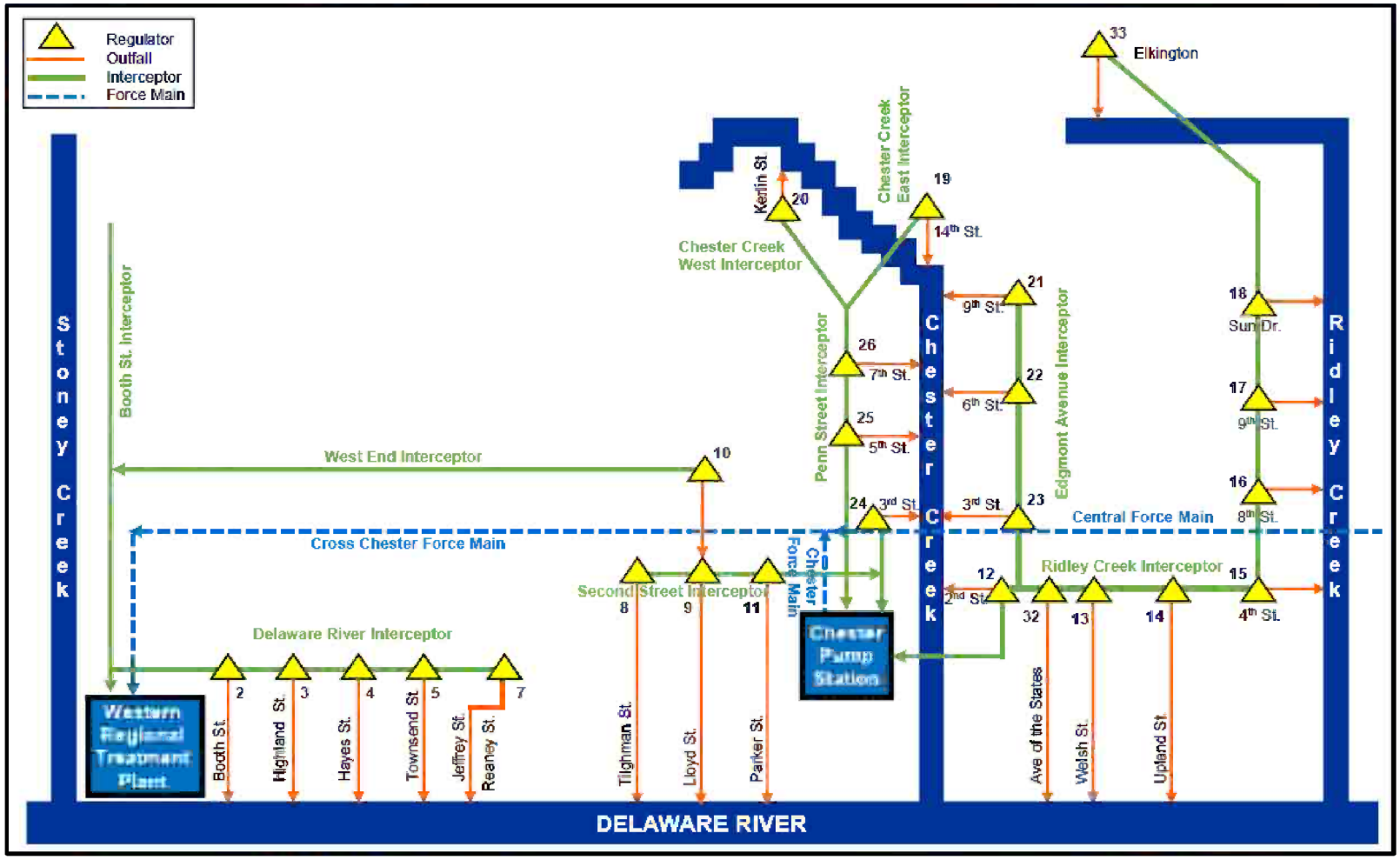


Figure 1-4: Schematic of Chester CSO System



Section 2 Sampling and Analysis Plan Overview

2.1 Existing Water Quality Monitoring Overview

The Water Quality Monitoring Program (WQMP) was designed to collect data that will be used to assess water quality concerns identified in the Delaware River watershed and its tributaries, Chester Creek and Ridley Creek, in the vicinity of Chester, PA. Pollutants of concern (POCs) are identified in the Identification of Sensitive Areas and Pollutants of Concern Report (Greeley and Hansen, 2016c) which was approved by US EPA on October 13, 2016. Table 2-1 below lists the POCs that were identified which exceeded the maximum water quality standards (WQS) in the receiving streams and were approved for further investigation through water quality monitoring and modelling. The POCs are Fecal coliform, *E. coli*, and *Enterococcus* and are the primary focus of the WQMP. Figure 2-1 shows the water quality standards in the receiving streams.

Table 2-1: List of Pollutants of Concern (POC)

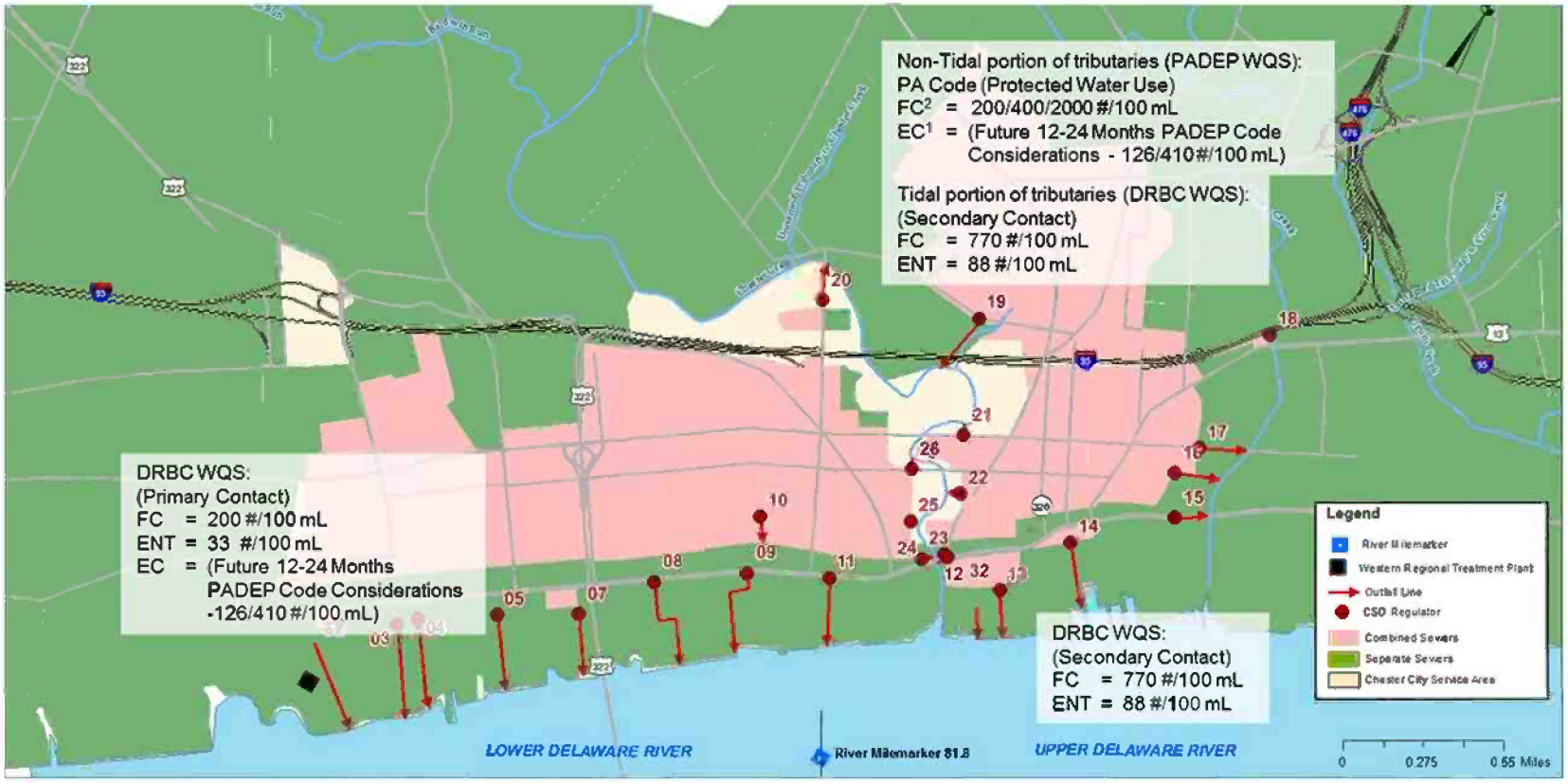
No.	Upper Delaware River		Lower Delaware River		Chester Creek		Ridley Creek	
Pollutants of Concern (>10% of observed samples exceed WQS)								
1	Fecal Coliform[b]	100%	Fecal Coliform[b]	100%	Fecal Coliform[a],[b]	100%	Fecal Coliform[a],[b]	100%
2	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%
3	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%

[a] Based on historical sampling conducted in 2010 upstream and downstream of CSO outfalls only on Chester and Ridley Creeks.

[b] Fecal Coliform and Enterococcus are listed as POCs due to both being parameters typically associated with CSOs.

[c] DRBC regulations are available for Enterococcus and it is typically associated with CSOs and therefore it is included as a POC. However, in consultation with PADEP Enterococcus could be replaced with E. coli bacteria in the future (based on the anticipation that national standards on E. coli will be adopted in Pennsylvania) and therefore E.coli is also included as a POC.

Figure 2-1: Water Quality Standards in the Receiving Streams



[1] E.coli (EC) standards likely to be codified by PADEP 12-24 months from July 2017. These criteria would apply to the non-tidal tributaries and Delaware River below R.H. 81.8, during recreational months only (May 1 - September 30). First value is a geometric mean standard, second is a statistical threshold value (STV) standard (no more than 10% of concentrations can be above this value).

[2] First value is a geometric mean standard, second is a statistical threshold value (STV) standard (no more than 10% of concentrations can be above this value), third value is a non-recreational season standard (October 1 - April 31).

2.2 Sampling and Analysis Plan Overview

Water quality sampling was undertaken at thirteen (13) in-stream locations (seven of which are Delaware River sampling locations), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) stormwater locations in the City of Chester municipal separate storm sewer system, as shown in Figure 2-1. Water quality sampling was conducted as follows:

- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area were sampled for water quality for (3) dry weather events; one of which was targeted for collection during a tributary low-flow period (less than 25th percentile flow). The mid-stream and far-shore Delaware River locations were not sampled during the dry weather surveys because the water quality in the river is found to be relatively uniform laterally due to the lack of active sources during dry weather. These dry weather events were distributed across the sampling season, which was from March through June of 2017. Grab samples and *in situ* measurements were collected at each location during each event.
- All thirteen (13) in-stream locations were sampled for water quality using grab samples and *in situ* monitoring for three (3) discrete wet weather events, according to the surface water quality monitoring program protocols described in the Water Quality Monitoring and Modeling Work Plan (Greeley and Hansen / Limnotech, Revised July 2017);
- Up to four (4) CSO and two (2) stormwater outfall locations were sampled for water quality for the same three (3) discrete wet weather events according to the outfall monitoring program protocols described in the Water Quality Monitoring and Modeling Work Plan (Greeley and Hansen / Limnotech, Revised July 2017). Samples for all outfalls were collected as grab samples.

The sampling events were planned and distributed across the sampling season, which was from March through June 2017.

2.3 Sampling Locations

Sampling locations were selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters are designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in Figure 2-2.

Tables 2-2, 2-3 and 2-4 include summaries of the rationales for each sampling location selected. The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater and Chester CSO pollutant loads. The Delaware River sampling locations provided a characterization of water quality entering the Chester CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples were collected across the transect corresponding to the DR-03 sampling location during each sampling round, when sampling across the river was feasible, to characterize lateral variability in the Delaware River during storm events.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency of overflow, their overflow volume, and their accessibility. The stormwater sampling locations

Figure 2-2: Receiving Water, Combined Sewer (CSO), and Stormwater (SW) Sampling Locations

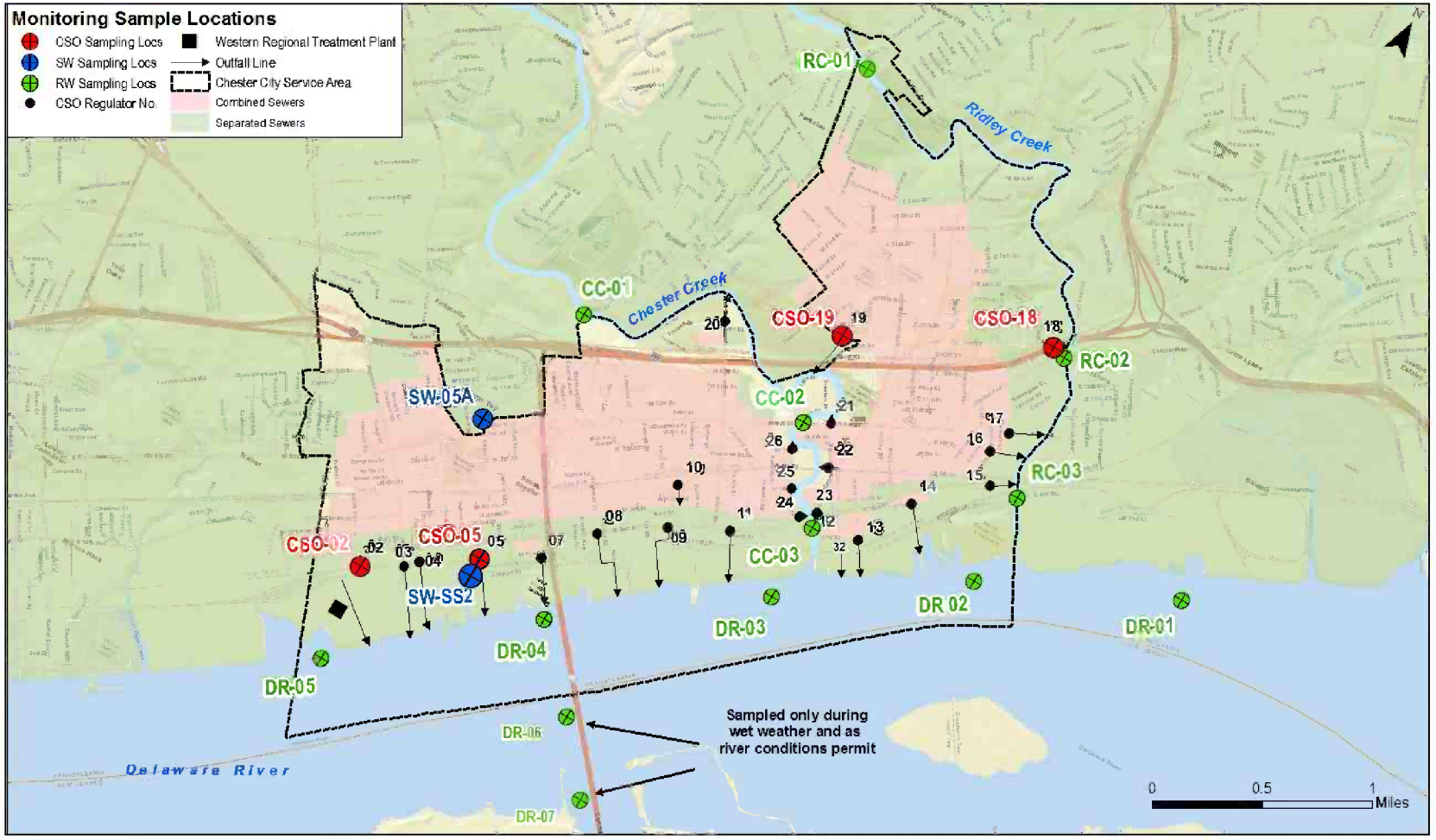


Table 2-2: Tributary Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CC-01	39.850122	-75.386348	Chester Creek	Tributary	Chester Creek at Upland-Incinerator Rd.	Upstream of all City sources and upstream of tidal influence
CC-02	39.850709	-75.365530	Chester Creek	Tributary	Chester Creek at the 9th St Bridge; 54 W 9th St	Characterize impacts from non-CSO urban runoff sources
CC-03	39.845227	-75.360284	Chester Creek	Tributary	Chester Creek at E 2nd St., William Penn's Landing Park	Characterize impacts from all CSOs discharging to Chester Creek
RC-01	39.873264	-75.375183	Ridley Creek	Tributary	Ridley Creek at Chester Park Drive Bridge; 298 East Elkington Blvd	Upstream of all City sources and upstream of tidal influence
RC-02	39.863016	-75.348686	Ridley Creek	Tributary	Ridley Creek at Morton Ave. Bridge; 1300 Sun Drive	Characterize impacts from non-CSO urban runoff sources
RC-03	39.853435	-75.346350	Ridley Creek	Tributary	Ridley Creek at East 4th St. (Harrah's) Bridge	Characterize impacts from all CSOs discharging to Ridley Creek

Notes:
[1] GPS Coordinates, WGS 1984

Table 2-3: Main Stem Receiving Water Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
DR-01	39.85282	-75.3299	Delaware River	Main stem	Delaware River between Ridley Creek and Crum Creek	"Upstream" of DELCORA's CSO discharges[2]
DR-02	39.84715	-75.3462	Delaware River	Main stem	Delaware River between CSO-14 and Ridley Creek	Characterize Ridley Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03	39.8398	-75.3606	Delaware River	Main stem	Delaware River between CSO-11 and Chester Creek	Characterize Chester Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-04	39.83132	-75.3766	Delaware River	Main stem	Delaware River at the boat launch off Highway 322	Priority area, in the lower Delaware River (Primary contact area)
DR-05	39.82182	-75.3917	Delaware River	Main stem	Delaware River between CSO-002 and Stony Creek	"Downstream" of DELCORA's CSO discharges[2], in the Atlantic sturgeon sensitive area
DR-06[3]	39.82636	-75.371	Delaware River	Main stem	Delaware River mid-stream along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events
DR-07[3]	39.82203	-75.3665	Delaware River	Main stem	Delaware River far shore (left descending bank) along the transect of DR-04	Characterize lateral variability in the Delaware River during storm events

Notes:

[1] GPS Coordinates, WGS 1984

[2] "Upstream" and "downstream" subject to tidal conditions at time of sampling

[3] These locations will be sampled during the wet weather events only, when river conditions permit. POC concentrations are assumed to be laterally well-mixed during dry weather due to the absence of significant pollutant sources.

Table 2-4: CSO and Stormwater Sampling Locations

Station ID	Latitude[1]	Longitude[1]	Receiving Water	Type	Description	Rationale
CSO-19	39.857132	-75.366105	Chester Creek	CSO	14th and Crozer Hospital; 1 Medical Center Blvd	Discharges to Chester Creek, one of the largest volume CSOs in DELCORA system
CSO-05	39.832598	-75.383958	Delaware River	CSO	Front and Townsend; 101 Townsend St	Discharges to Delaware River, one of the largest volume CSOs in DELCORA system
CSO-02	39.828334	-75.392570	Delaware River	CSO	Front and Booth; 100 Booth St	Aggregates cumulative effect of CS conditions, one of the largest volume CSOs in DELCORA system
CSO-18	39.863501	-75.349203	Ridley Creek	CSO	Sun Drive and Hancock St.; 1310 Sun Dr	Discharges to Ridley Creek
SW-05A	39.838501	-75.387708	Chester Creek	SW	7th and Engle Street; by tennis courts	Characterize runoff quality from predominantly residential area representative of the residential portion of the study area
SW-SS2	39.832853	-75.384193	Delaware River	SW	Front and Townsend; 105 Townsend St	Characterize runoff quality from predominantly commercial/industrial area representative of the commercial/industrial portion of the study area

Notes:
[1] **GPS Coordinates, WGS 1984**

were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the study area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

2.4 Analytical Parameters

All of the in-stream dry and wet weather samples was analyzed for the parameters shown in Table 2-5. The outfall samples was analyzed for *E. coli*, *Enterococcus* and Fecal coliform.

Table 2-5: Analytical and Field Parameters

Parameter	Description	Sampling Program	Type of Measurement
E. coli	Escherichia coli	Dry, Wet	Grab
Enterococcus	Enterococcus sp.	Dry, Wet	Grab
Fecal coliform	Fecal coliform	Dry, Wet	Grab
Temp	Water temperature	Dry, Wet, Receiving Water Only	In-situ
Cond	Conductivity	Dry, Wet, Receiving Water Only	In-situ
Salinity	Salinity	Dry, Wet, Receiving Water Only	In-situ

2.5 Sampling Schedule

2.5.1 Dry Weather Sampling

Collection of water quality samples was performed for three (3) dry weather events; with one dry weather sampling event collected during a low-flow period (less than 25th percentile flow) in Chester Creek and Ridley Creek.

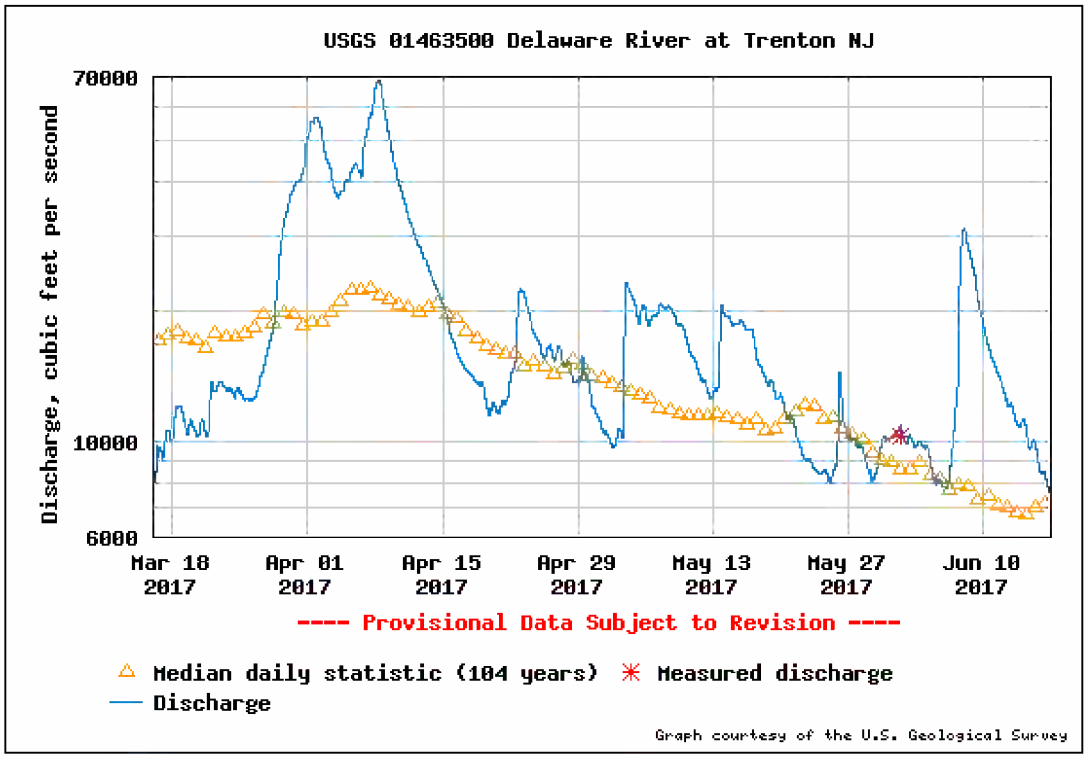
The values and statistics in Tables 2-6 and 2-7 were obtained from the United States Geological Survey (USGS). The USGS StreamStats (https://streamstats.usgs.gov/ss/) website provided the 25th percentile for the period of record for each water body and the National Water Information System (NWIS) provided current flow data. For each Dry Weather Event, the flow listed was reported as the average for the time of the sampling event calculated from 15-minute recorded observations not the average daily flow.

Table 2-6: Gage Information

Water Body	Gage Identification	Gage Description	Latitude	Longitude	Period of Record	StreamStats Weblink	NWIS Weblink
Delaware River	USGS 01463500	Delaware River at Trenton, NJ	40°13'18"	-74°46'41"	1912-2015	https://streamstatsags.cr.usgs.gov/gagepages/html/01463500.htm	https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01463500
Chester Creek	USGS 01477000	Chester Creek near Chester, PA	39°52'08"	-75°24'31"	1931-2015	https://streamstatsags.cr.usgs.gov/gagepages/html/01477000.htm	https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01477000
Ridley Creek	USGS 01476480	Ridley Creek at Media, PA	39°54'58"	-75°24'13"	1986-2015	https://streamstatsags.cr.usgs.gov/gagepages/html/01476480.htm	https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01476480

A graph of the stream flow for each gage over the duration of the sampling program is shown below in Figures 2.3 - 2.5. The percentile for the streamflow during each event was interpolated from the statistical data provided on the StreamStats page.

Figure 2-3: Delaware River Flow, USGS Gage at Trenton, NJ



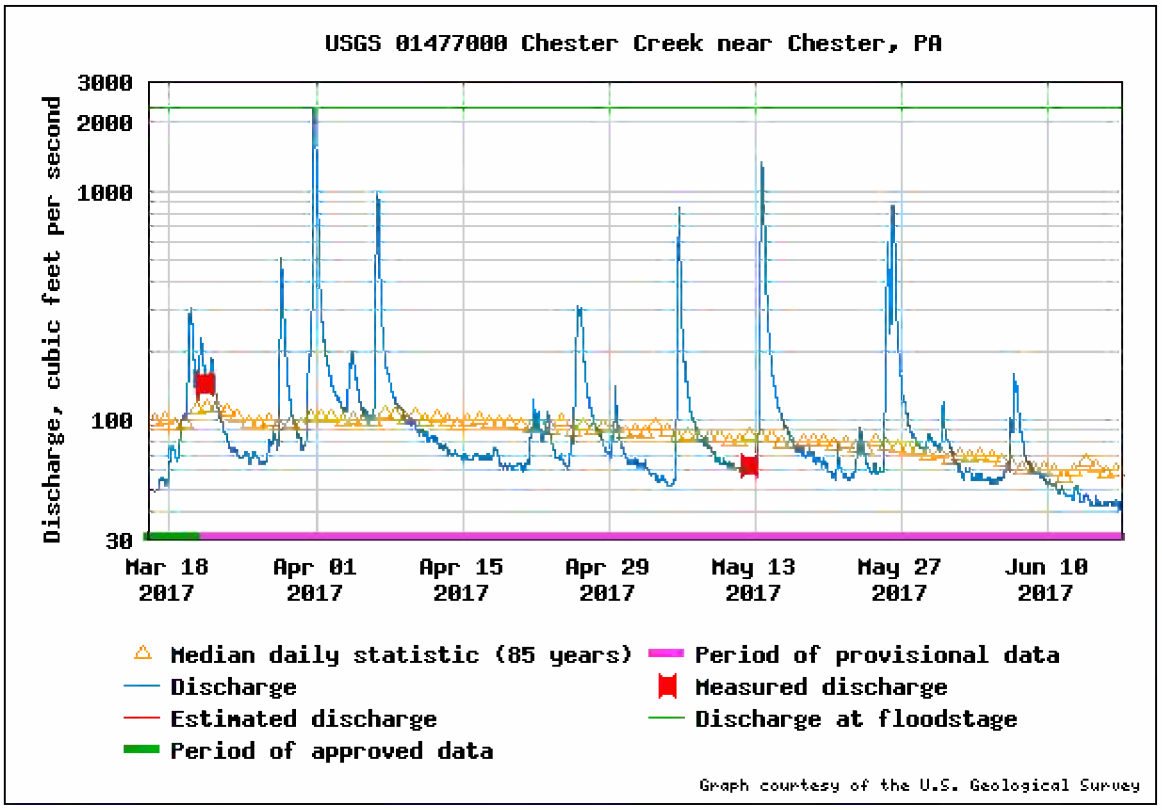
https://nwis.waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01463500&parm_cd=00060&begin_date=2017-03-16&end_date=2017-06-16

Table 2-7: Receiving Waters 25th Percentile Flow

Water Body	Gage Identification	Gage Description	25th Percentile Flow	Dry Weather Event 1 Average Flow		Dry Weather Event 2 Average Flow		Dry Weather Event 3 Average Flow	
			(cfs)	(cfs)	Percentile	(cfs)	Percentile	(cfs)	Percentile
Delaware River	USGS 01463500	Delaware River at Trenton, NJ	4,600	13,323	70.1	16,306	78.1	10,862	62.1
Chester Creek	USGS 01477000	Chester Creek near Chester, PA	41	75.7	60.5	63.9	50.7	46.8	32.2
Ridley Creek	USGS 01476480	Ridley Creek at Media, PA	18	29.4	49	25.0	41.7	19.0	27.5

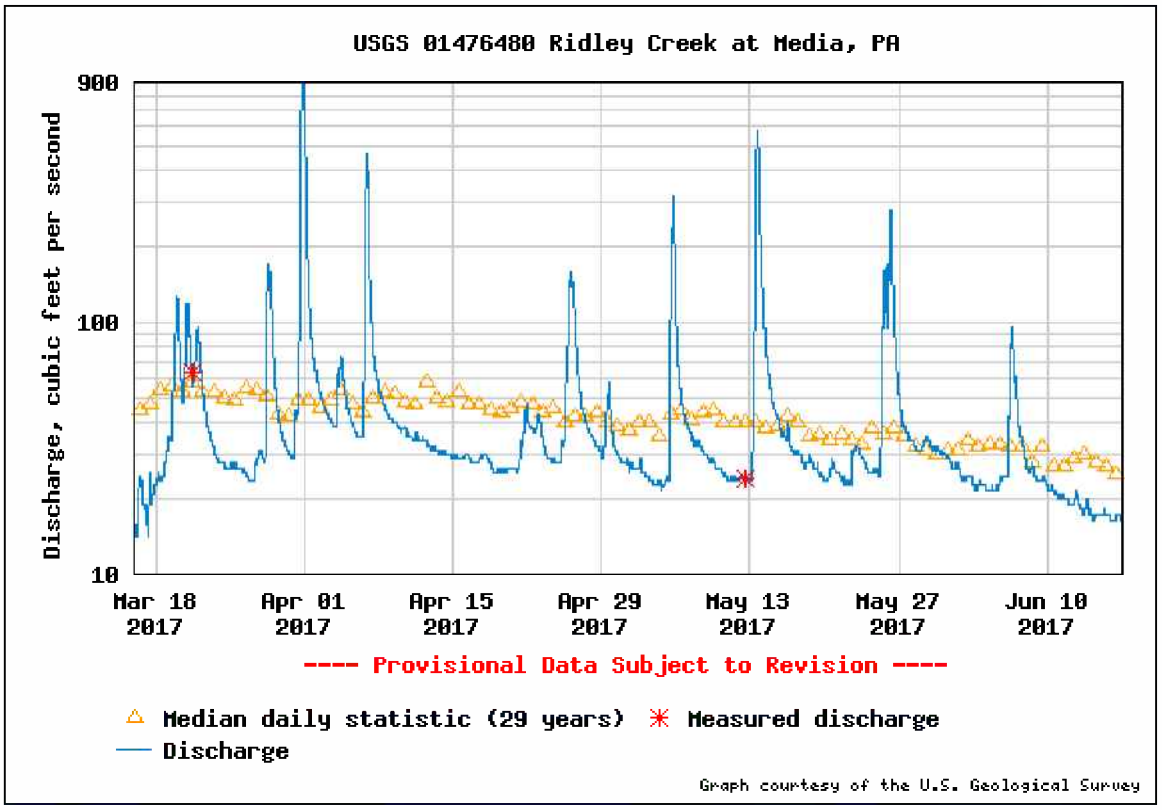
Source:
-25th percentile flow (cfs) and percentile for each water body is courtesy of the U.S. Geological Survey (USGS) StreamStats (https://streamstats.usgs.gov/ss/)
-Observed flow data (cfs) for each Dry Weather Event is courtesy of the following current/historical observations link on the National Water Information System (NWIS) webpage:
Delaware River: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01463500
Chester Creek: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01477000
Ridley Creek: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01476480

Figure 2-4: Chester Creek Flow, USGS Gage near Chester, PA



https://nwis.waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01477000&parm_cd=00060&begin_date=2017-03-16&end_date=2017-06-16

Figure 2-5: Ridley Creek Flow, USGS Gage at Media, PA



https://nwis.waterdata.usgs.gov/nwisweb/graph?agency_cd=USGS&site_no=01476480&parm_cd=00060&begin_date=2017-03-16&end_date=2017-06-16

Two rounds of sampling were conducted for each dry weather survey: one round was completed during ebb (outgoing) tide and the second round was completed during flood (incoming) tide.

Dry weather event samples were taken at eleven (11) locations:

- **Three (3) locations on Chester Creek** that characterizes water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations used reflect these tidal influences on water quality.
- **Three (3) locations on Ridley Creek** that characterizes water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations used reflect these tidal influences on water quality.
- **Five (5) locations on the Delaware River** that characterizes water quality in the vicinity of DELCORA's CSO discharges. Sampling locations used are selected to separate to the extent possible the effect of DELCORA's CSOs on water quality from other sources contributing pollutants to the waterways. Sampling was conducted near the shoreline adjacent to the City of Chester

The locations of these stations are shown in Figure 2-1. Details for the parameters for which the samples were analyzed is provided in Table 2-5. In-situ measurements of physical parameters, such as salinity, temperature, and conductivity were collected at each sampling location with a YSI sonde. In the Delaware River, *in situ* measurements were collected at three depths at each sampling location during each round of sampling.

2.5.2 Wet Weather Sampling

Collection of water quality samples were performed for three (3) wet weather events. The purpose of the wet weather sampling was to characterize the impact of CSO discharges and non-CSO source runoff on in-stream water quality. The wet weather events spanned a range of precipitation, flow and seasonal conditions.

Wet weather event samples were taken at all 13 in-stream locations as well as at up to six source locations in the intervals described below:

- **Six (6) In-Stream Tributary Sampling Locations:** Three (3) locations were on Chester Creek and three (3) locations on Ridley Creek. The locations were the same locations used for the dry weather surveys. Tributary locations were sampled up to five times per event at the following approximate intervals: Hour 0.5-2.5, Hour 4.5-6.5, Hour 8.5-10.5, Hour 14.5-16.5, and Hour 22-24. Sampling intervals were defined by the start of rainfall rather than CSO or SSO activation. A total of 30 samples were collected during each wet weather sampling event from in-stream locations. One field blank and one field duplicate were collected during each event to be used as field quality control (QC).

- **Up to Seven (7) In-Stream Delaware River Locations:** Up to seven locations were on the Delaware River and were sampled up to ten times per event at the following approximate intervals: Hour 0, Hour 2, Hour 4, Hour 6, Hour 9, Hour 12, Hour 15, Hour 18, Hour 21, and Hour 24. Sampling intervals were defined by the start of rainfall rather than CSO or SSO activation. The frequency of sampling was intended to capture in-stream impacts in the vicinity of DELCORA's service area from both DELCORA's CSOs as well as upstream sources. Two additional locations on the Delaware River, one at mid-stream and one near the far shore, were added to characterize lateral variability in water quality during storm event conditions, when sampling across the river is feasible. The sampling regimen was also designed to allow a semi-quantitative mass balance to be computed over a complete tidal cycle. When the river conditions were unsafe for sampling (e.g. small craft advisories, heavy barge traffic, etc.), sampling was suspended for one or more locations and/or sampling rounds. One field blank and one field duplicate were collected during each event to be used as field QC. Final selection of sampling locations and sampling intervals were determined prior to the start of the sampling program and were based on logistic considerations (e.g. can seven locations be sampled and dropped off to a courier within the 3 hour sampling window), safety and accessibility to the Delaware River, and available resources.
- **Up to Six (6) Outfall Locations:** Sampling was be conducted at up to two (2) stormwater outfalls and up to four (4) combined sewer overflow outfalls. The CSO and stormwater sampling locations were finalized prior to the initiation of the sampling program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources. It was assumed that each of the outfall locations will have up to eight sets of samples collected for each event at the following intervals: 1st flush, 30 minutes, and 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours. If a location was found to be not flowing, no sample was collected. One field blank and one field duplicate were collected during each event to be used as field QC.

The locations of these stations are shown in Figure 2-2. The set of parameters for which the samples will be analyzed are summarized in Table 2-4. *In-situ* measurements was not collected at the outfall locations.

Sampling crews conducted all wet weather event sampling using the protocols described in the Water Quality Monitoring and Modeling Quality Assurance Project Plan (Greeley and Hansen / Limnotech, Revised July 2017). Crews were required to keep a City of Chester Map with sampling locations clearly marked as well as a letter from DELCORA permitting the crews access to manholes, shorelines, outfalls, and surface waters (see Appendix J). Samples were delivered to the laboratory where the samples were analyzed for the laboratory parameters identified in Table 2-5.

Determination to mobilize for a Wet Weather Event was a collaborative effort between Greeley and Hansen, LimnoTech, the field sampling contractor and the laboratory contractor personnel. The intent was to identify a 4 to 6 hour window in which a wet weather event that commenced 24 hours in advance to assist in mobilization of the sampling crews.

Section 3 Dry and Wet Weather Sampling Activities

3.1 Dry Weather Sampling Event 1

Dry Weather Sampling Event-1 occurred on March 23, 2017. See Table 2-7 for receiving water flows and percentiles based on USGS gages.

3.1.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). On this date, the observed daily average flows for Chester Creek and Ridley Creek were 75.7 cfs and 29.4 cfs, respectively, at the locations indicated in Table 2-7.

3.1.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek - CC-01, CC-02, CC-03
- Three (3) on Ridley Creek - RC-01, RC-02, RC-03

A single in-situ measurement was collected at every location and sampling round.

See Figure 2-2 for map of sampling locations. See Appendix K for sampling photos.

3.1.1.2 Sampling Round and Sampling Time

An incoming tide and outgoing tide sample was collected at each of the three Chester Creek and three Ridley Creek locations described above along with the required Field Blanks and Duplicates. Field Blanks were collected at the first sampling location for each event regardless of tide condition. Samples from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round - CC-03, RC-03, RC-02, RC-01, CC-02 and CC-01. The number and type of samples collected from the Creeks for Dry Event 1 are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

The sampling event started on March 23, 2017 at 1:00 PM and ended at 7:30 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The outgoing tide samples were collected first followed by the incoming tide later in the evening. The tide data for that date showed a range of high tide to low tide from 9:15 AM to 4:22 PM and a range of low tide to high tide from 4:22 PM to 9: 54 PM. The sample collection times from the Creeks for Dry Weather Event 1 are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.1.1.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) (Weston Solutions, Inc., March 2017) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event 1 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of Dry Weather Event 1 Chain of Custody Forms are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

3.1.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river. On this date, the observed daily average flow for the Delaware River was 13,323 cfs at the location indicated in Table 2-7.

3.1.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Five (5) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

See Figure 2-2 for map of sampling locations.

3.1.2.2 Sampling Round and Sampling Time

There was an incoming tide and outgoing tide sample collected at each of the five Delaware River locations along with the required Field Blanks and Duplicates. The samples on the river were collected in the following order for each sampling round - DR-01, DR-02, DR-03, DR-04 and DR-05. The number and type of samples collected from the river for Dry Weather Event 1 are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

The sampling event started on March 23, 2017 at 12:55 PM and ended at around 6:30 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The outgoing tide samples were collected first followed by the incoming tide later in the afternoon/evening. The tide data for that date showed a range of high tide to low tide from 9:15 AM to 4:22 PM and a range of low tide to high tide from 4:22 PM to 9:54 PM. The sample collection times from the Creeks for Dry Weather Event 1 are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.1.2.3 Field Observation and Sample Management

The grab sample was collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event 1 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix A - Dry Weather Event 1- Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of Dry Weather Event 1 Chain of Custody Forms are shown in Appendix A - Dry Weather Event 1 - Field Logs and Lab Results Summary.

3.2 Dry Weather Sampling Event 2

Dry Weather Sampling Event-2 occurred on 5/10/2017. See Table 2-7 for receiving water flows and percentiles based on USGS gages.

3.2.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). On this date, the observed daily average flows for Chester Creek and Ridley Creek were 63.9 cfs and 25.0 cfs respectively at the locations indicated in Table 2-7.

3.2.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek – CC-01, CC-02, CC-03
- Three (3) on Ridley Creek – RC-01, RC-02, RC-03

A single in-situ measurement was collected at every location and sampling round.

See Figure 2-2 for map of sampling locations.

3.2.1.2 Sampling Round and Sampling Time

An incoming tide and outgoing tide sample was collected at each of the three Chester Creek and three Ridley Creek locations described above along with the required Field Blanks and Duplicates. Field Blanks were collected at the first sampling location for each event regardless of tide condition. Samples

from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round – CC-03, RC-03, RC-02, RC-01, CC-01 and CC-02. The number and type of samples collected from the Creeks for Dry Weather Event 2 are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

The sampling event started on May 10, 2017 at 10:00 AM and ended at 5:45 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The incoming tide samples were collected first followed by the outgoing tide later in the afternoon. The tide data for that date showed a range of low tide to high tide from 7:35 AM to 12:56 PM and a range of high tide to low tide from 12:56 PM to 7: 45 PM. The sample collection times from the Creeks for Dry Weather Event 2 are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for Sample Collection Matrix.

3.2.1.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event 2 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of Dry Weather Event 2 Chain of Custody Forms are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

3.2.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river. On this date, the observed daily average flow for the Delaware River was 16,306 cfs at the location indicated in Table 2-7.

3.2.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Five (5) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

See Figure 2-2 for map of sampling locations.

3.2.2.2 Sampling Round and Sampling Time

There was an incoming tide and outgoing tide sample collected at each of the five Delaware River locations along with the required Field Blanks and Duplicates. The samples on river were collected in the following order for each sampling round - DR-01, DR-02, DR-03, DR-04 and DR-05. The number and type of samples collected from the river for Dry Weather Event 2 are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

The sampling event started on May 10, 2017 at 10:00 AM and ended at 5:45 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The incoming tide samples were collected first followed by the outgoing tide later in the afternoon. The tide data for that date showed a range of low tide to high tide from 7:35 AM to 12:56 PM and a range of high tide to low tide from 12:56 PM to 7: 45 PM. The sample collection times from the Creeks for Dry Weather Event 2 are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.2.2.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event 2 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Dry Weather Event 2 Chain of Custody Forms are shown in Appendix B - Dry Weather Event 2 - Field Logs and Lab Results Summary.

3.3 Dry Weather Sampling Event 3

Dry Weather Sampling Event-3 occurred on 6/13/2017. See Table 2-7 for receiving water flows and percentiles based on USGS gages.

3.3.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). On this date, the observed flows for Chester Creek and Ridley Creek were 46.8 cfs and 19.0 cfs, respectively, at the locations indicated in Table 2-7.

3.3.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek – CC-01, CC-02, CC-03
- Three (3) on Ridley Creek – RC-01, RC-02, RC-03

A single in-situ measurement was collected at every location and sampling round.

See Figure 2-2 for map of sampling locations.

3.3.1.2 Sampling Round and Sampling Time

An incoming tide and outgoing tide sample was collected at each of the three Chester Creek and three Ridley Creek locations described above along with the required Field Blanks and Duplicates. Field Blanks were collected at the first sampling location for each event regardless of tide condition. Samples from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round - CC-03, RC-03, RC-02, RC-01, CC-01 and CC-02. The number and type of samples collected from the Creeks for Dry Weather Event -3 are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

The sampling event started on June 13, 2017 at 12:50 AM and ended at 20:06 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The incoming tide samples were collected first followed by the outgoing tide later in the evening. The tide data for that date showed a range of low tide to high tide from 10:33 AM to 3:42 PM and a range of high tide to low tide from 3:42 PM to 10:24 PM. The sample collection times from the Creeks for Dry Weather Event 3 are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.3.1.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event-3 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Dry Weather Event 3 Chain of Custody Forms are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

3.3.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river. On this date, the observed flow for the Delaware River was 10,862 cfs at the location indicated in Table 2-7.

3.3.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Five (5) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

See Figure 2-2 for map of sampling locations.

3.3.2.2 Sampling Round and Sampling Time

There was an incoming tide and outgoing tide sample collected at each of the five Delaware River locations along with the required Field Blanks and Duplicates. The samples on river were collected in the following order for each sampling round - DR-01, DR-02, DR-03, DR-04 and DR-05. The number and type of samples collected from the river for Dry Weather Event 3 are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

The sampling event started on June 13, 2017 at 12:50 PM and ended at 20:06 PM. The sampling times were selected so that they were in between the high tide and low tide time data. The incoming tide samples were collected first followed by the outgoing tide later in the evening. The tide data for that date showed a range of low tide to high tide from 10:33 AM to 3:42 PM and a range of high tide to low tide from 3:42 PM to 10:24 PM. The sample collection times from the Creeks for Dry Weather Event 3 are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

3.3.2.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event-3 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Dry Weather Event 3 Chain of Custody Forms are shown in Appendix C - Dry Weather Event 3 - Field Logs and Lab Results Summary.

3.4 Wet Weather Sampling Event 1

Wet Weather Sampling Event 1 occurred on 3/31/2017. See Table 2-7 and Figures 2-2 thru 2-4 for receiving water flows based on USGS gages.

3.4.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). The observed flows for Chester Creek were 79.1 cfs at the beginning of the sampling event, reached a peak flow of 2,260 cfs at 6:45PM, and was 1,330 cfs when the sampling event concluded. For Ridley Creek, flow was 28.8 cfs at the beginning of the sampling event, reached a peak flow of 898 cfs at 9:30PM, and was 790 cfs when the sampling event concluded. The flow gauge locations are shown on Figure 3-1 - Flow Gauge Locations.

3.4.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek – CC-01, CC-02, CC-03
- Three (3) on Ridley Creek – RC-01, RC-02, RC-03

A first grab sample collected on creek was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges start occurring (whichever occurs first). Significant rainfall began at 11:45 PM and sampling personnel were already in place to begin sampling within the first half hour. Accordingly, the first storm water sample was taken at location SW-SS2 at 11:50 PM and the first creek sample was collected on Chester Creek at CC-03 at midnight 0:00 hours. The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

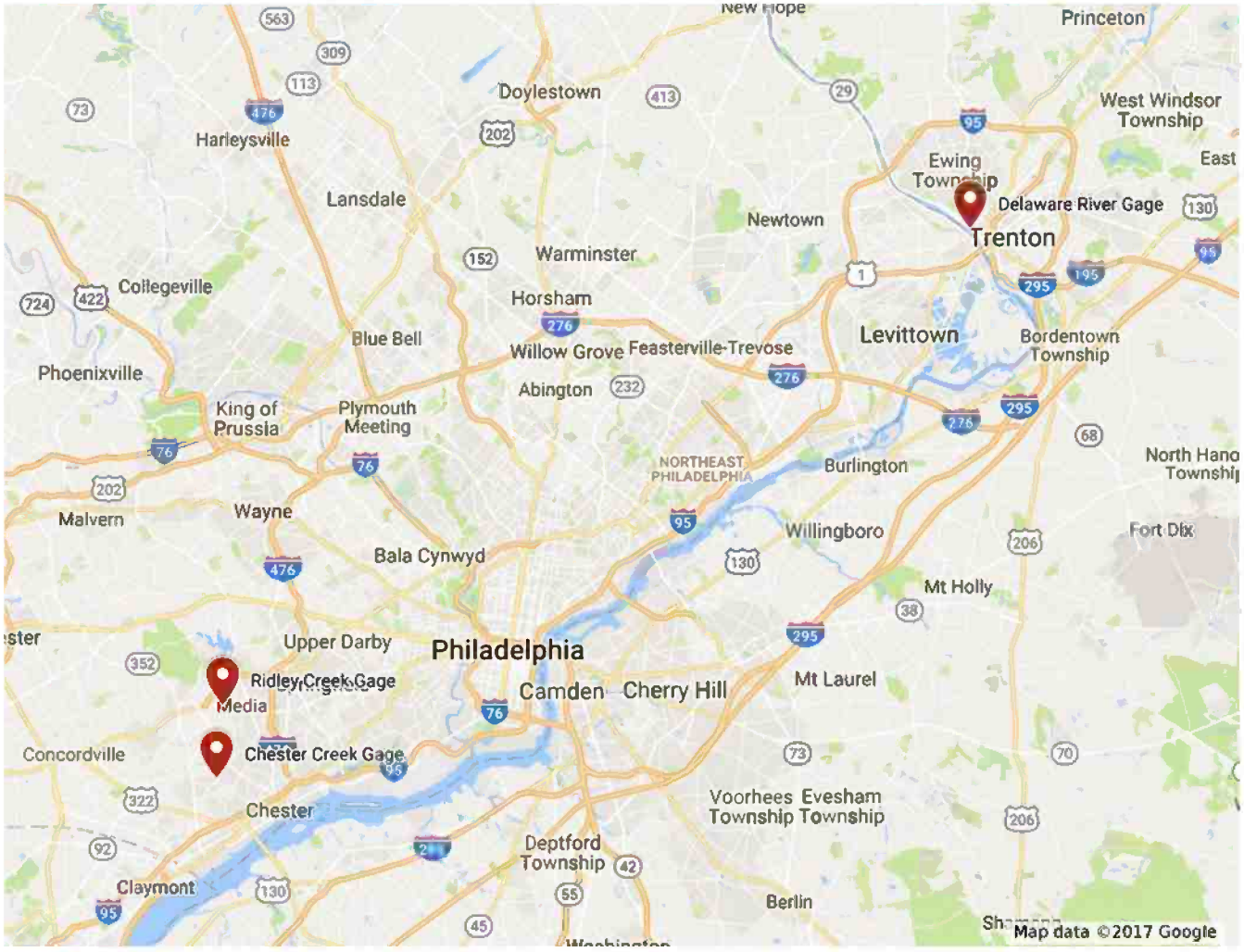
A single in-situ measurement was collected at every location and sampling round.

3.4.1.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24 hour rain event. The intervals for sampling on creeks were at hour 0.5-2.5, hour 4.5-6.5, hour 8.5-10.5, hour 14.5-16.5, and hour 22-24. The samples also included the required Field Blanks and Duplicates as indicated in the Sampling collection matrix shown in Appendix G. Field Blanks were collected at the first sampling location. Samples from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round - CC-03, RC-03, RC-02, RC-01, CC-02 and CC-01. The number and type of samples collected from the Creeks for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The sampling event started on March 31, 2017 at 12:30 AM and ended on April 1, 2017 at 12:30 AM. There were a total of five (5) rounds of sampling conducted on the creeks. The sampling intervals were selected to capture the earlier part of the rainfall event and any impact of CSOs and Storm water runoff on the Creeks water quality. All samples from each location and from each sampling round were collected

Figure 3-1: Flow Gauge Locations



for analysis. The sample collection times from the Creeks for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.4.1.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event 1 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix D – Wet Weather Event 1 – Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 1 Chain of Custody Forms are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

3.4.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river and 2 locations, mid-channel and New Jersey side, on a transect near the Commodore Barry Bridge. On this date, the observed flow for the Delaware River was 44,100 cfs at the location shown on Figure 3-1.

3.4.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Seven (7) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05, DR-06, DR-07

A first grab sample collected on river was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges start occurring (whichever occurs first). The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

3.4.2.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24 hour rain event. The intervals for sampling on creeks were at hour 0, hour 2, hour 4, hour 6, hour 9, hour 12, hour 15, hour 18, hour 21, and hour 24. The samples also included the required Field Blanks and Duplicates as indicated in the Sampling collection matrix shown in Appendix G. The samples on river were collected in the by two boat crews. One of the boat crews were assigned to sample the northern sampling locations DR-01, DR-02, DR-03 and the other boat crew was assigned to sample the southern sampling locations and points across the river at DR-04, DR-05, DR-06 and DR-07. The two boat crews were used to collect samples during the first five (5) sampling rounds to provide enough time to return the samples to the lab and complete the entire sampling loop on the river within the decided sampling intervals. After the first five (5) rounds only one boat crew was required to sample at all locations due to the availability of more time between sampling intervals after completing the entire loop. The number and type of samples collected from the river for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

Boat activities became too hazardous as determined by the boat captain and all on-water activities were halted at 4:45 AM. A couple of shore grabs were collected at near locations DR-04, DR-05 between 7:00 AM and 7:30 AM. Conditions improved allowing for the resumption of boat activities after a period of approximately 4 hours. Delaware River loop was behind by one (1) entire set due to skipped locations because of boat motor issues, ship docking on river near sampling location and hazardous conditions on river.

See Appendix G for Sample collection matrix.

3.4.2.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Dry Weather Event-1 samples on the creeks was held within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 1 Chain of Custody Forms are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

3.4.3 Activity at Combined Sewer Overflow (CSO) Locations

3.4.3.1 Sample Type and Locations

Grab samples were collected from the following CSO locations:

- Four (4) locations – CSO-02, CSO-05, CSO-18, CSO-19

See Figure 2-2 for map of sampling locations.

3.4.3.2 Sampling Round and Sampling Time

The samples were collected at each of the CSO locations along with the required Field Blanks and Duplicates. The samples at the CSOs were collected in the following order for each sampling round - first flush, 30 minutes, 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours. The samples were collected only if there was any active overflow occurring over the weir at the CSO location. The number and type of samples collected from the river for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The sampling event started on March 30, 2017 at 12:30 AM and ended on April 1, 2017 at around 12:30 AM. The sampling was started at time T=0 at the start of rain fall event to collect the first flush sample. The sampling intervals were distributed over a 24 hour sampling period. If it was found that a CSO was not active then no samples were collected at those locations during those sampling rounds. It was observed that CSO-02 activated very fast whereas CSO-05 took longer to activate compared to CSO-18 and CSO-19. Any samples that were not collected in the previous round were recaptured in the next round so as to have the desired number of samples for analysis. The sample collection times from the CSO locations for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.4.3.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 1 samples at the CSO locations was held within the recommended time for lab analysis. While collecting the samples the sample was collected on the downstream side of the overflow for an active overflow at the CSO locations. The sampling equipment was used and then decontaminated using DI water at every sampling location. The field observations and Field Blanks and Duplicate information is provided in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 1 Chain of Custody Forms are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

3.4.4 Activity at Storm Water (SW) Locations

3.4.4.1 Sample Type and Locations

Grab samples were collected from the following storm water locations:

- Two (2) locations – SW-05A, SW-SS2

See Figure 2-2 for map of sampling locations.

3.4.4.2 Sampling Round and Sampling Time

Samples were collected at both of the storm water locations along with the required Field Blanks and Duplicates. The samples on were collected in the following order for each sampling round - SW-SS2 and SW-05A. The number and type of samples collected for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The sampling event started on March 30, 2017 at 12:30 AM and ended on March 31 at 12:30 PM. The sampling times were distributed to cover the storm over 24 hour period and samples were collected whenever there was active storm flow occurring. The sample collection times from the Storm water locations for Wet Weather Event 1 are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.4.4.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate equipment and protective gear. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 1 samples at the Storm water locations was held within the recommended time for lab analysis. The sampling equipment was used and decontaminated using DI water at every sampling location. The number of samples, Field Blanks and Duplicates are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 1 Chain of Custody Forms are shown in Appendix D - Wet Weather Event 1 - Field Logs and Lab Results Summary.

3.5 Wet Weather Sampling Event 2

Wet Weather Sampling Event 2 occurred on 5/5/2017. See Table 2-7 and Figures 2-2 through 2-4 for receiving water flows based on USGS gages.

3.5.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). The observed flows for Chester Creek were 54.8 cfs at the beginning of the sampling event, reached a peak flow of 841 cfs at 4:15PM, and was 160 cfs when the sampling event concluded. For Ridley Creek, flow was 24.5 cfs at the beginning of the sampling event, reached a peak flow of 315 cfs at 5:30PM, and was 60.8 cfs when the sampling event concluded. The flow gauge locations are shown on Figure 3-1.

3.5.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek – CC-01, CC-02, CC-03
- Three (3) on Ridley Creek – RC-01, RC-02, RC-03

A first grab sample collected on creek was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges start occurring (whichever occurs first). Significant rainfall began at 7:00 AM and sampling personnel were already in place to begin sampling within the first half hour. Accordingly, the first creek sample was taken at 7:20 AM. The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

A single in-situ measurement was collected at every location and sampling round.

3.5.1.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24-hour period. The intervals for sampling on creeks were at hour 0.5-2.5, hour 4.5-6.5, hour 8.5-10.5, hour 14.5-16.5, and hour 22-24. The samples also included the required Field Blanks and Duplicates as indicated in the sampling collection matrix shown in Appendix G. Field Blanks were collected at the first sampling location. Samples from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round - CC-03, RC-03, RC-02, RC-01, CC-02 and CC-01. The number and type of samples collected from the Creeks for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The sampling event started on May 5, 2017 at 7:00 AM and ended on May 6, 2017 at 7:00 AM. There were a total of five (5) rounds of sampling conducted on the creeks. The sampling intervals were selected to capture the earlier part of the rainfall event and any impact of CSOs and Storm water runoff on the Creeks water quality. All samples from each location and from each sampling round were collected for analysis. The sample collection times from the Creeks for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for sample collection matrix.

3.5.1.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protection equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 2 samples on the creeks was within the recommended time for lab analysis. While collecting the samples, field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 2 Chain of Custody Forms are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

3.5.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river and 2 locations, mid-channel and New Jersey side, on a transect near the Commodore Barry Bridge. On this date, the observed flow for the Delaware River was 19,900 cfs at the location shown on Figure 3-1.

3.5.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Seven (7) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05, DR-06, DR-07

A first grab sample collected on river was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges start occurring (whichever occurs first). The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

3.5.2.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24-hour period. The intervals for sampling on the Delaware River were at hour 0, hour 2, hour 4, hour 6, hour 9, hour 12, hour 15, hour 18, hour 21, and hour 24. The samples also included the required Field Blanks and Duplicates as indicated in the sampling collection matrix shown in Appendix G. The samples on the river were collected by two boat crews. One of the boat crews was assigned to sample the northern sampling locations DR-01, DR-02, DR-03 and the other boat crew was assigned to sample the southern sampling locations and points across the river at DR-04, DR-05, DR-06 and DR-07. The two boat crews were planned for sample collection during the first five (5) sampling rounds, to provide enough time to return the samples to the lab and complete the entire sampling loop on

the river within the decided sampling intervals. After the first three (3) rounds, only one boat crew would be required to sample at all locations because of the availability of more time between sampling intervals after completing the entire loop.

As Round 2 was being completed, lightning was observed in the area. Safety protocols required that both boats be removed from the water and that 30 minutes elapse with no lightning before resumption of boat activities. This resulted in a 35-minute delay in the start of Round 3. After the third round of sampling, several punctures were discovered in one of the boat's hull causing water to inundate the boat see Appendix K - Sampling Photos). For safety and maneuverability concerns, this boat was pulled from the river. As the second boat began Round 4, it also encountered mechanical issues when its engine could not propel the boat forward. After inspection, a problem with the transmission was identified and this boat was also removed from the river. It was suggested to switch out the engine so that sampling on the Delaware River could continue, but was unsuccessful due to the incompatibility of the steering systems between the two boats. At this point two (2) rounds were missed, hour 6 and hour 9. As an alternative option (to get as much data as possible) the remainder of sampling on the Delaware River for rounds six through ten were taken from shore locations close to DR-03 and DR- 04. There were no accessible points along Chester City shoreline to collect grab samples for DR-01, DR-02 and DR-05. Grab sample for DR-03 was collected from shore on Norris Street and that for DR-04 was collected from the boat launch ramp near the stadium. Grab samples were collected using bailer and rope along with insitu readings for both locations. For reference, the number and type of samples collected from the river for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The sampling event started on May 5, 2017 at 7:00 AM and ended on May 6, 2017 at 7:00 AM. There were a total of eight (8) rounds of sampling conducted on the Delaware. The sampling intervals were selected to capture the earlier part of the rainfall event and any impact the CSOs and storm water runoff had on river water quality. The sample collection times from the Creeks for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for sample collection matrix.

3.5.2.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 2 samples on the Delaware River was within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples.

Copies of the Wet Weather Event 2 Chain of Custody Forms are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

3.5.3 Activity at Combined Sewer Overflow (CSO) Locations

3.5.3.1 Sample Type and Locations

Grab samples were collected from the following CSO locations:

- Four (4) locations – CSO-02, CSO-05, CSO-18, CSO-19

See Figure 2-2 for map of sampling locations.

3.5.3.2 Sampling Round and Sampling Time

Grab samples were collected at each of the CSO locations along with the required Field Blanks and Duplicates. The samples at the CSOs were collected in the following order for each sampling round - first flush, 30 minutes, 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours. The samples were collected only for the first five (5) rounds for all CSO locations because there was not any active overflow occurring over the weir after 6 hours. The number and type of samples collected from the river for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The sampling event started on May 5, 2017 at 7:00 AM and ended on May 6, 2017 at around 7:00 AM. The sampling was started at time T=0, the beginning of an active overflow, to collect the first flush sample. The sampling intervals were distributed over a 24 hour sampling period, but before sampling rounds six through eight, it was found that no CSOs were actively discharging, therefore no samples were collected at those locations during those sampling rounds. Because of the precipitation intensity for this particular round of sampling, all CSOs discharged within minutes of each other. The sample collection times from the CSO locations for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.5.3.3 Field Observation and Sample Management

The samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 2 samples at the CSO locations was within the recommended time for lab analysis. Samples were collected on the downstream side of the overflow for an active overflow at the CSO locations. The sampling equipment was used and then decontaminated using DI water at every sampling location. The field observations, Field Blanks, and Duplicate information is provided in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples.

Copies of the Wet Weather Event 2 Chain of Custody Forms are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

3.5.4 Activity at Storm Water (SW) Locations

3.5.4.1 Sample Type and Locations

Grab samples were collected from the following storm water locations:

- Two (2) locations – SW-05A, SW-SS2

See Figure 2-2 for map of sampling locations.

3.5.4.2 Sampling Round and Sampling Time

Samples were collected at both of the storm water locations along with the required Field Blanks and Duplicates. The samples at SW-05A and SW-SS2 were collected in the following order for each sampling round - first flush, 30 minutes, 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours. The samples were collected only for the first five (5) rounds for both storm water locations because there was not any flow occurring in the storm sewers after 6 hours. The number and type of samples collected from the river for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs, Chain of Custody Forms, and Lab Results.

The sampling event started on May 5, 2017 at 7:00 AM and ended on May 6, 2017 at around 7:00 AM. The sampling was started at time T=0, the beginning of an active flow, to collect the first flush sample. The sampling intervals were distributed over a 24 hour sampling period, but before sampling rounds six through eight, it was found that neither storm sewer had active flow occurring, therefore no samples were collected at those locations during those sampling rounds. The sample collection times from the CSO locations for Wet Weather Event 2 are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.5.4.3 Field Observation and Sample Management

The samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 2 samples at the storm water locations was within the recommended time for lab analysis. The sampling equipment was used and decontaminated using DI water at every sampling location. The number of samples, Field Blanks and Duplicates are shown in Appendix E – Wet Weather Event 2 – Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 2 Chain of Custody Forms are shown in Appendix E - Wet Weather Event 2 - Field Logs and Lab Results Summary.

3.6 Wet Weather Sampling Event 3

Wet Weather Sampling Event 3 occurred on 5/22/2017

3.6.1 Activity on Creeks

Sampling was conducted on Chester Creek (CC) and Ridley Creek (RC). The observed flows for Chester Creek were 58.1 cfs at the beginning of the sampling event, reached a peak flow of 92.1 cfs at 12:15AM, and was 70.4 cfs when the sampling event concluded. For Ridley Creek, flow was 23.6 cfs at the beginning of the sampling event, reached a peak flow of 32.5 cfs at 8:15PM, and was 28.8 cfs when the sampling event concluded. The flow gauge locations are shown on Figure 3-1.

3.6.1.1 Sample Type and Locations

Grab samples were collected from the following locations on the Creeks:

- Three (3) on Chester Creek – CC-01, CC-02, CC-03
- Three (3) on Ridley Creek – RC-01, RC-02, RC-03

A first grab sample collected on creek was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges started occurring (whichever occurs first). Significant rainfall began at 10:20 AM and sampling personnel were already in place to begin sampling within the first half hour. Accordingly, the first creek sample was taken at 10:42 AM. The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

A single in-situ measurement was collected at every location and sampling round.

3.6.1.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24 hour period. The intervals for sampling on creeks were at hour 0.5-2.5, hour 4.5-6.5, hour 8.5-10.5, hour 14.5-16.5, and hour 22-24. The samples also included the required Field Blanks and Duplicates as indicated in the sampling collection matrix shown in Appendix G. Field Blanks were collected at the first sampling location. Samples from the downstream end of the creeks were collected first to capture the outgoing tide at the earliest. The samples on creeks were collected in the following order for each sampling round - CC-03, RC-03, RC-02, RC-01, CC-02 and CC-01. The number and type of samples collected from the Creeks for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The sampling event started on May 22, 2017 at 9:00 AM and ended on May 23, 2017 at 10:30 AM. There were a total of five (5) rounds of sampling conducted on the creeks. The sampling intervals were selected to capture the earlier part of the rainfall event and any impact of CSOs and Storm water runoff on the Creeks water quality. All samples from each location and from each sampling round were collected for analysis. The sample collection times from the Creeks for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

See Appendix G for sample collection matrix.

3.6.1.3 Field Observation and Sample Management

The samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protection equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 3 samples on the creeks was within the recommended time for lab analysis. While collecting the samples, field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. The sonde was used and decontaminated using DI water at every sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 3 Chain of Custody Forms are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

3.6.2 Activity on Delaware River

Sampling was conducted on Delaware River (DR) with 5 locations on the Pennsylvania side of the river and 2 locations, mid-channel and New Jersey side, on a transect near the Commodore Barry Bridge. On this date, the observed flow for the Delaware River was 9,180 cfs at the location shown on Figure 3-1 - Flow Gauge Locations.

3.6.2.1 Sample Type and Locations

Grab samples were collected from the following locations on the Delaware River:

- Seven (7) on Delaware River – DR-01, DR-02, DR-03, DR-04, DR-05, DR-06, DR-07

A first grab sample collected on river was during T=0 at the beginning for the rainfall event. Time T=0 for collection of the in-stream sample was initiated approximately 0.5 hours after the start of rainfall, or when 0.1 inches of rain had fallen or when CSO discharges started occurring (whichever occurs first). Very light precipitation had occurred intermittently throughout the early morning hours (2:00 AM to 9:00 AM). Steady rainfall began after 9:00 AM, by which time 0.05 inches of rain had fallen, according to the WRTP rain gauge. Sampling personnel were already in place to begin sampling immediately. Accordingly, the first river sample was taken at 9:05 AM. The sampling round intervals for all sampling locations are shown in the sampling collection matrix in Appendix G. See Figure 2-2 for map of sampling locations.

A single in-situ measurement was collected at every location at surface, mid and near bottom depths.

3.6.2.2 Sampling Round and Sampling Time

The grab samples collected on the Creeks as shown above were collected in intervals. The sampling intervals spanned over a 24 hour period. The intervals for sampling on the Delaware River were at hour 0, hour 2, hour 4, hour 6, hour 9, hour 12, hour 15, hour 18, hour 21, and hour 24. The samples also included the required Field Blanks and Duplicates as indicated in the sampling collection matrix shown in Appendix G. The samples on the river were collected by two boat crews. One of the boat crews was assigned to sample the northern sampling locations DR-01, DR-02, DR-03 and the other boat crew was assigned to sample the southern sampling locations and points across the river at DR-04, DR-05, DR-06 and DR-07. The two boat crews were planned for sample collection during the first five (5) sampling rounds, to provide enough time to return the samples to the lab and complete the entire sampling loop on the river within the decided sampling intervals. After the first five (5) rounds, only one boat crew would be required to sample at all locations because of the availability of more time between sampling intervals after completing the entire loop.

In actuality, two boat crews were used for 3 rounds, due to mechanical issues with the boats. After the third round of sampling, several small punctures were discovered in one of the boat's hull causing water to inundate the boat. For safety and maneuverability concerns, the boat was pulled from the river. The second boat also encountered issues at this time when its engine could not propel the boat forward. After inspection, a problem with the transmission was identified and this boat was also removed from the river. An attempt to switch out the engine was made so that sampling on the Delaware River could continue, but was unsuccessful. At this point two (2) rounds were missed, hour 6 and hour 9. As an alternative option (to get as much data as possible) the remainder of sampling on the Delaware River for rounds six through ten were taken from shore locations close to DR-03 and DR- 04. There were no accessible points along Chester City shoreline to collect grab samples for DR-01, DR-02 and DR-05. Grab sample for DR-03 was collected from shore on Norris Street and that for DR-04 was collected from the boat launch ramp near the stadium. Grab samples were collected using bailer and rope along with in-situ readings for both locations. For reference, the number and type of samples collected from the river for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The sampling event started on May 22, 2017 at 9:00 AM and ended on May 23, 2017 at 10:30 AM. There were a total of ten (10) rounds of sampling conducted on the Delaware. The sampling intervals were selected to capture the earlier part of the rainfall event and any impact the CSOs and storm water runoff had on river water quality. The sample collection times from the Creeks for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

See Appendix G for sample collection matrix.

3.6.2.3 Field Observation and Sampling Management

The samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 3 samples on the Delaware River was within the recommended time for lab analysis. While collecting the samples the field observations were noted to indicate any specific weather, water body, site, and sample conditions. In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde at surface, mid and near bottom depths of the river. The sonde was used and decontaminated using DI water at every

sampling location. The field observations and in-situ field measurements including water salinity readings, temperature and conductivity are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 3 Chain of Custody Forms are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

3.6.3 Activity at Combined Sewer Overflow (CSO) Locations

3.6.3.1 Sample Type and Locations

Grab samples were collected from the following CSO locations:

- Four (4) locations – CSO-02, CSO-05, CSO-18, CSO-19

See Figure 2-2 for map of sampling locations.

3.6.3.2 Sampling Round and Sampling Time

Samples were collected at each of the CSO locations along with the required Field Blanks and Duplicates. The samples at the CSOs were collected in the following order for each sampling round - first flush, 30 minutes, 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours. The samples were collected only for the first five (5) rounds for all CSO locations because there was not any active overflow occurring over the weir after 6 hours. The number and type of samples collected from the river for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The sampling event started on May 22, 2017 at 9:00 AM and ended on May 23, 2017 at around 10:30 AM. The CSO sampling was started at time T=0, the beginning of an active overflow, to collect the first flush sample. Significant rainfall began at 10:20 AM and sampling personnel were already in place to begin CSO sampling at first flush, which occurred at 10:25 AM. Because of the precipitation intensity for this particular round of sampling, all CSOs discharged within minutes of each other. The sampling intervals were distributed over a 24-hour sampling period, but before sampling rounds six through eight, it was found that no CSOs were actively discharging, therefore no samples were collected at those locations during those sampling rounds. The sample collection times from the CSO locations for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.6.3.3 Field Observation and Sample Management

The grab samples were collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 3 samples at the CSO locations was within the recommended time for lab analysis. Samples were collected on the

downstream side of the overflow for an active overflow at the CSO locations. The sampling equipment was used and then decontaminated using DI water at every sampling location. The field observations, Field Blanks, and Duplicate information is provided in Appendix F - Wet Weather Event 3 - Field Logs, Chain of Custody Forms, and Lab Results.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 3 Chain of Custody forms are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

3.6.4 Activity at Storm Water (SW) Locations

3.6.4.1 Sample Type and Locations

Grab samples were collected from the following storm water locations:

- Two (2) locations – SW-05A, SW-SS2

See Figure 2-2 for map of sampling locations.

3.6.4.2 Sampling Round and Sampling Time

Samples were collected at both of the storm water locations along with the required Field Blanks and Duplicates. The samples at SW-05A and SW-SS2 were collected in the following order for each sampling round - first flush, 30 minutes, 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours. The samples were collected only for the first five (5) rounds for both storm water locations because there was not any flow occurring in the storm sewers after 6 hours. The number and type of samples collected from the river for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs, Chain of Custody Forms, and Lab Results.

The sampling event started on May 5, 2017 at 7:00 AM and ended on May 6, 2017 at around 7:00 AM. The sampling was started at time T=0, the beginning of active flow, to collect the first flush sample. Significant rainfall began at 10:20 AM and sampling personnel were already in place to begin SW sampling at first flush, which occurred at 10:30 AM. The sampling intervals were distributed over a 24-hour sampling period, but before sampling rounds six through eight, it was found that neither storm sewer had active flow occurring, therefore no samples were collected at those locations during those sampling rounds. The sample collection times from the CSO locations for Wet Weather Event 3 are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

See Appendix G for Sample collection matrix.

3.6.4.3 Field Observation and Sample Management

The sample was collected as per the requirements of the Sampling and Analysis Plan (SAP) using appropriate sampling and personal protective equipment. The samples were preserved immediately on ice for transfer to laboratory for further analysis. The hold time for all the Wet Weather Event 3 samples at the storm water locations was within the recommended time for lab analysis. The sampling equipment

was used and decontaminated using DI water at every sampling location. The number of samples, Field Blanks and Duplicates are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

The samples were handed over the laboratory for analysis with their respective Chain of Custody Forms. The Chain of Custody Forms included details on the sample IDs, type of sample and release of samples. Copies of the Wet Weather Event 3 Chain of Custody Forms are shown in Appendix F - Wet Weather Event 3 - Field Logs and Lab Results Summary.

Section 4 Laboratory Results

The Sampling Program succeeded in acquiring the volume and range of pollutant data needed to construct, calibrate and validate the water quality model. Table 4-1 provides a summary of the number of samples collected for each of the sampling events at each sampling station. Table 4-2 provides a summary of the range of observed pollutant concentrations collected during the dry and wet weather sampling events.

The pollutants of concern (POCs) analyzed in the samples collected in the Sampling Program include fecal coliform, *Escherichia coliform (E. coli)*, and enterococcus. The coliform group has been used to assess sanitary quality in recreational waterways for decades (Standard Methods, 1980). Fecal coliform is a member of the coliform group present in the gut and feces of warm-blooded animals and is used as an indicator of fecal contamination and associated pathogens. The fecal coliform group includes many genera, including *Enterobacter, Klebsiella, Citrobacter, and Escherichia* (Standard Methods, 1998). E. coli is a one member of the fecal coliform group that provides more specificity than fecal coliform as a potential indicator of pathogenic organisms (USEPA, 1986), particularly in freshwater systems (USEPA, 2012). Enterococcus is a subgroup of the fecal streptococcus group, another type of bacteria found in the gastrointestinal tract of warm-blooded animals (Standard Methods, 1998). Enterococci have been found to be the best pathogenic indicator of fecal contamination in marine waters (USEPA, 2012). Because the DELCORA service area includes both freshwater and tidal/marine waterways, all of these indicators are pertinent to assessing water quality conditions in the local waterways and comparing to corresponding water quality standards.

This section describes the laboratory results for each of the individual sampling events. The environmental conditions of each of these sampling events were described in Section 3. Plots of concentrations over time are presented in this section for a subset of locations, and plots for all locations are included in Appendix H. For the tributaries, the flow at the upstream USGS gage is also included in the figures. However, for the Delaware River, no flow values are shown because the nearest flow gage is in Trenton, NJ, which is too far away (~80 miles upstream) to be indicative of local conditions.

The quality of the data with respect to the QAPP objectives are described in additional detail in Section 5. Additional analysis of the data, such as developing Event Mean Concentrations (EMCs) for the CSOs and stormwater locations are described in Section 6.

Table 4-1: Number of Samples Collected During the Sampling Program

Sample Summary	Dry1	Dry2	Dry3	Wet1	Wet2	Wet3	Total
Chester Creek							
CC-01	2	2	2	5	5	5	**21**
CC-02	2	2	2	5	5	5	**21**
CC-03	2	2	2	5	5	5	**21**
Ridley Creek							
RC-01	2	2	2	5	5	5	**21**
RC-02	2	2	2	5	5	5	**21**
RC-03	2	2	2	5	5	5	**21**
Delaware River							
DR-01	2	2	2	8	3	9	**26**
DR-02	2	2	2	8	3	10	**27**
DR-03	2	2	2	8	3	10	**27**
DR-03 (Shore)					5		**5**
DR-04	2	2	2	9	3	10	**28**
DR-04 (Shore)					5		**5**
DR-05	2	2	2	9	3	10	**28**
DR-06				7	3	10	**20**
DR-07				7	3	10	**20**
CSO							
CSO-02				9	5	4	**18**
CSO-05				8	5	5	**18**
CSO-18				7	5	4	**16**
CSO-19				8	5	2	**15**
SW							
SW-05A				8	6	5	**19**
SW-SS2				8	6	5	**19**
Field Blanks and Duplicates							
Blanks	3	2	2	5	4	5	**21**
Duplicates	3	3	3	5	4	5	**23**

Notes: At DR-06 and DR-07, the CSOs and SW locations were only sampled during wet weather. Due to challenges described in Section 3, DR-03 (Shore) and DR-04 (Shore) were added to collect samples from the bank of the river.

Table 4-2: Range of Observed Pollutant Concentrations during Dry and Wet Weather Events

Parameter	Event Type	Location	Minimum	Maximum	Average	Count
E. COLI	DRY	Chester Creek	10	470	130	18
		Delaware River	1	45	17	27
		Ridley Creek	2	1,900	265	16
	WET	Chester Creek	40	22,000	4,937	45
		Delaware River	2	6,900	207	143
		Ridley Creek	56	87,000	5,690	45
		CSO	25,000	1,780,000	254,403	67
		Stormwater	36	156,000	16,248	38
ENTERO-COCCUS	DRY	Chester Creek	8	190	70	18
		Delaware River	1	320	21	22
		Ridley Creek	6	900	167	16
	WET	Chester Creek	40	41,000	9,584	44
		Delaware River	2	40,000	476	141
		Ridley Creek	20	31,000	8,112	45
		CSO	4,800	3,220,000	193,961	67
		Stormwater	1,091	505,000	72,206	38
FECAL COLIFORM	DRY	Chester Creek	4	1,200	361	17
		Delaware River	2	54	27	30
		Ridley Creek	4	3,800	709	18
	WET	Chester Creek	52	44,000	7,134	45
		Delaware River	2	10,000	250	145
		Ridley Creek	44	103,000	7,646	45
		CSO	15,300	1,630,000	165,486	67
		Stormwater	20	1,480,000	54,081	38

4.1 Dry Weather Sampling – Event 1 Results

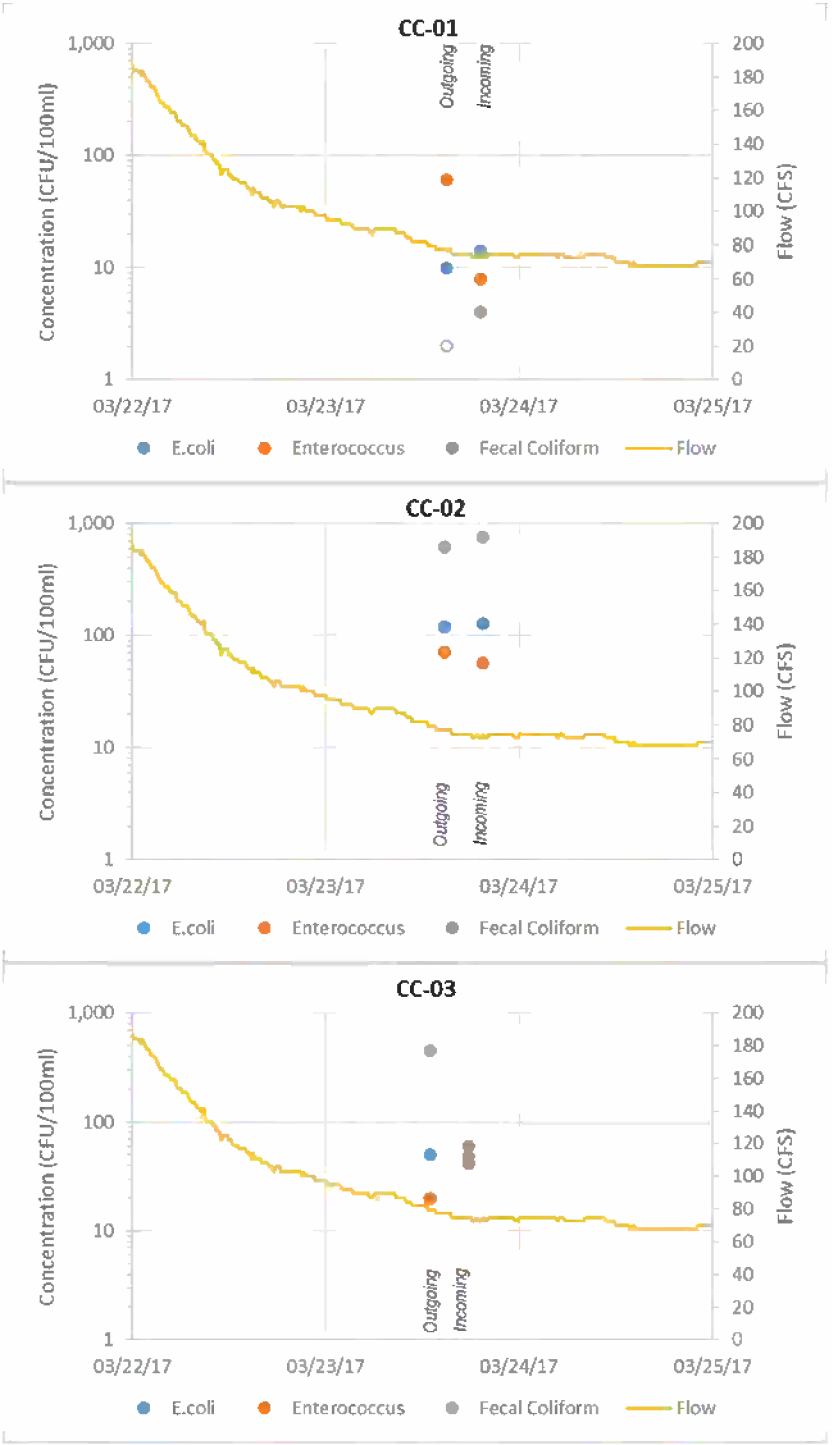
The first dry weather event (Dry 1), on March 23, 2017, had the highest tributary (i.e. Chester Creek, Ridley Creek) flows of all of the dry weather sampling events (as shown in Table 2-7). This was expected as the Spring (mid-March) season tends to have higher base flow due to snow melt infiltration and higher frequency of rainfall that typically occurs. Laboratory results are presented by waterbody below.

4.1.1 Chester Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and the majority of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-1 shows the concentrations at each station. Note that in this figure, solid dots are measured results while open dots are non-detect results plotted at the detection limit. Additional plots are provided in Appendix H.

Fecal coliform levels tended to have the highest concentrations of the three pollutants of concern (POC) while enterococcus tended to have the lowest concentrations. However, the fecal coliform results at CC-01 appear to be anomalous, as they are the lowest concentrations of the POCs and lower than corresponding E. coli levels, which is physically impossible because E. coli is a subgroup within the fecal coliform group. These anomalies are likely mostly due to the difficulty in measuring low levels of bacteria concentrations (see Section 5 for additional discussion). These figures also illustrate an increase in each POC levels from the upstream location (CC-01) to the downstream locations (CC-02 &CC-03) during both incoming and outgoing tidal conditions. This may be indicative of dry weather sources of bacteria entering Chester Creek, such as illicit discharges and connections or wildlife and pet contributions. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

Figure 4-1: Dry Weather 1 Concentrations in Chester Creek

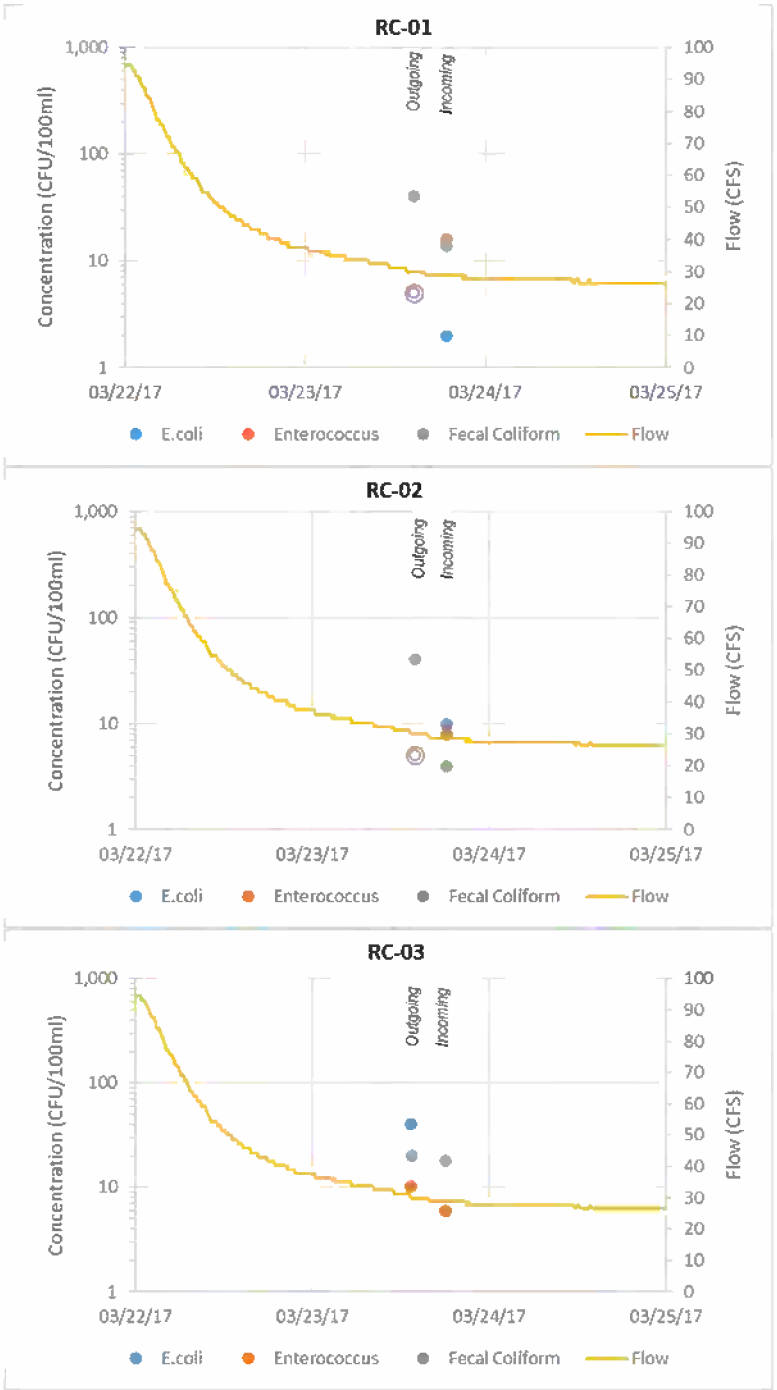


4.1.2 Ridley Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and the majority of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-2 shows the concentrations at each station. Note that in this figure, solid dots are measured results while open dots are non-detect results plotted at the detection limit. Additional plots are provided in Appendix H.

With few exceptions, fecal coliform tended to have the highest concentrations of the three pollutants of concern (POC) while enterococcus tended to have the lowest concentrations. These figures also illustrate an increase in E. coli levels from the upstream (RC-01) locations to the downstream locations (RC-02 and RC-03). However, the spatial trend for fecal coliform show a decrease in concentrations from upstream to downstream, while enterococcus levels were similar at all locations. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

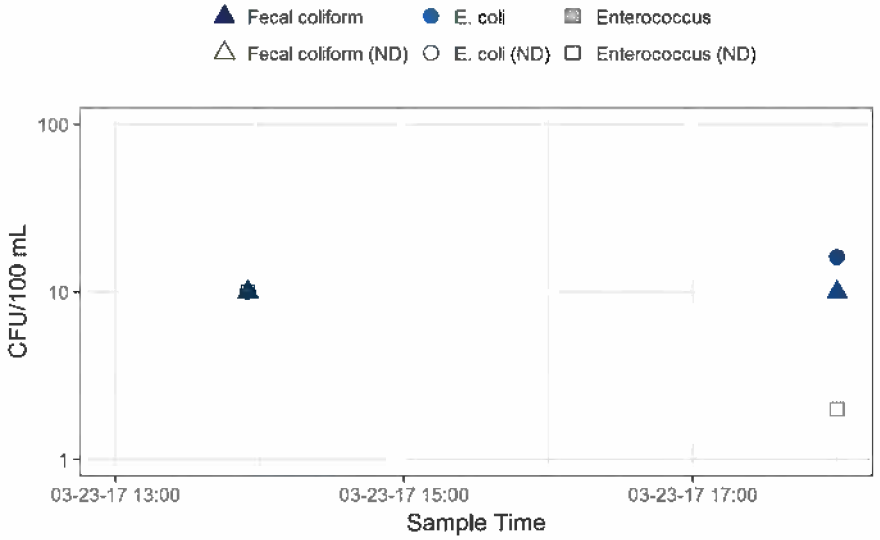
Figure 4-2: Dry Weather 1 Concentrations in Ridley Creek



4.1.3 Delaware River Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and all of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-3 shows the concentrations at DR-03, the mid-point station on the river. Additional plots are provided in Appendix H.

Figure 4-3: Dry Weather 1 Concentrations in Delaware River at DR-03



Fecal coliform levels tended to have the highest of the three pollutants of concern (POC) while enterococcus levels tended to be the lowest. Concentrations for all POCs were all fairly low, with twelve (12) of the 33 results reported as less than the reporting limit (shown as open symbols in the Appendix figures). In addition, nineteen (19) of the 33 results were flagged as based on counts outside the ideal counting range, which is often applied when the concentrations are very low. Results are similar to historical data collected previously by the Delaware River Basin Commission (DRBC).

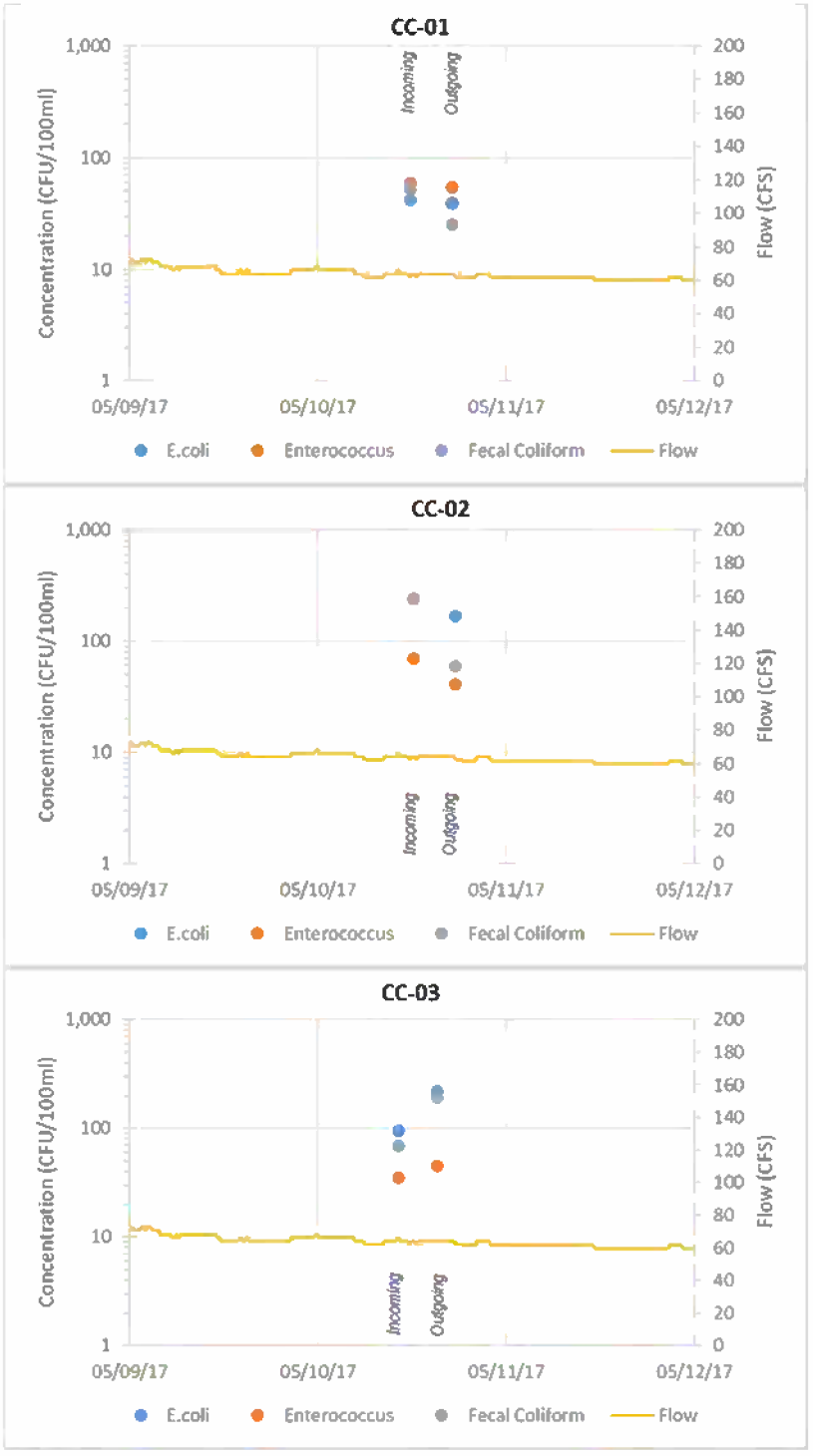
4.2 Dry Weather Sampling – Event 2 Results

The second dry weather event (Dry 2), on May 10, 2017, had fairly typical dry weather flows in each waterbody (as shown in Table 2-7). Laboratory results are presented by waterbody below.

4.2.1 Chester Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and the majority of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-4 shows the concentrations at each station. Additional plots are provided in Appendix H.

Figure 4-4: Dry Weather 2 Concentrations in Chester Creek



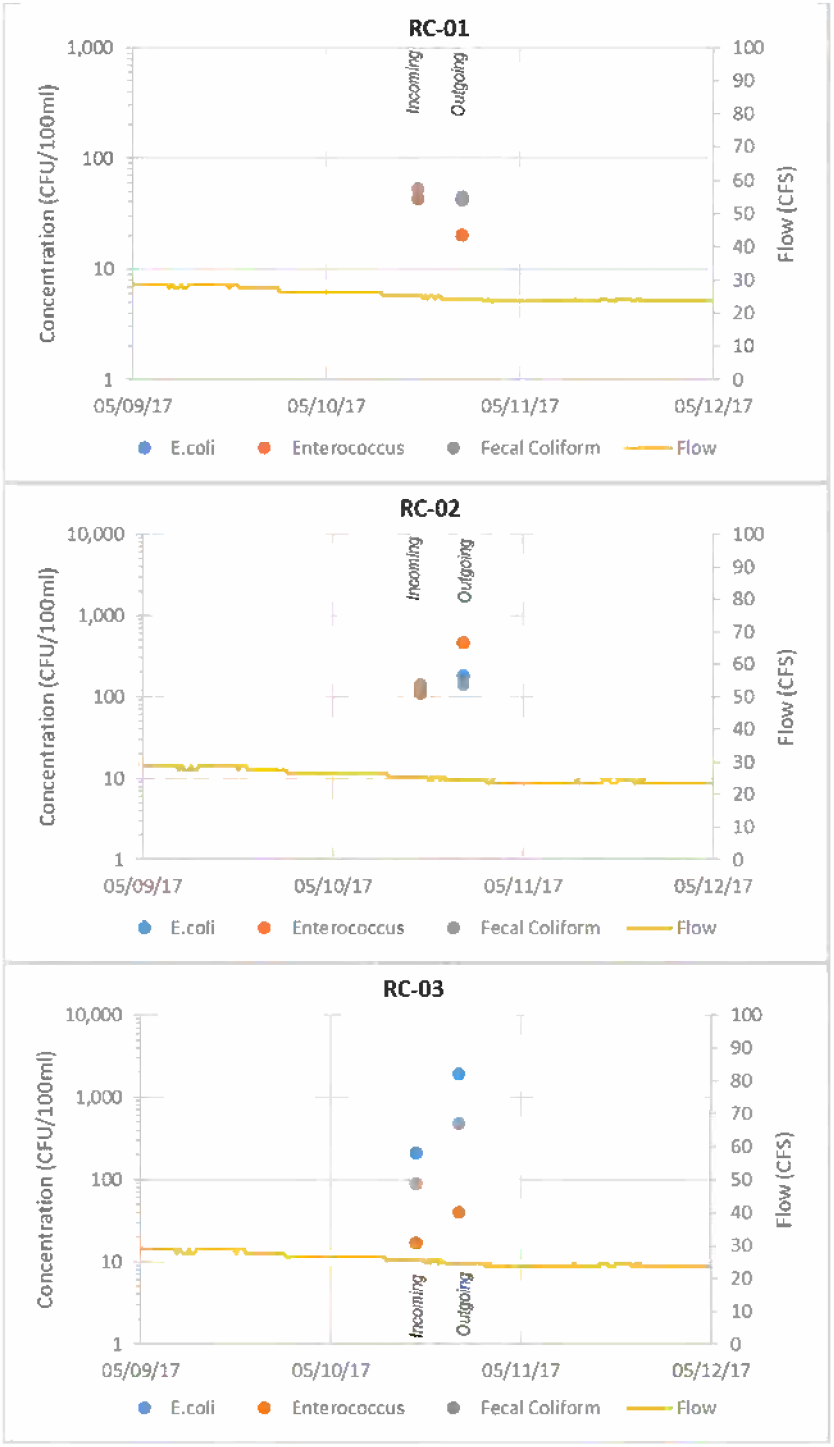
E. coli levels tended to have the highest of the three pollutants of concern (POC) while enterococcus levels tended to be the lowest. As noted in the introduction to Section 4, E. coli is a subgroup of fecal coliform and should have lower concentrations than fecal coliform. It is, however, fairly common for E. coli to be reported with higher concentrations than corresponding fecal coliform results, due to differences in the analytical methodology, the challenge of obtaining a homogenous sample, and the difficulty in measuring low levels of bacteria concentrations (see Section 5 for additional discussion). These figures also illustrate an increase in fecal coliform and E. coli POC levels from upstream (CC-01) to downstream to the mouth (CC-03) during both incoming and outgoing tidal conditions while enterococcus levels tended to be similar from upstream to downstream. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

4.2.2 Ridley Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and the majority of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-5 shows the concentrations at each station. Additional plots are provided in Appendix H.

At RC-01 and RC-02, fecal coliform levels tended to have the highest of the three pollutants of concern (POC) while enterococcus levels tended to be the lowest. At RC-03, E. coli concentrations were higher than corresponding fecal coliform concentrations. As noted in the introduction to Section 4, E. coli is a subgroup of fecal coliform and should have lower concentrations than fecal coliform. It is, however, fairly common for E. coli to be reported with higher concentrations than corresponding fecal coliform results, due to differences in the analytical methodology, the challenge of obtaining a homogenous sample, and the difficulty in measuring low levels of bacteria concentrations. These figures also illustrate an increase in fecal coliform and E. coli levels from upstream (RC-01) to downstream to the mouth (RC-03), while enterococcus levels were similar at all locations. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

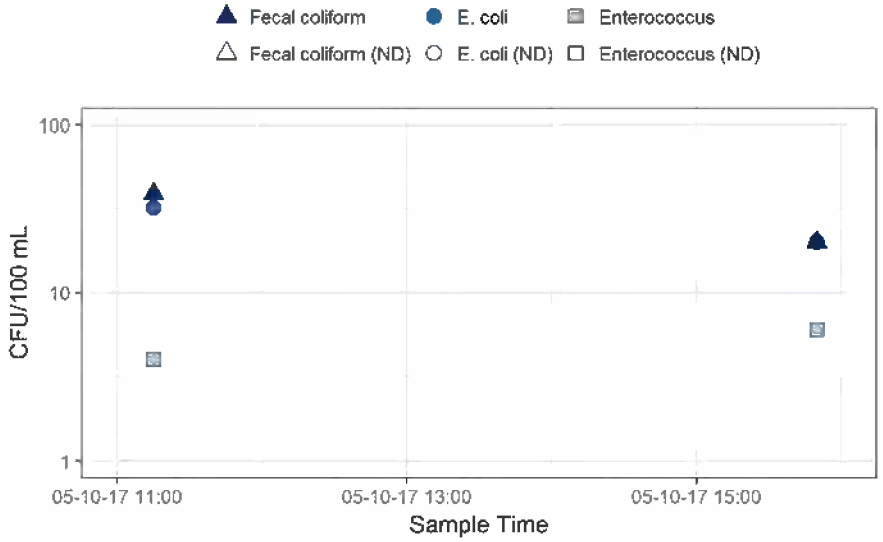
Figure 4-5: Dry Weather 2 Concentrations in Ridley Creek



4.2.3 Delaware River Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and all of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-6 shows the concentrations at DR-03, the mid-point station on the river. Additional plots are provided in Appendix H.

Figure 4-6: Dry Weather 2 Concentrations in Delaware River at DR-03



Concentrations for all POCs were higher than Dry 1 but were still fairly low, well below maximum water quality standard criteria. Results were similar to historical data collected previously by the Delaware River Basin Commission (DRBC).

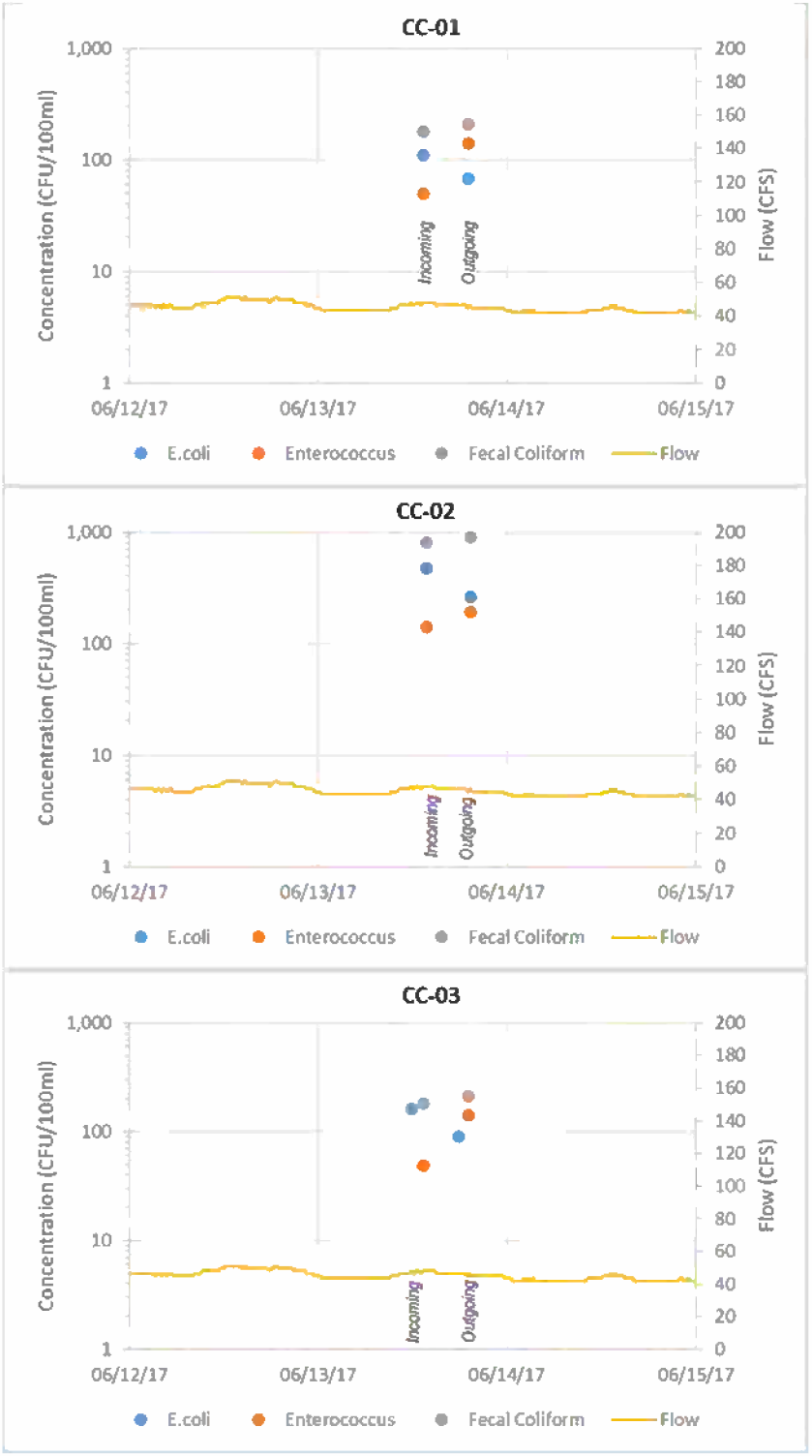
4.3 Dry Weather Sampling – Event 3 Results

The third dry weather event (Dry 3), on June 13, 2017, had the lowest dry weather flows in each waterbody (as shown in Table 2-7), approaching the 25th percentile flow. Laboratory results are presented by waterbody below.

4.3.1 Chester Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant. Enterococcus concentrations at each location tended to be higher on outgoing tide samples than incoming tide samples while the reverse was observed for E. coli. The majority of concentrations were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-7 shows the concentrations at each station. Additional plots are provided in Appendix H.

Figure 4-7: Dry Weather 3 Concentrations in Chester Creek



Fecal coliform levels tended to have the highest of the three pollutants of concern (POC) while enterococcus levels tended to be the lowest. These figures also illustrate an increase in POC levels from upstream (CC-01) to downstream to the mid-point (CC-02) during both incoming and outgoing tidal conditions, followed by a decline in POC levels near the mouth (CC-03). Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

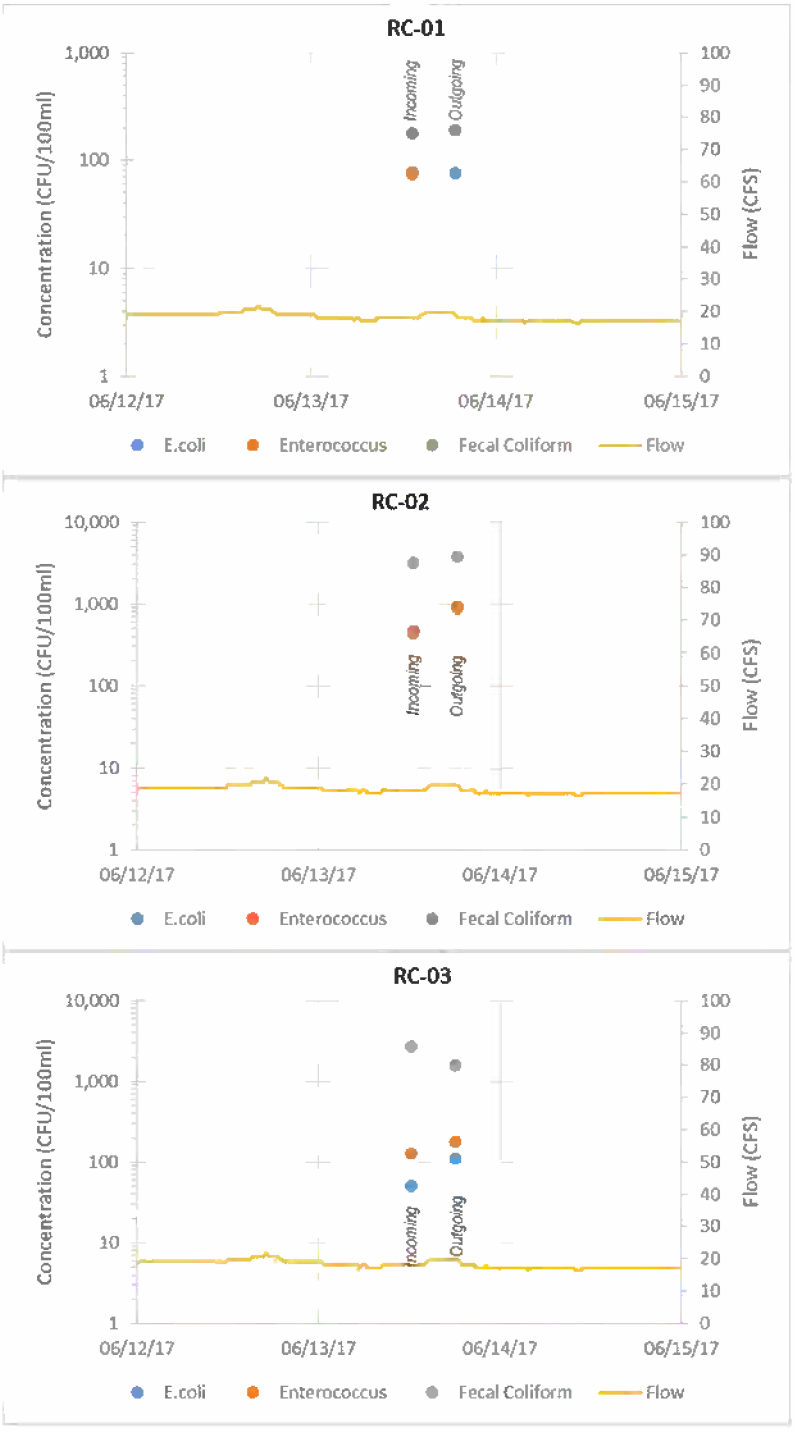
4.3.2 Ridley Creek Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant. However, concentrations of enterococcus tended to be about two times higher in the outgoing samples than incoming sample levels.

Fecal coliform and enterococcus concentrations tended to be higher than the other dry weather events and maximum water quality standard criteria. The majority of E. coli concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-8 shows the concentrations at each station. Additional plots are provided in Appendix H.

Fecal coliform levels tended to have the highest of the three pollutants of concern (POC) while enterococcus levels tended to be the lowest, except at RC-03. As with the other dry weather events, the laboratory encountered difficulties in analyzing the samples at the best dilution and quantifying results for samples with low concentrations. These figures also illustrate an increase in POC levels from upstream (RC-01) to downstream to the mid-point (RC-02) during both incoming and outgoing tidal conditions, followed by a decline in POC levels near the mouth (RC-03).

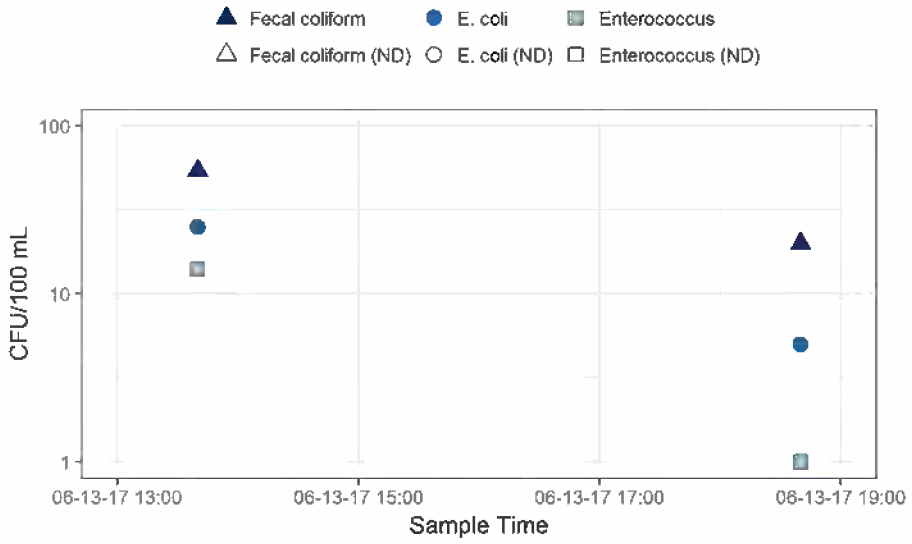
Figure 4-8: Dry Weather 3 Concentrations in Ridley Creek



4.3.3 Delaware River Results

Samples collected on incoming and outgoing tides were fairly similar in concentrations of each pollutant and all of concentrations were within values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-9 shows the concentrations at DR-03, the mid-point station on the river. Additional sampling plots are provided in Appendix H.

Figure 4-9: Dry Weather 3 Concentrations in Delaware River at DR-03



Concentrations for all POCs were fairly low, well below maximum water quality standard criteria. Results were similar to historical data collected previously by the Delaware River Basin Commission (DRBC).

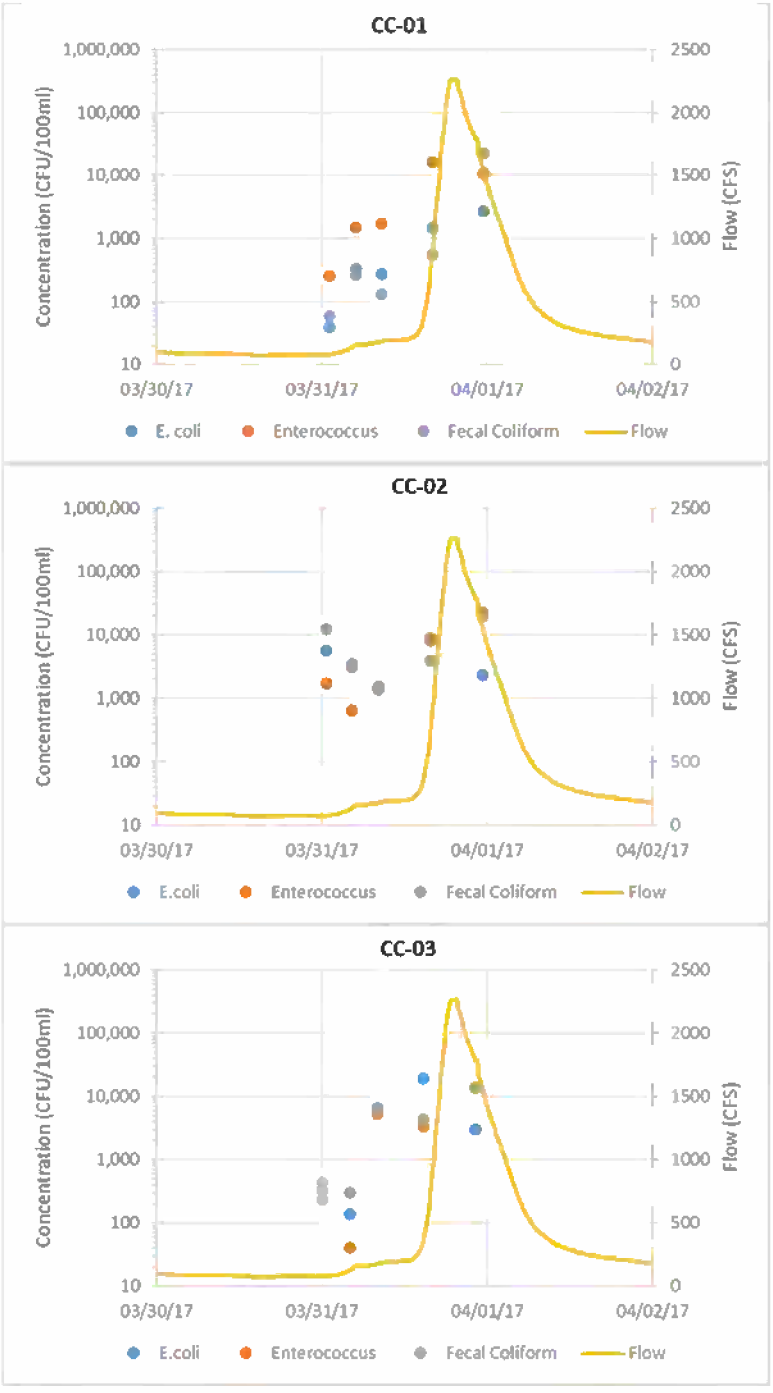
4.4 Wet Weather Sampling – Event 1 Results

Wet weather event 1 (Wet 1), was conducted on March 31-April 1, 2017. This event was the largest of the three events, with just over 1.5" recorded at the Philadelphia Airport. Rainfall was also mostly uniform across the watershed. This event also had the highest flows in the tributaries of the three sampled wet weather events. Laboratory results are presented by waterbody and source type below.

4.4.1 Chester Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. The majority of concentrations for all of the POCs were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-10 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

Figure 4-10: Wet Weather Event 1 Concentrations in Chester Creek



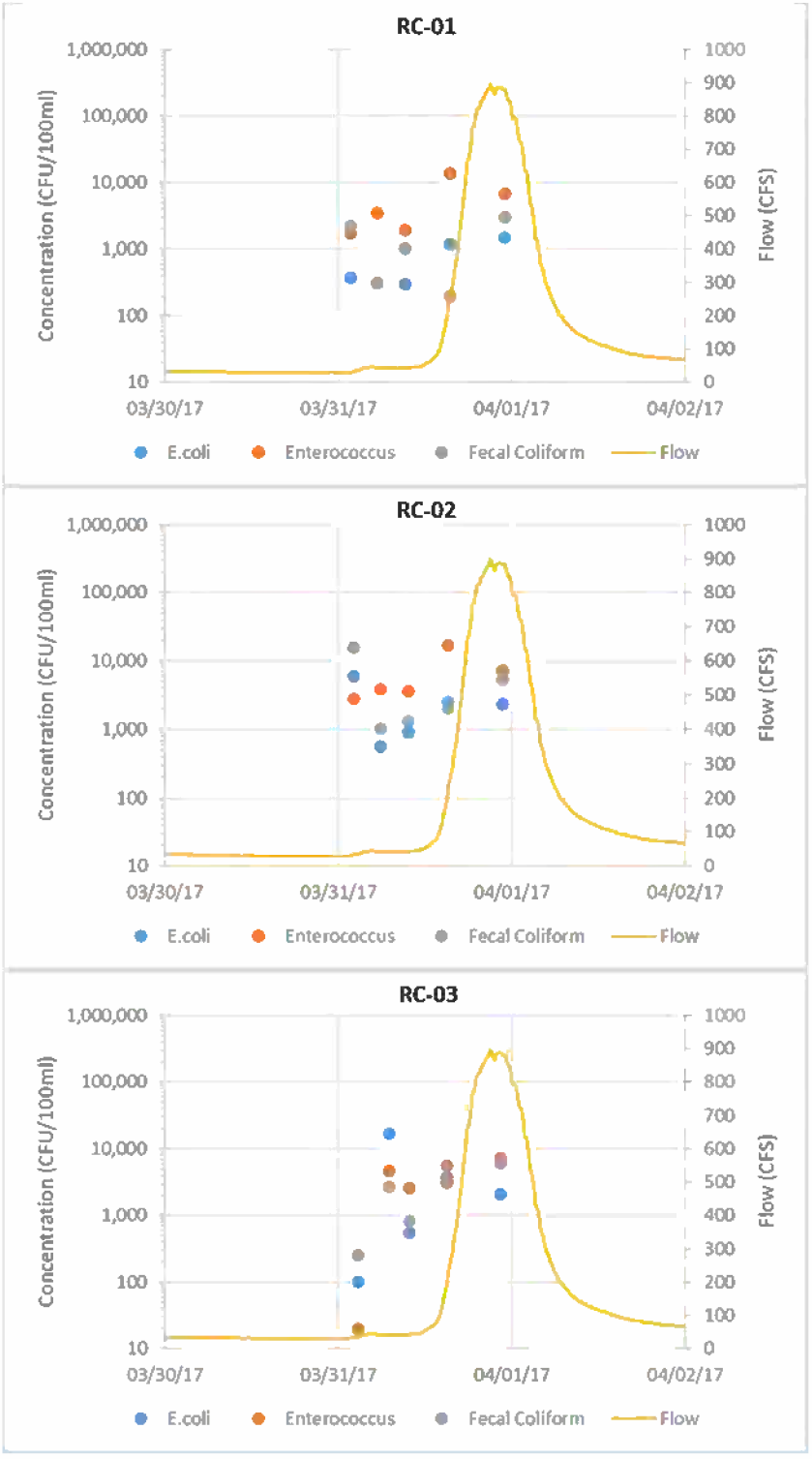
The impact of DELCORA's CSOs and Chester stormwater POC loads are most evident in the data at CC-02 for first two rounds of sampling, which correspond to roughly the first six hours of the event. Similar concentrations were measured further downstream at CC-03 during the third and fourth rounds of sampling, which corresponds to approximately hours 8 through 16 of the event. The data at CC-01 suggest that loads from upstream sources reached the study area in the fourth and fifth rounds of sampling, approximately 16 to 24 hours of the event. POC concentrations peak at 23,000 cfu/100 ml (fecal coliform).

4.4.2 Ridley Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and Section 2.5.2. The majority of concentrations for all of the POCs were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-11 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

The impact of DELCORA's CSOs and Chester stormwater POC loads are most evident in the data at RC-02 for first two rounds of sampling. Similar concentrations were measured further downstream at RC-03 during the third and fourth rounds of sampling. The data at RC-01 suggest that loads from upstream sources reached the study area in the fourth and fifth rounds of sampling. POC concentrations peak at 17,000 cfu/100 ml (enterococcus).

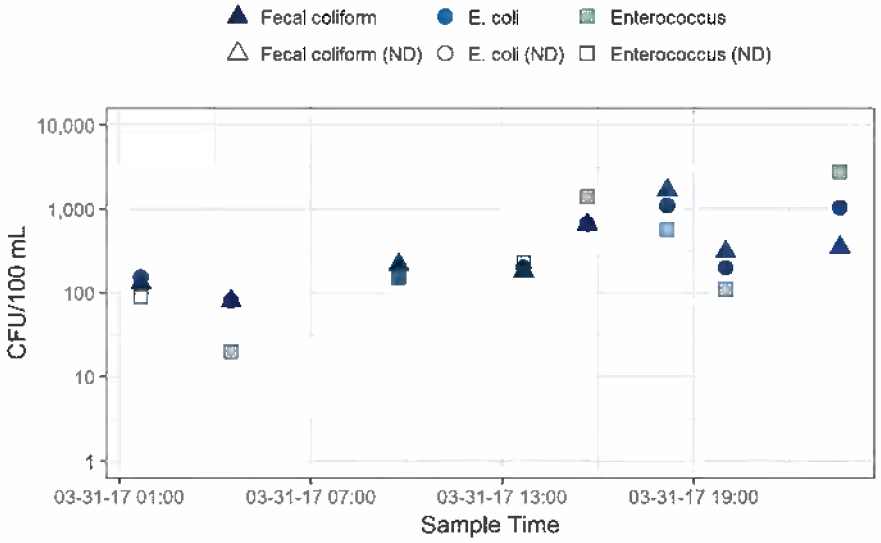
Figure 4-11: Wet Weather Event 1 Concentrations in Ridley Creek



4.4.3 Delaware River Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Samples were collected more frequently in the Delaware River than in the tributaries to ensure that wet weather impacts were characterized under an entire tidal cycle. Figure 4-12 shows the concentrations at DR-03, the mid-point station on the river. CSOs impacts would be captured at this station under all tidal conditions. Similar levels were observed at the other near shore Delaware River locations. These time series plots are provided in Appendix H.

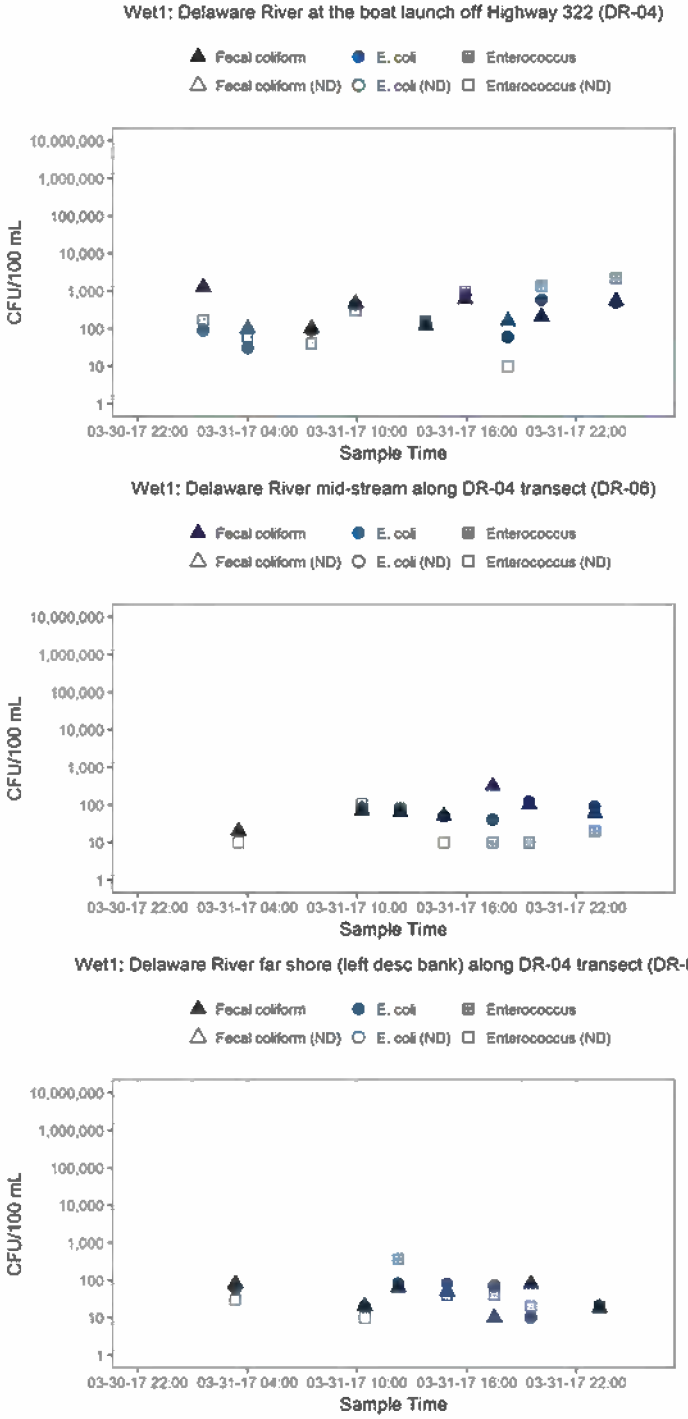
Figure 4-12: Wet Weather Event 1 Concentrations in Delaware River at DR-03



POC concentrations in the Delaware River tend to be approximately an order of magnitude lower than the levels observed in the tributaries, though there are several measurements that are higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2.

Near shore impacts of DELCORA's CSOs were assessed by collecting samples across the transect corresponding to near shore station DR-04 (see Figure 2-2). Results are shown for DR-04, DR-06 (mid-stream) and DR-07 (far shore) in Figure 4-13. This figure indicates that there is a small lateral gradient during the period when DELCORA's CSOs were discharging. The near shore concentrations are typically an order of magnitude larger than the mid or far shore concentrations, indicating that the influence of the DELCORA CSOs is limited to the near shore area. A better understanding of lateral mixing will be obtained through the model calibration process.

Figure 4-13: Wet Weather Event 1 Concentrations Across the Delaware River



4.4.4 Combined Sewer Overflow (CSO) Location Results

All of the CSOs were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. A full set of samples (i.e. 8 rounds) were collected at each CSO, except CSO-018, which had 7 rounds of sampling conducted before it stopped discharging. Concentrations for each POC for each CSO are presented in Figures 4-14 through 4-16. Concentration time series figures are presented in Appendix H.

Figure 4-14: CSO Fecal coliform Concentrations in Wet 1 Event

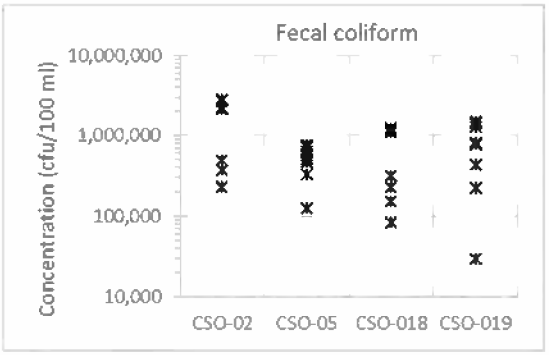


Figure 4-15: CSO E. coli Concentrations in Wet 1 Event

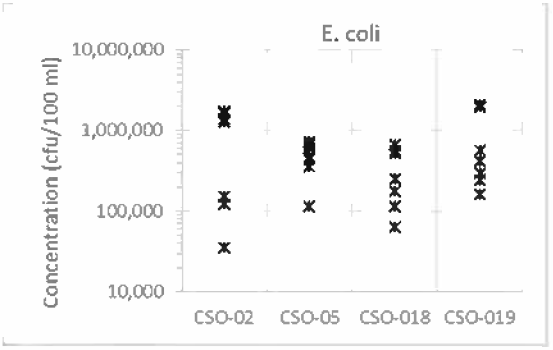
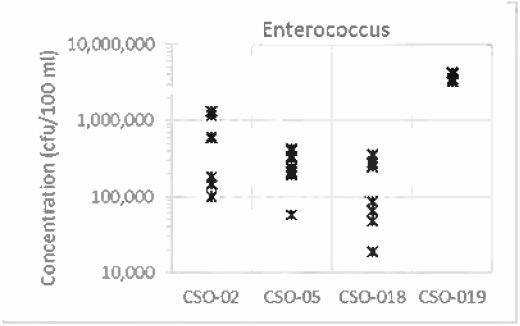


Figure 4-16: CSO Enterococcus Concentrations in Wet 1 Event



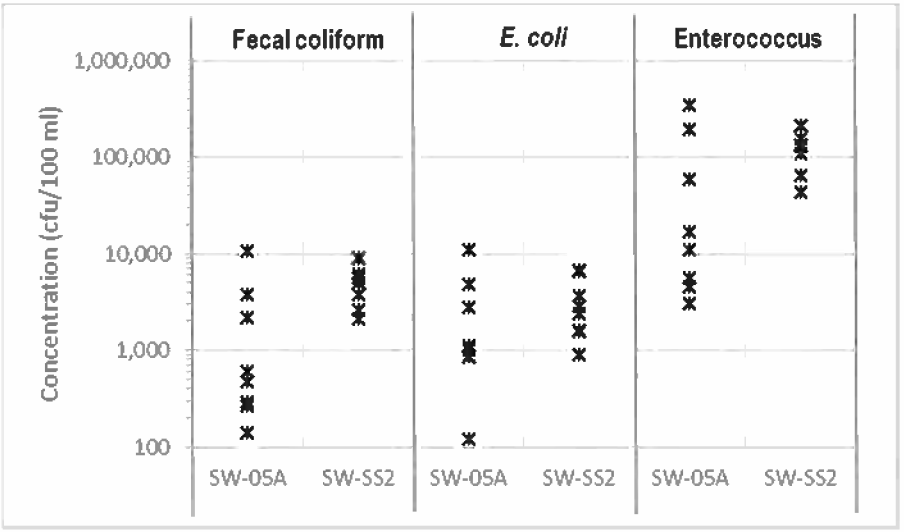
One potential outlier result was identified: the enterococcus result in round 1 at CSO-019 was 3,220,000 cfu/100 ml, and flagged as quantified with a count outside the ideal counting range. The next highest quantified result was 500,000 cfu/100 ml, nearly an order of magnitude lower. However, in round 4 at CSO-019, the result was reported as >600,000 cfu/100 ml (ie. actual concentration is greater than 600,000 cfu/100 ml), which provides some supporting evidence that enterococcus results in CSO-019 were higher than in the other CSOs and the potential outlier may be a legitimate reflection of conditions. The effect of this potential outlier will be further evaluated through the model calibration process.

Measured concentrations were within the range of CSO bacteria concentrations reported in the literature (EPA 2002) but tended to be lower than concentrations measured in other communities. Several potential explanations for this include: 1) the highly industrialized nature of the DELCORA service area may result in a smaller bacteria load to the combined system than communities with less industrial land; 2) DELCORA may have a relatively high percentage of stormwater in the combined system.

4.4.5 Stormwater Location Results

Both stormwater outfalls were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. A full set of samples (e.g. 8 rounds) were collected at each stormwater location. Concentrations for each POC are presented in Figure 4-17. Concentration time series figures are provided in Appendix H.

Figure 4-17: Stormwater POC Concentrations in Wet 1 Event



Most of the measured concentrations were within the range of stormwater bacteria concentrations reported in the literature (NSQD, 2015). It was somewhat surprising that the enterococcus results tended to be higher than the fecal coliform and E. coli data at both locations. However, there is very little data in the literature for enterococcus so it is difficult to assess whether these results are unusual. Additional evaluation of POC loads will be conducted as part of the watershed and water quality model calibrations.

4.5 Wet Weather Sampling – Event 2 Results

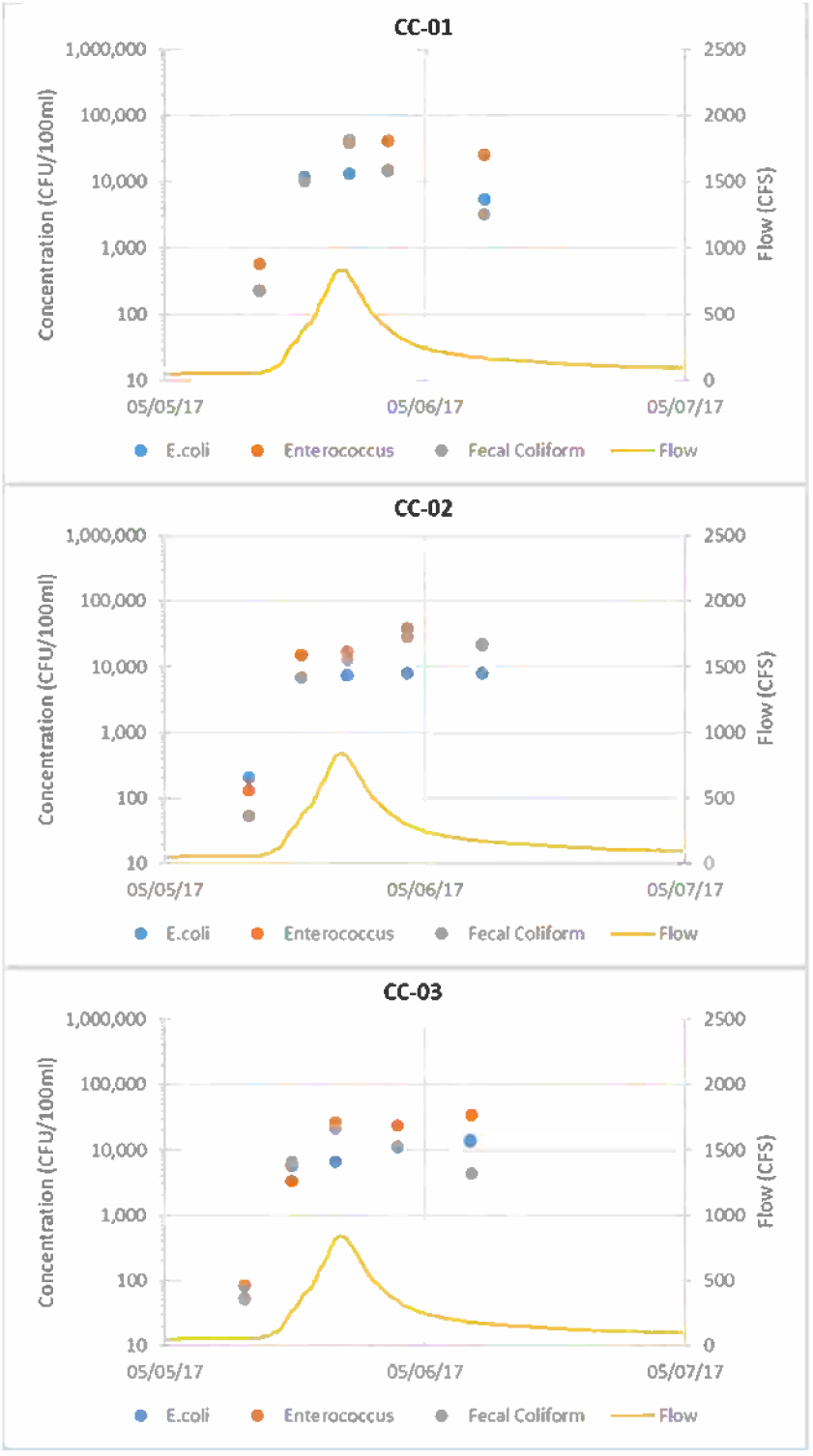
Wet weather event 2 (Wet 2), was conducted on May 5, 2017. This event was slightly smaller than the first wet weather event, with 1.47" recorded at the Philadelphia Airport. Rainfall varied somewhat across the watershed, with less rain falling in the DELCORA area and the upstream Chester and Ridley Creek watersheds, than in the Philadelphia area and areas bordering the Delaware River. Laboratory results are presented by waterbody and source type below.

4.5.1 Chester Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan (SAP). The majority of concentrations for all of the POCs were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-18 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

The impact of DELCORA's CSOs and Chester stormwater POC loads appear to begin in the second round of sampling. Concentrations remain elevated throughout the rest of the event at all three locations, despite the fact that DELCORA CSOs stopped discharging within 8 hours. This suggests that upstream and/or other bacteria sources are likely also impacting the creek. POC concentrations peak at 44,000 cfu/100 ml (fecal coliform).

Figure 4-18: Wet Weather Event 2 Concentrations in Chester Creek

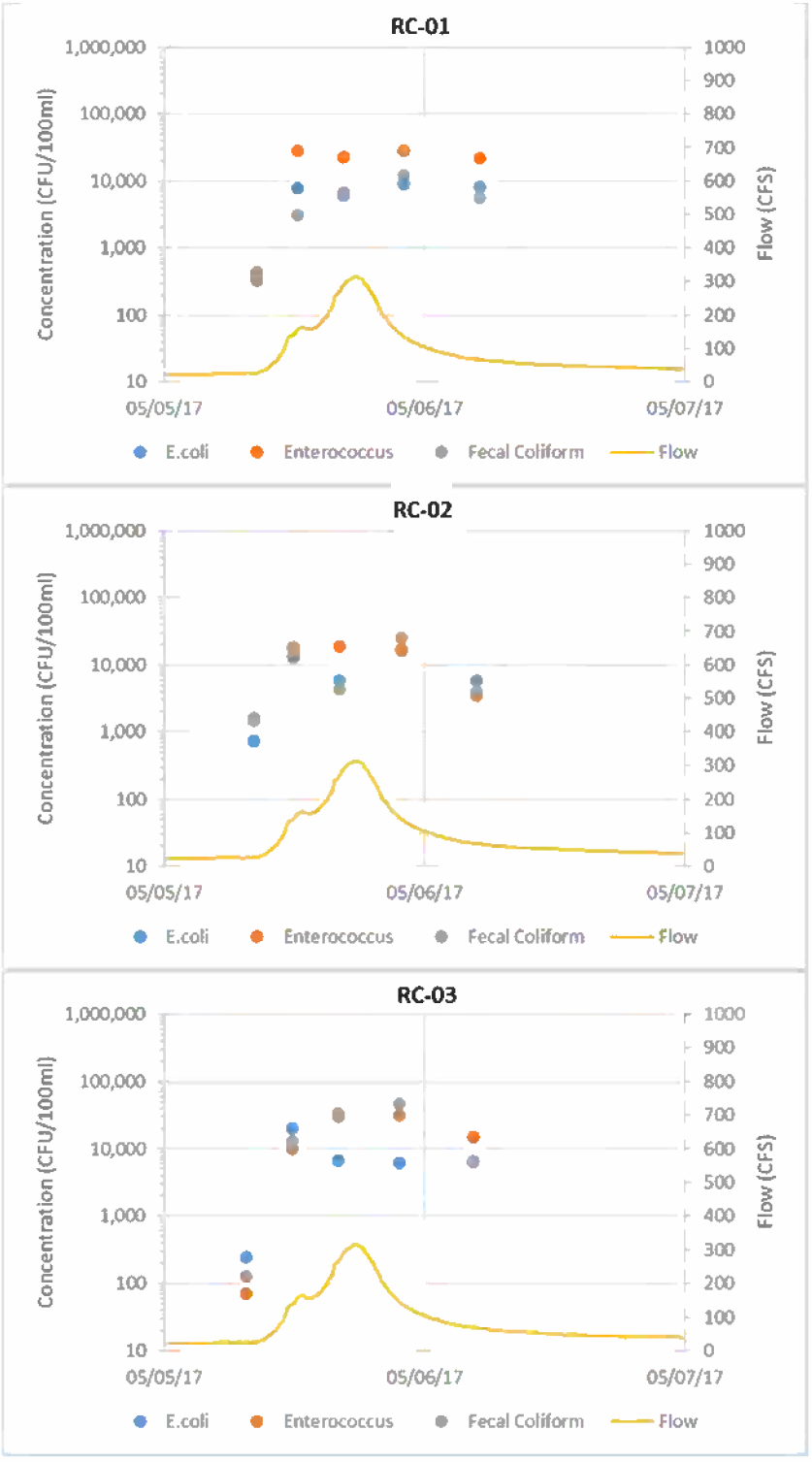


4.5.2 Ridley Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. The majority of concentrations for all of the POCs were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-19 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

The impact of DELCORA's CSOs and Chester stormwater POC loads appear to begin in the second round of sampling. Concentrations remain elevated throughout the rest of the event at all three locations, despite the fact that DELCORA CSOs stopped discharging within 8 hours (based on sampling intervals where samples could be collected in the CSOs). This suggests that upstream and/or other bacteria sources are likely also impacting the creek. POC concentrations peak at 47,000 cfu/100 ml (fecal coliform).

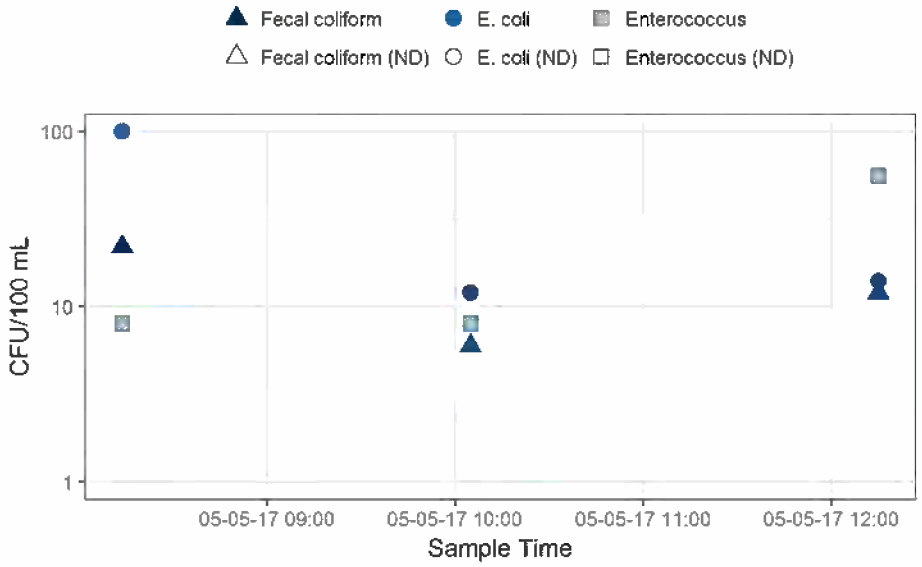
Figure 4-19: Wet Weather Event 2 Concentrations in Ridley Creek



4.5.3 Delaware River Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Samples were collected more frequently in the Delaware River than in the tributaries to ensure that wet weather impacts were characterized under an entire tidal cycle. Figure 4-20 shows the concentrations at DR-03, the mid-point station on the river. CSOs impacts would be captured at this station under all tidal conditions. Similar levels were observed at the other near shore Delaware River locations. All concentration time series figures are provided in Appendix H.

Figure 4-20: Wet Weather Event 2 Concentrations in Delaware River at DR-03



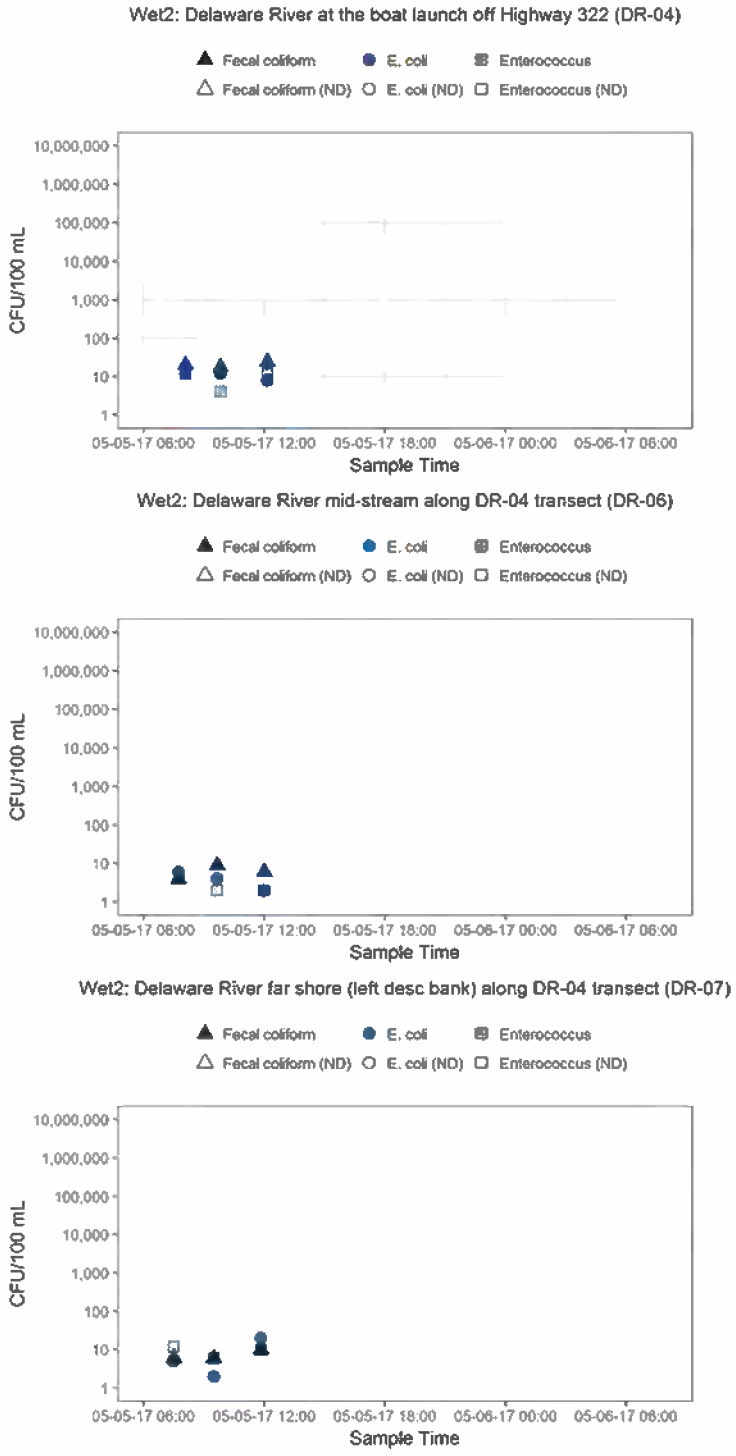
Note that sample collection in the Delaware River had to be stopped midway through the event, as described in Section 3 so the time series includes the three rounds of sampling that were completed as per the Sampling and Analysis Plan. Additional samples were collected from the bank during this event. The data from these locations are higher than the samples collected with the boat and likely reflect localized conditions rather than conditions at the scale of the water quality model.

POC concentrations in the Delaware River tend to be approximately 1-2 orders of magnitude lower than the levels observed in the tributaries. Only the last round of sampling at DR-05 had any POC concentrations greater than 100 cfu/100 ml (the maximum value shown on the y-axis). Because DELCORA's CSOs had stopped discharging well before this round, the concentrations are likely due to loads from other sources. All of the other measurements in the Delaware River are lower than values used as values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2.

Near shore impacts of DELCORA's CSOs were assessed by collecting samples across the transect corresponding to near shore station DR-04. Results are shown for DR-04, DR-06 (mid-stream) and DR-07 (far shore) in Figure 4-21. This figure indicates that a lateral gradient is very slight for the sampling rounds that could be collected. POC concentrations on the near shore and far shore are slightly higher

(~2x) than the mid-stream concentrations. A better understanding of lateral mixing will be obtained through the model calibration process.

Figure 4-21: Wet Weather Event 2 Concentrations Across the Delaware River



4.5.4 Combined Sewer Overflow (CSO) Location Results

All of the CSOs were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Five rounds of samples were collected at each CSO before discharges ended. Concentrations for each POC for each CSO are presented in Figures 4-22 through 4-24. Time series plots are presented in Appendix H.

Figure 4-22: CSO Fecal coliform Concentrations in Wet 2 Event

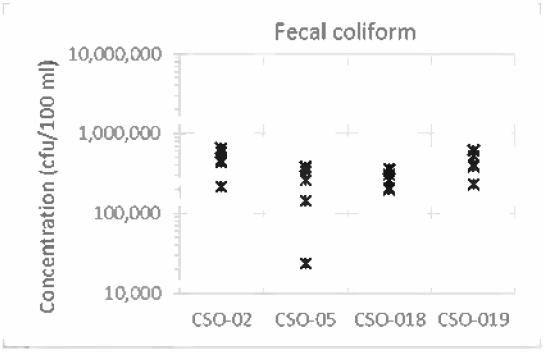


Figure 4-23: CSO E. coli Concentrations in Wet 2 Event

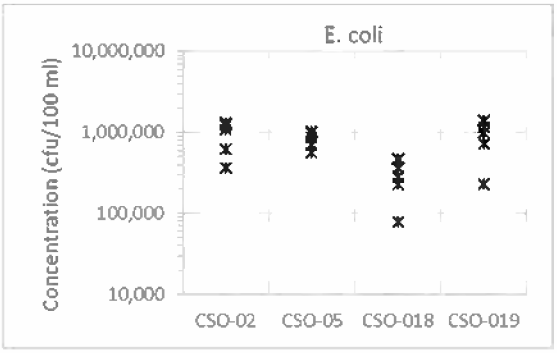
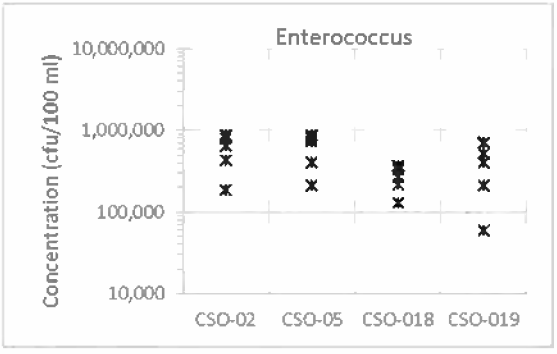


Figure 4-24: CSO Enterococcus Concentrations in Wet 2 Event

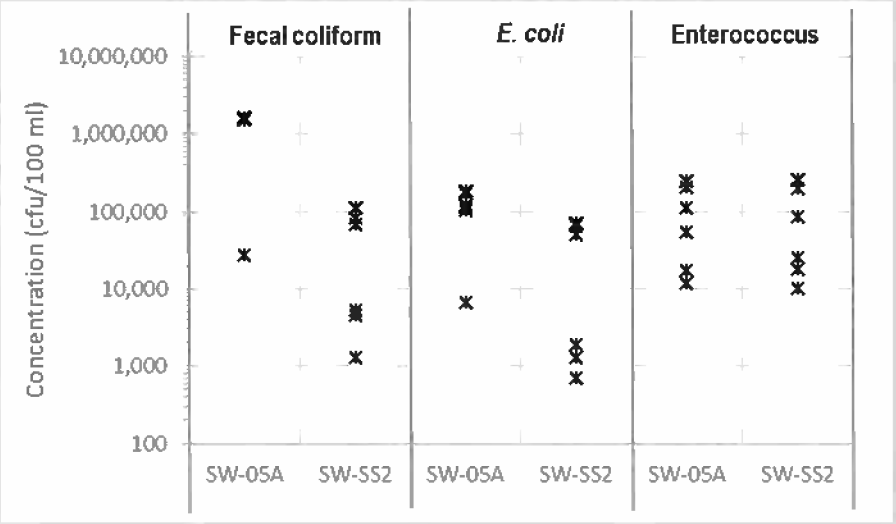


Measured concentrations were within the range of CSO bacteria concentrations reported in the literature (EPA 2002) and were similar to concentrations measured in other communities. Because this event had less rain than Wet Weather Event 1, CSO discharges likely had a smaller fraction of stormwater than in Wet Weather Event 1, resulting in slightly higher concentrations throughout the discharge period.

4.5.5 Stormwater Location Results

Both stormwater outfalls were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Six rounds of samples were collected at each stormwater location before the runoff ended. Concentrations for each POC are presented in Figure 4-25. Time series plots are provided in Appendix H.

Figure 4-25: Stormwater POC Concentrations in Wet 2 Event



Most of the measured concentrations were within the range of stormwater bacteria concentrations reported in the literature. The enterococcus results were similar in magnitude to, though still higher on average than, the fecal coliform and E. coli data. Additional evaluation of POC loads will be conducted as part of the watershed and water quality model calibrations.

4.6 Wet Weather Sampling – Event 3 Results

Wet weather event 3 (Wet 3), was conducted on May 22, 2017. This event was the smallest storm, with 0.51" recorded at the Philadelphia Airport. Rainfall varied across the watershed, with the upper tributary watersheds receiving much less rain than the areas closer to the Delaware River. Less rain fell in the DELCORA area than Philadelphia. Laboratory results are presented by waterbody and source type below.

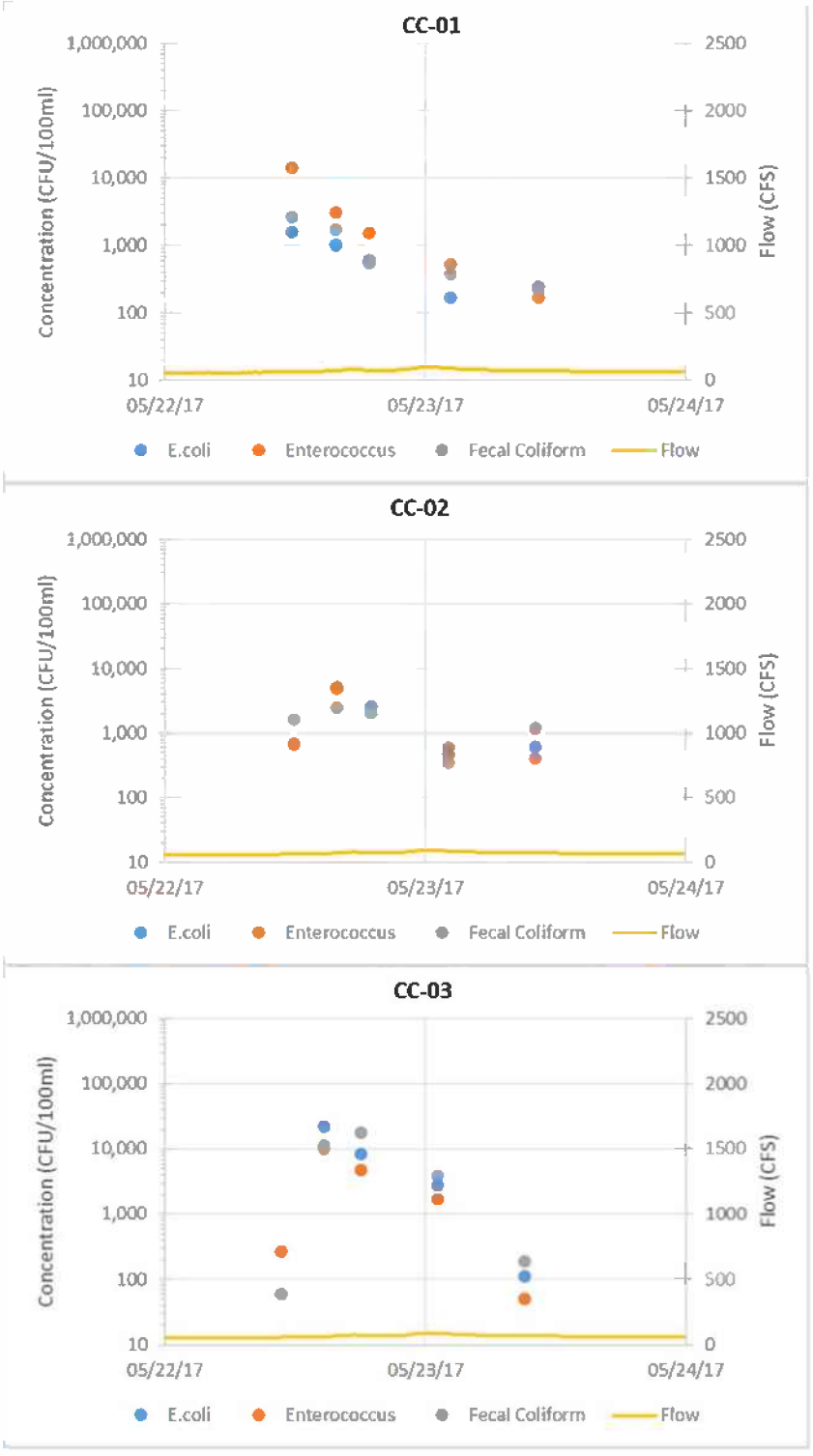
4.6.1 Chester Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. The majority of concentrations for all of the POCs were higher than values used as

maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-26 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

The impact of DELCORA's CSOs and Chester stormwater POC loads are most evident in the data at CC-03 for second and third rounds of sampling. The data at CC-01 suggest that loads from upstream sources reached the study area at the beginning of the event, which likely reflects the spatial variability in the rainfall. POC concentrations peak at 22,000 cfu/100 ml (E. coli).

Figure 4-26: Wet Weather Event 3 Concentrations in Chester Creek

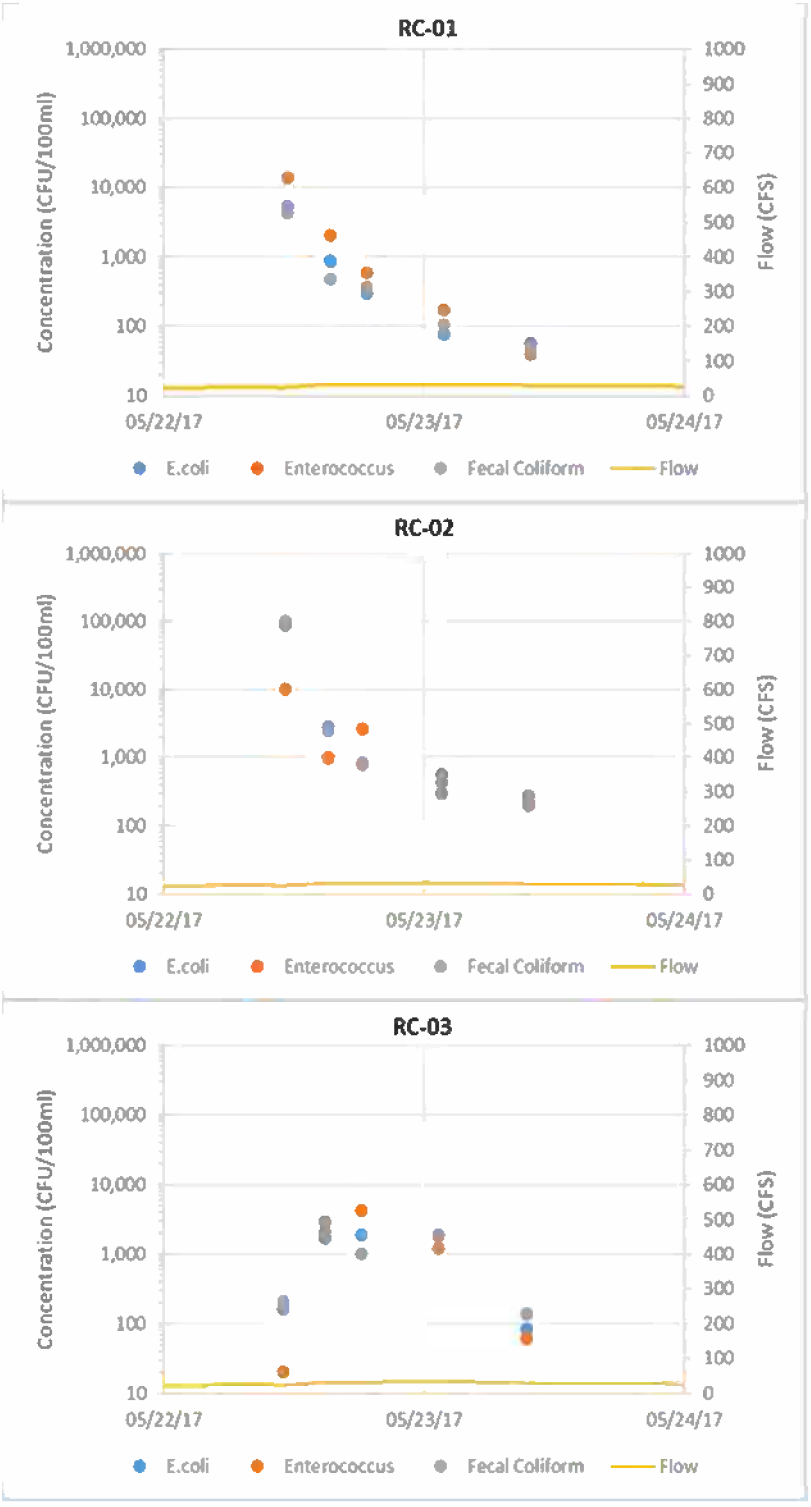


4.6.2 Ridley Creek Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. The majority of concentrations for all of the POCs were higher than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2. Figure 4-27 shows the concentrations at each station in the creek and the flow measured at the USGS gage just upstream of the DELCORA study area. Additional sampling plots are provided in Appendix H.

The impact of DELCORA's CSOs and Chester stormwater POC loads are most evident in the data at RC-02 in the second round and RC-03 in the second and third rounds of sampling. The data at RC-01 suggest that loads from upstream sources reached the study area at the beginning of the event, which likely reflects the spatial variability in the rainfall. POC concentrations peak at 103,000 cfu/100 ml (fecal coliform).

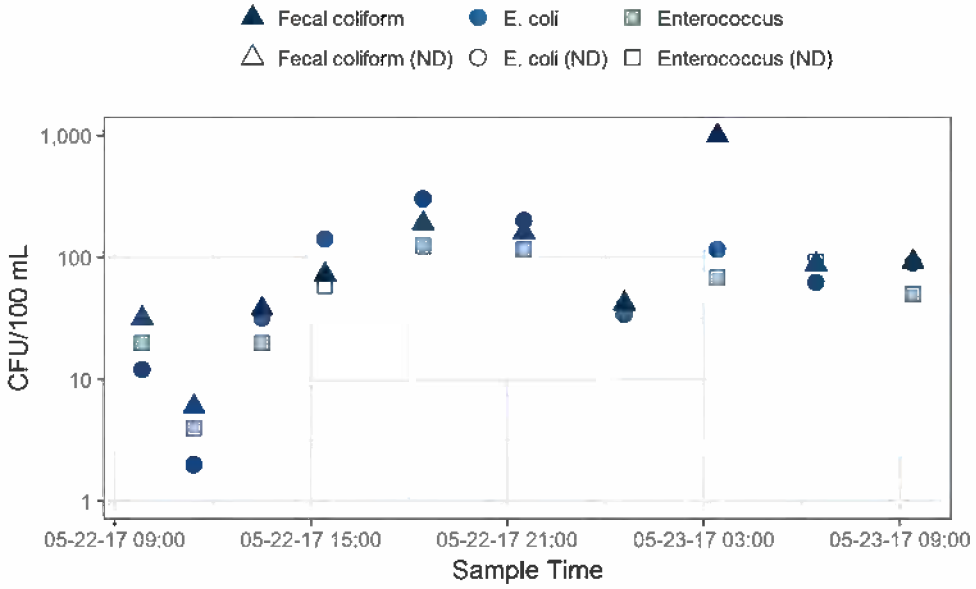
Figure 4-27: Wet Weather Event 3 Concentrations in Ridley Creek



4.6.3 Delaware River Results

Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Samples were collected more frequently in the Delaware River than in the tributaries to ensure that wet weather impacts were characterized under an entire tidal cycle. Figure 4-28 shows the concentrations at DR-03, the mid-point station on the river. CSOs impacts would be captured at this station under all tidal conditions. Similar levels were observed at the other near shore Delaware River locations. All concentration time series figures are provided in Appendix H.

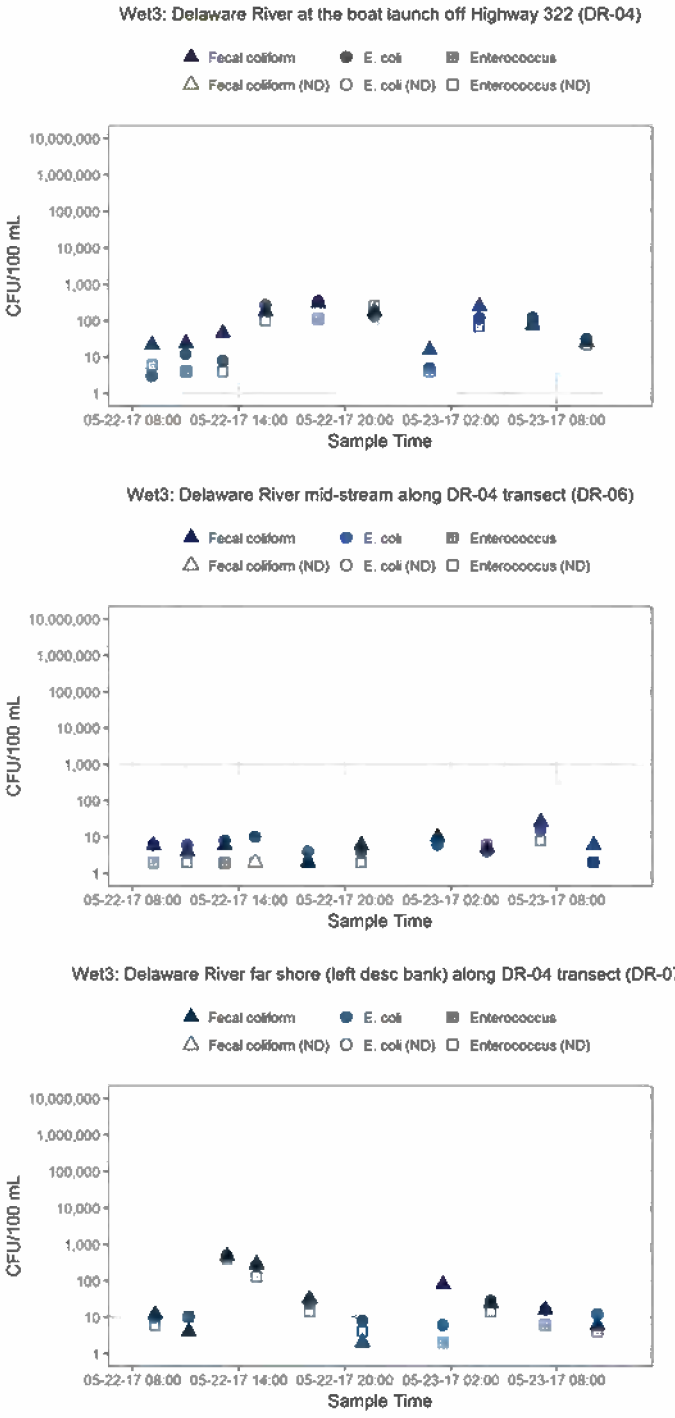
Figure 4-28: Wet Weather Event 3 Concentrations in Delaware River at DR-03



POC concentrations in the Delaware River tend to be approximately 1-2 orders of magnitude lower than the levels observed in the tributaries. The highest concentrations were observed in Rounds 5 and 8 (Hours 9 and 18) at this location. Most of the other measurements in the Delaware River are lower than values used as maximum water quality standard criteria. Maximum water quality standard criteria are shown in Figure 2.1 in Section 2.

Near shore impacts of DELCORA's CSOs were assessed by collecting samples across the transect corresponding to near shore station DR-04. Results are shown for DR-04, DR-06 (mid-stream) and DR-07 (far shore) in Figure 4-29. This figure indicates that a lateral gradient exists with both shores. POC concentrations on the near shore and far shore are approximately 1-2 orders of magnitude higher than the mid-stream concentrations. A better understanding of lateral mixing will be obtained through the model calibration process.

Figure 4-29: Wet Weather Event 3 Concentrations Across the Delaware River



4.6.4 Combined Sewer Overflow (CSO) Location Results

All of the CSOs were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan (SAP). Four rounds of samples were collected at each CSO before discharges ended. Concentrations for each POC for each CSO are presented in Figures 4-30 through 4-32. Figures of concentrations over time are presented in Appendix H.

Figure 4-30: CSO Fecal coliform Concentrations in Wet 3 Event

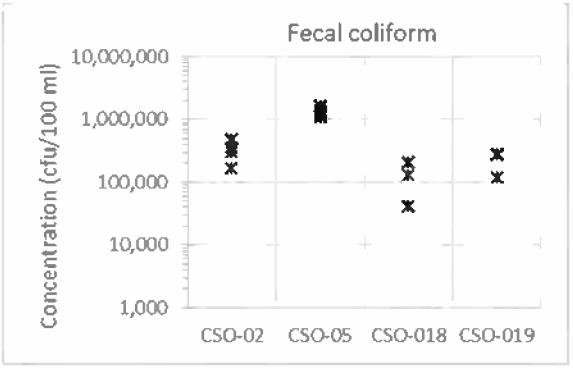


Figure 4-31: CSO E. coli Concentrations in Wet 3 Event

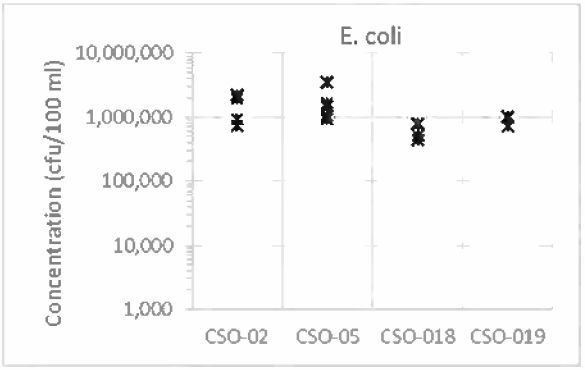
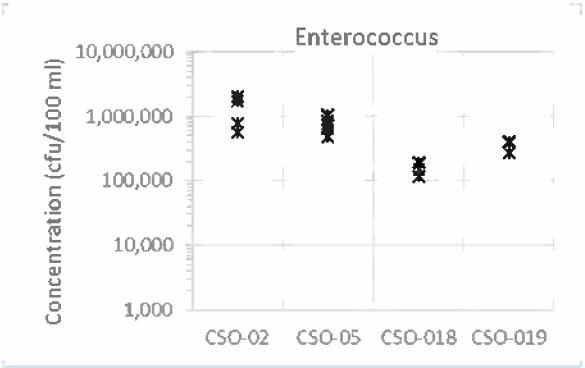


Figure 4-32: CSO Enterococcus Concentrations in Wet 3 Event

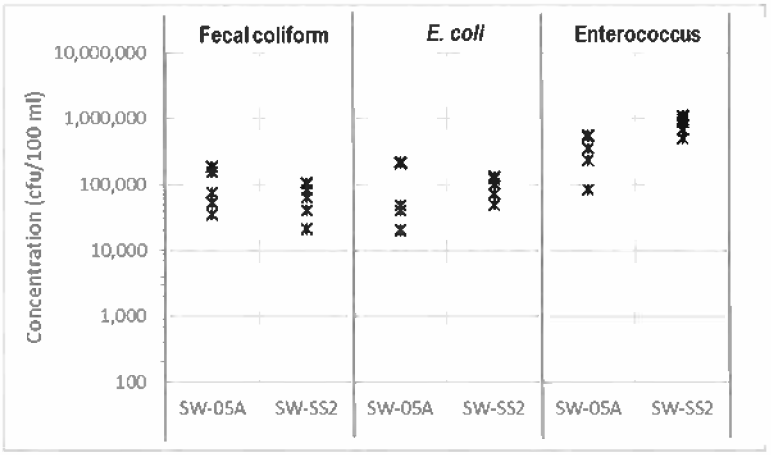


Measured concentrations were within the range of CSO bacteria concentrations reported in the literature (EPA 2002) and tended to be somewhat higher overall than concentrations measured in other communities. Because this event had much less rain than the first two wet weather events, the CSO discharges likely contained a much higher percentage of sanitary sewage than the other events.

4.6.5 Stormwater Location Results

Both stormwater outfalls were sampled during this event. Samples were collected at the intervals specified in the Sampling and Analysis Plan and summarized in Section 2.5.2. Five rounds of samples were collected at each stormwater location before the runoff ended. Concentrations for each POC are presented in Figure 4-33. Figures of concentration over time are provided in Appendix H.

Figure 4-33: Stormwater POC Concentrations in Wet 3 Event



Most of the measured concentrations were within the range of stormwater bacteria concentrations reported in the literature (NSQD 2015). It was somewhat surprising that the enterococcus results tended to be higher than the fecal coliform and E. coli data at both locations. However, there is very little stormwater data in the literature for enterococcus so it is difficult to assess whether these results are unusual. Additional evaluation of POC loads will be conducted as part of the watershed and water quality model calibrations.

Section 5 Comparison of Laboratory Results to QAPP

The Sampling Program execution was consistent with the QAPP objectives. This section presents a summary of the quality of the data relative to the QAPP objectives. Out of a total of 1,195 analysis, 1,104 (92%) did not require data qualifications as a result of poor QA/QC. The remaining 91 analysis were conducted outside the specified 8 hour hold time. However, of these 91 analyses, 84 were completed within 10 hours. These results have been qualified but minimal impact on the use of the data is anticipated due to the similarity in concentrations between results measured within and outside the analytical hold time. Much more uncertainty exists within the analytical methodology and field practices (e.g. obtaining a homogenous, representative sample, etc.). The most common qualifier applied to the data was due to bacteria counts outside ideal ranges. Most of these were the result of low ambient concentrations and the uncertainty associated with their quantification reflects the limitations of the analytical methodology.

Complete Laboratory QA Program Manuals and SOPs for each laboratory procedure are found in Appendix I.

5.1 QAPP Requirements

Section 2.4 of the QAPP provided data quality objectives for the following areas:

- Accuracy
- Precision
- Completeness
- Representativeness
- Comparability
- Required detection limits

Accuracy, precision and detection limits requirements for field and laboratory activities are summarized in Table 5-1. Completeness objectives for the field measurements and sample collection was 90%. The completeness objective was 95% for the laboratory (see Section 2.1.4.3 of the QAPP). Representativeness and comparability objectives were qualitative and will be presented in the context of the sample program comparison in Section 5.2.

Table 5-1: Data Quality Objectives

Parameter	Data Accuracy Objectives (% R)		Data Precision Objectives				Required Detection Limits	
			Field Precision (RPD)		Analytical Precision (RPD)			
	Estimated By	Objective	Estimated By	Objective	Estimated By	Objective	Reference Method	RL*
Fecal coliform	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	SM 9222D	10 No./ 100 ml
Escherichia coliform (E. coli)	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	EPA 1603	10 No./ 100 ml
Enterococcus	Presence/ Absence Control	P/A	Field Duplicates	50%	Lab Replicates	40%	EPA 1600	10 No./ 100 ml

P/A - method detects presence when bacteria is present in control (P) and method does not detect bacteria when absent in control (A).
RL - Reporting Limit
SM - Standard Methods of the Examination of Water and Wastewater, 22nd Edition

5.2 Comparison of Results to QAPP

This section presents a high level summary of the comparison of the QAPP objectives to the results from the Sampling Program.

5.2.1 Accuracy

Accuracy cannot be directly measured for bacterial samples. Accuracy was assessed by the laboratory through the analysis of positive and negative controls and matrix spikes and with field blanks in the field. Field blanks are used to determine if samples collected were contaminated. Dilution blank samples and method blank samples were generated by the contract laboratory and used to assess contamination resulting from laboratory procedures. Overall, the accuracy of the Sampling Program was excellent.

A total of 21 field blanks were collected during the Sampling Program with at least one field blank collected per sampling event. Each field blank was analyzed for all three POCs, providing up to 63 measures of field accuracy. Only two of the 63 field blank results had a measurement higher than the analytical reporting limit. The field blank concentrations for these two results were inspected for potential evidence of contamination in the associated sample. The comparison indicated that the field blank concentration was much lower than the corresponding sample concentration, so the apparent field contamination impact on the sample result was nominal.

Eurofins, the laboratory that conducted the bacteria analyses for the sampling program, conducted positive/negative controls for E.Coli and Enterococci. Fecal coliform does not require analysis of this QA/QC measure. A positive control is a sample known to have bacteria while a negative control is a

sample known to be bacteria-free. The test is intended to confirm that the laboratory can grow bacteria for the positive controls and does not grow any measurable bacteria for the negative controls. For both E. coli and Enterococcus, six positive and six negative controls were analyzed. All measures met the requirements except one E. coli positive control, which did not have sufficient bacteria growth. Overall, this corresponds to a 96% success rate.

Matrix spikes are analyzed at a frequency of approximately one every 20 samples, depending on available sample volume, sufficient hold time and laboratory capacity. Matrix spikes are prepared by adding a known quantity of bacteria to a sample and measuring the amount recovered. Although this QA/QC measure was not included in the Sample Program QAPP, it provides another measure of laboratory accuracy. Matrix spikes were performed for all three parameters of interest using DELCORA samples.

Results are summarized in the table below. A percent recovery range of 50% - 150% recovery was used for acceptance windows. Note that percent recovery cannot be calculated under the following circumstances:

1. If the unspiked sample has a very high concentration relative to the amount spiked
2. If the matrix spike sample concentration exceeds the quantitation range (e.g. ">")

Both of these situations occurred with each parameter, as shown in the table below.

Table 5-2: Laboratory Matrix Spike Summary

Parameter	Number of MS samples analyzed	Number of MS samples without calculable percent recovery	Number of MS samples with measurable percent recovery	Number of MS samples with acceptable percent recovery
E. coli	13	4	9	6 (67%)
Enterococcus	12	4	8	8 (100%)
Fecal Coliform	10	5	5	3 (60%)

Overall, 77% of the matrix spikes where a percent recovery could be calculated were within the 50% - 150% windows.

5.2.2 Precision

Precision is a measure of agreement between two or more measurements. The precision test objective is shown in Table 5-1. Field duplicates and laboratory replicates samples were taken for a portion of the samples. As noted in the QAPP (Section 2.4.1.2), the precision test (i.e.: comparison between two or more samples) is applied if the average result of the duplicate/replicate samples is greater than five times the analysis detection limit. If the average result of the duplicate/replicate samples is less than five times the analysis detection limit, the precision test was not utilized. Overall, the precision of the Sampling Program was mostly successful at meeting the QAPP objectives. The issues impacting field precision were largely due to factors outside the control of sampling personnel as well as by the well-established difficulty in generating reproducible results analytically for these parameters.

A total of 23 field duplicates were collected during the Sampling Program, with at least one field duplicate collected per sampling event. Each field duplicate was analyzed for all three POCs, providing up to 69 measures of field precision. Table 5-2 provides a summary of the field duplicate precision, calculated as the relative percent difference (% RPD).

Table 5-3: Field Precision % RPD Summary

Event	Location	E. coli % RPD	Fecal % RPD	Entero % RPD
Dry1	CC-01	<5x RL	<5x RL	<5x RL
Dry1	DR-02	<5x RL	<5x RL	<5x RL
Dry1	RC-03	91%	<5x RL	<5x RL
Dry2	CC-02	60%	59%	11%
Dry2	DR-04	80%	7%	<5x RL
Dry2	RC-02	7%	49%	42%
Dry3	CC-03	22%	9%	55%
Dry3	DR-03	18%	5%	<5x RL
Dry3	RC-01	44%	10%	0%
Wet1	CC-03	44%	36%	56%
Wet1	CSO-02	45%	107%	20%
Wet1	DR-02	55%	41%	<5x RL
Wet1	DR-04	133%	0%	52%
Wet1	RC-01	34%	67%	1%
Wet2	CC-01	27%	35%	3%
Wet2	CSO-018	2%	19%	18%
Wet2	DR-03 (LAND)	75%	147%	15%
Wet2	RC-02	34%	6%	18%
Wet3	CC-02	2%	50%	18%
Wet3	CSO-019	22%	1%	36%
Wet3	DR-01	50%	58%	<5x RL
Wet3	DR-02	6%	40%	34%
Wet3	RC-03	41%	21%	26%

Twelve (12) of the 69 RPDs could not be calculated because of the low pollutant concentrations in the samples and the field duplicates. For E. coli, 15 of the 21 calculable field duplicates met the 50% precision objective. For fecal coliform, 15 of the 20 calculable field duplicates met the 50% precision objective. For enterococcus, 13 of the 16 calculable field duplicates met the 50% precision objective.

Laboratory replicates are analyzed at a frequency of approximately one every 20 samples, depending on available sample volume, sufficient hold time and laboratory capacity. Replicates are prepared by analyzing a second aliquot of a sample and measuring the agreement between the two analyses as the

relative % difference (% RPD). Replicates provide an assessment of laboratory precision. Replicates were performed for all three parameters of interest using DELCORA samples.

Results are summarized in the table below. A % RPD target of 40% was specified in the QAPP for acceptance windows. Note that % RPD cannot be calculated under the following circumstances:

1. If the sample or replicate concentration exceeds the quantitation range (e.g. ">")
2. If the sample or replicate concentration is less than the reporting limit (e.g. "<")

Both of these situations occurred with each parameter, as shown in the table below. In addition, the sample id for one of the replicates for each parameter was inadvertently not recorded so it was not possible to compare its concentration to the first aliquot.

Table 5-4: Relative Percent Difference Summary

Parameter	Number of replicate samples analyzed	Number of replicate samples without calculable % RPD	Number of replicate samples with measurable % RPD	Number of replicate samples with acceptable % RPD
E. coli	13	6	7	7 (100%)
Enterococcus	12	7	5	3 (40%)
Fecal Coliform	10	7	3	1 (40%)

Overall, 73% of the replicates where a % RPD could be calculated were within the 40% window.

5.2.3 Completeness

Completeness is a measure of the amount of valid data obtained from the monitoring program compared to the amount of data that were expected. Events that may contribute to reduction in measurement completeness include sample container breakage, inaccessibility to desired sampling locations, automatic sampler failure, and laboratory equipment failures.

Field completeness is determined by the number of measurements collected versus the number of measurements planned for collection. As noted in the QAPP, The completeness criterion for all measurements and sample collection is 90 percent, but will be influenced by environmental situations that may alter monitoring schedules. These environmental situations were presented in Section 3 of this report for each event. Laboratory completeness is a measure of the amount of valid measurements obtained from all samples submitted for each sampling activity. The completeness criterion for all measurements is 95 percent.

All analyses were completed on the samples that were collected so the laboratory completeness measure is 100%. The overall field completeness was 87%. Field completeness was impacted by the sampling challenges described in Section 3, including weather-related safety issues and mechanical problems with the boat that resulted in several rounds of sampling that could not be conducted as planned. These issues only impacted the wet weather sampling in the Delaware River. When possible, samples were collected from the bank but access was limited to only two stations. For the tributaries, CSOs and stormwater

locations, the field completeness was 100%. Depending on the location in the Delaware River, the field completeness ranged from 67% to 78%. Overall, the completeness objective was successfully achieved as most of the problems affecting the ability to collect the planned samples in the Delaware River were unavoidable.

5.2.4 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representative data of dry weather and wet weather conditions are required to support the evaluation and modeling efforts.

For sample collection, representativeness will be assured by following the Water Quality Monitoring and Modeling Work Plan (Greeley and Hansen / Limnotech, Revised July 2017) and applying proper collection techniques including the proper sample sizes and volumes, sampling times, and sampling locations. The volumes of the samples depend on the analytical methods and should allow for QC sample analysis and reanalysis, if required. In the laboratory, representativeness will be ensured by using the appropriate sample preparation techniques, by following appropriate analytical procedures, and by meeting the recommended sample holding times.

Representativeness was achieved in the Sampling Program by sampling three dry weather events under a range of flow conditions and during both the spring and summer season, and by sampling three wet weather events under a range of environmental conditions, with rainfall ranging from 0.5 inches to more than 1.5 inches. Figures 5-1 and 5-2 shows the sampling intervals in each of the waterways for the three dry weather and three wet weather events, respectively. There were no instances where samples lacked sufficient volume for analysis. In the laboratory, representativeness was generally good.

All samples were analyzed for all POCs using accepted methods. However, of the 459 samples collected in the Sampling Program, 61 had at least one parameter analyzed outside the specified hold time of 8 hours. Most of these samples were associated with the wet weather events, reflecting the logistical challenges associated with this type of sampling. A total of 91 analyses were conducted after the hold time had expired. However, 84 of these analyses were completed within 10 hours, so the hold time was missed by less than 2 hours for the vast majority of samples. These results have been qualified but minimal impact on the use of the data is anticipated due to the similarity in concentrations between results measured within and outside the analytical hold time. Much more uncertainty exists within the analytical methodology and field practices (e.g. obtaining a homogenous, representative sample, etc.).

Overall, the representativeness objectives of the QAPP was achieved through the selection of sampling events that collectively, capture the river and tributary characteristics over a range of environmental conditions.

Figure 5-1: Representativeness of Dry Weather Sampling Events and Sampling Intervals in Each Waterway

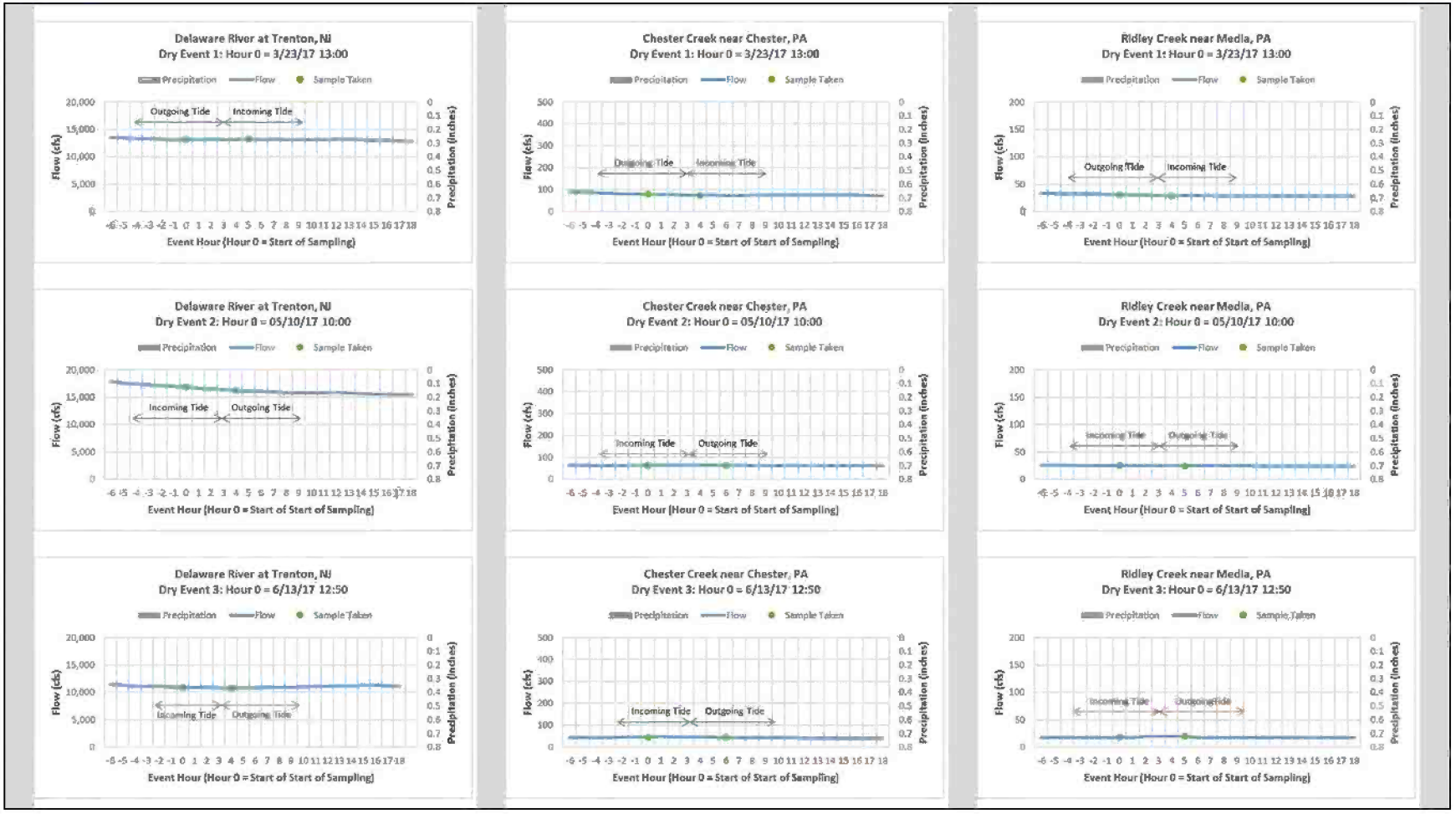
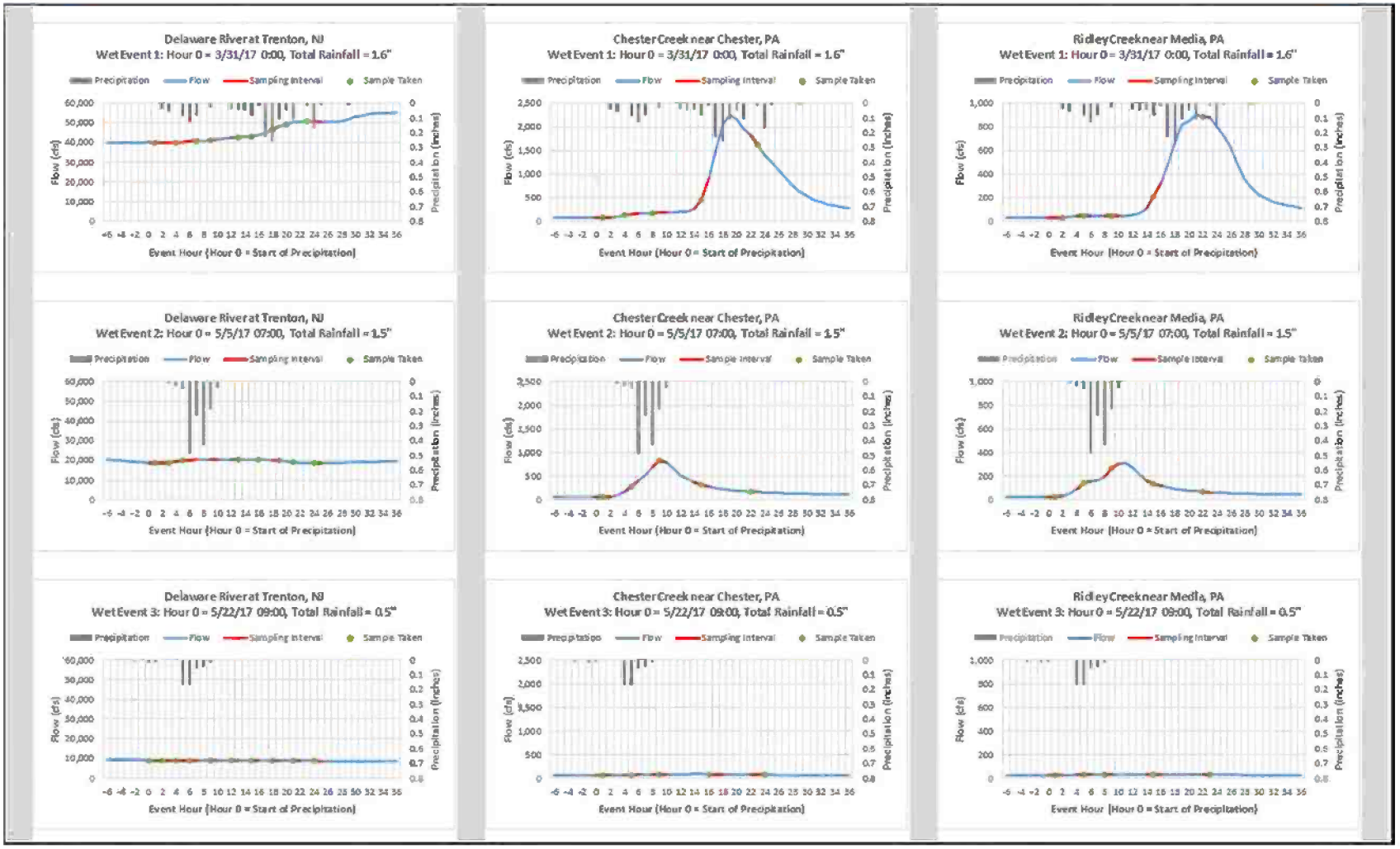


Figure 5-2: Representativeness of Wet Weather Sampling Events and Sampling Intervals in Each Waterway



5.2.5 Comparability

The objective for data comparability is to generate data for each parameter that related water quality conditions between sampling locations and over time. Data comparability will be promoted by:

1. Using standard U.S. EPA approved methods, where possible.
2. Consistently following the sampling methods detailed in the SAP.
3. Consistently following the analytical methods detailed in the QAPP.
4. Achieving the required detection limits detailed in the QAPP.

All sample collection and analytical methods will be specified, and any deviations from the methods will be documented. All results will be reported in the standard units as shown in QAPP. All field and laboratory calibrations will be performed using standards traceable to National Institute of Science and Technology (NIST) or other U.S. EPA approved sources.

The field crews and laboratory were consistent in collecting and analyzing the samples from the Sampling Program in a manner that allows the data to be compared between events. In the laboratory, the same EPA-approved analytical method was used for each parameter across all sampling events and samples were consistently analyzed at the dilutions specified in the QAPP and Work Plan. The Sampling Program successfully met this objective of the QAPP.

5.2.6 Required Detection Limits

All required detection limits were met in the Sampling Program.

Section 6 Water Quality Sampling Results Summary

This section presents additional analysis of the water quality sampling program results, particularly with respect to their use in the development and calibration of the water quality model.

6.1 Data Analysis

Section 4 presented an overview of the dry and wet weather datasets by individual event. The following observations were presented with respect to the data:

- Bacteria concentrations tended to be similar in all of the waterbodies during dry weather for both incoming and outgoing tidal conditions;
- Dry weather concentrations in the tributaries were mostly below numeric thresholds used for water quality standard criteria;
- Dry weather concentrations in the Delaware River tended to be well below numeric thresholds used for water quality standard criteria;
- An increase in POC concentration from upstream to downstream was observed in each of the tributaries, suggesting there may be significant bacteria sources impacting these tributaries during dry weather;
- Wet weather concentrations in all of the waterbodies tended to exceed numeric thresholds used for water quality standard criteria;
- Lateral POC gradients in the Delaware River were present but not at a significant level (e.g. orders of magnitude); and,
- The time series profiles in the Chester Creek and Ridley Creek waterbodies suggest that DELCORA's CSO discharges and Chester's stormwater discharges are not the only sources impacting these tributaries during wet weather. Upstream or other wet-weather sources also contribute to high bacteria concentrations during wet weather events.

In addition to the insights gleaned from the time series figures described in Section 4 and presented in Appendix H, this section presents data analyses that considered the results for the events more holistically than the individual event summaries presented in Section 4. Additional data analyses presented in this section include 1) an evaluation of the waterway response to the various environmental conditions during the sampled events and 2) an evaluation of whether a first flush could be discerned for any of the POCs in the source (e.g. CSO and stormwater) data.

6.1.1 Evaluation of Waterway Response to Environmental Conditions

Because multiple storm events were sampled, along with several dry weather events, a comparison of the response at each stream location across the sampling events may yield insight into how sensitive a given stream reach is to the amount and distribution of rainfall. This may be an important factor to consider in developing CSO control strategies. For example, a control strategy may target reductions of CSOs in non-tidal areas if those portions of the streams show a stronger response to rainfall than tidal areas.

Figure 6-1 presents box-and-whisker plots of the tributary sampling locations in Chester Creek and Ridley Creek. The figures are ordered such that the top figure is the most upstream sampling location and the bottom figure is the most downstream sampling location. The boxes in the figure correspond to the 25th and 75th percentiles of the data. The line in the center of the box is the median concentration. The end of the whiskers correspond to the minimum and maximum concentrations. The data for each wet and dry weather events were grouped separately into subsets for the purpose of the plot. Similar figures are presented in Appendix H for the other POCs and sampling locations.

The following insights can be gleaned from these figures:

- Dry weather concentrations of the analyzed bacteria are lower than each of the wet weather event concentrations;
- The stream response was most pronounced for the second wet weather event. This event was slightly less depth than the first wet weather event (1.47 inches vs. 1.5 inches) but the rainfall occurred over a shorter duration and with higher intensity in the second wet weather event, resulting in a stronger in-stream response.
- Downstream locations show more spread in the distribution of concentrations within each event as compared to the most upstream locations. This is likely the result of higher mixing with the Delaware River and the tidal influence on water quality at the more downstream locations.

Figure 6-2 presents box-and-whisker plots of three Delaware River locations: DR-01, which is the most upstream (e.g. least tidally impacted) station, DR-03, which is approximately midway along the reach of the river adjacent to the DELCORA service area, and DR-05, which is the most downstream station.

This figure shows some of the same characteristics as Figure 6-1 as well as some differences. Like the tributaries, the most downstream location shows the largest spread in concentrations, likely the result of higher mixing associated with the tidal influence on water quality at this station compared to the others located further upstream. Unlike the tributaries, which had the largest response to the second wet weather event, the Delaware River had the highest concentrations in the first wet weather event, though at DR-05, the peak concentration occurred during the second wet weather event. Another difference between the characteristics of the Delaware River and the tributaries' water quality is that the dry and wet weather concentrations in the Delaware River tended to be more similar than in the tributaries. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

Figure 6-1: Comparison of Fecal Coliform Concentrations for the Sampling Events in Chester and Ridley Creeks

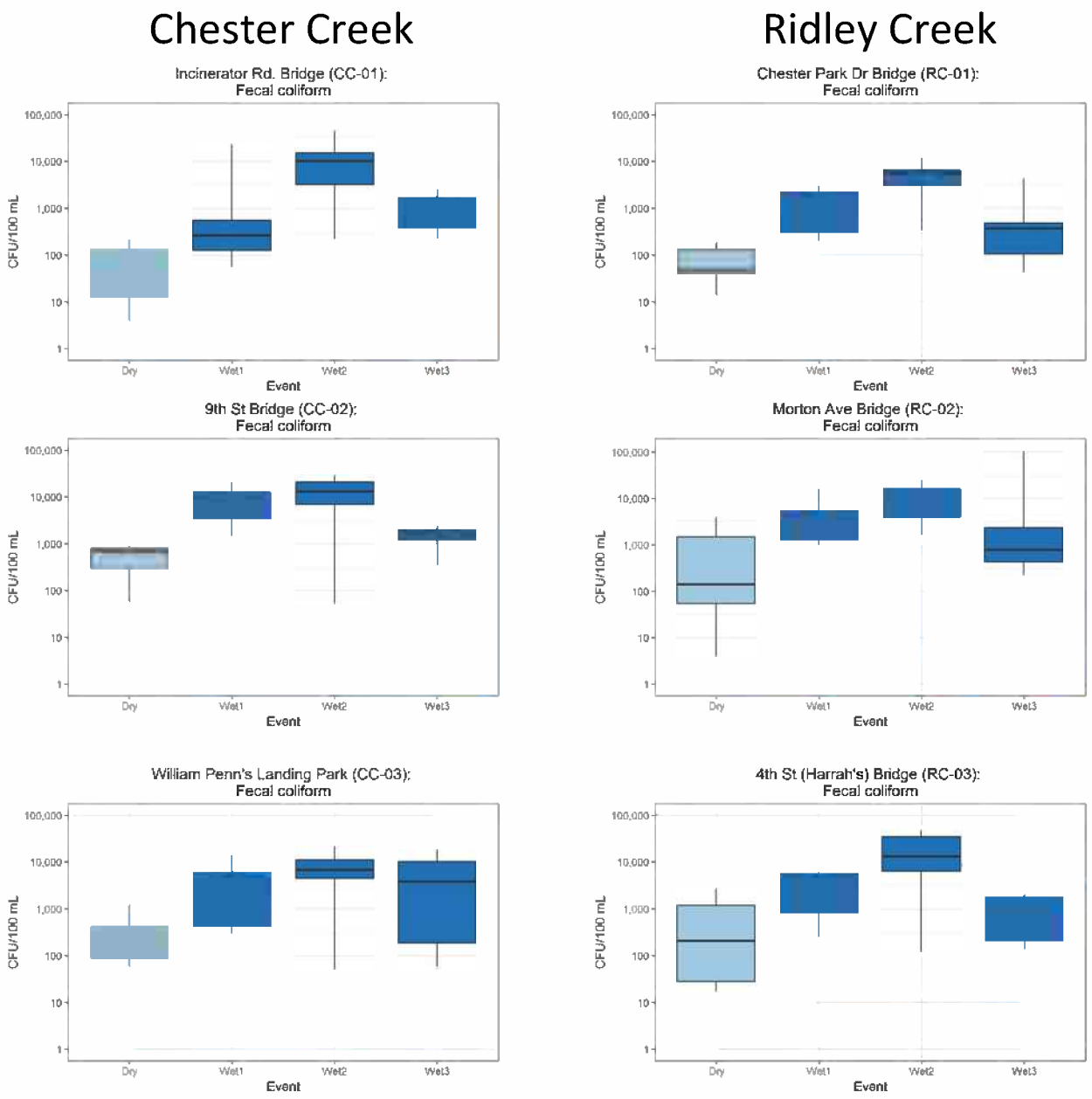
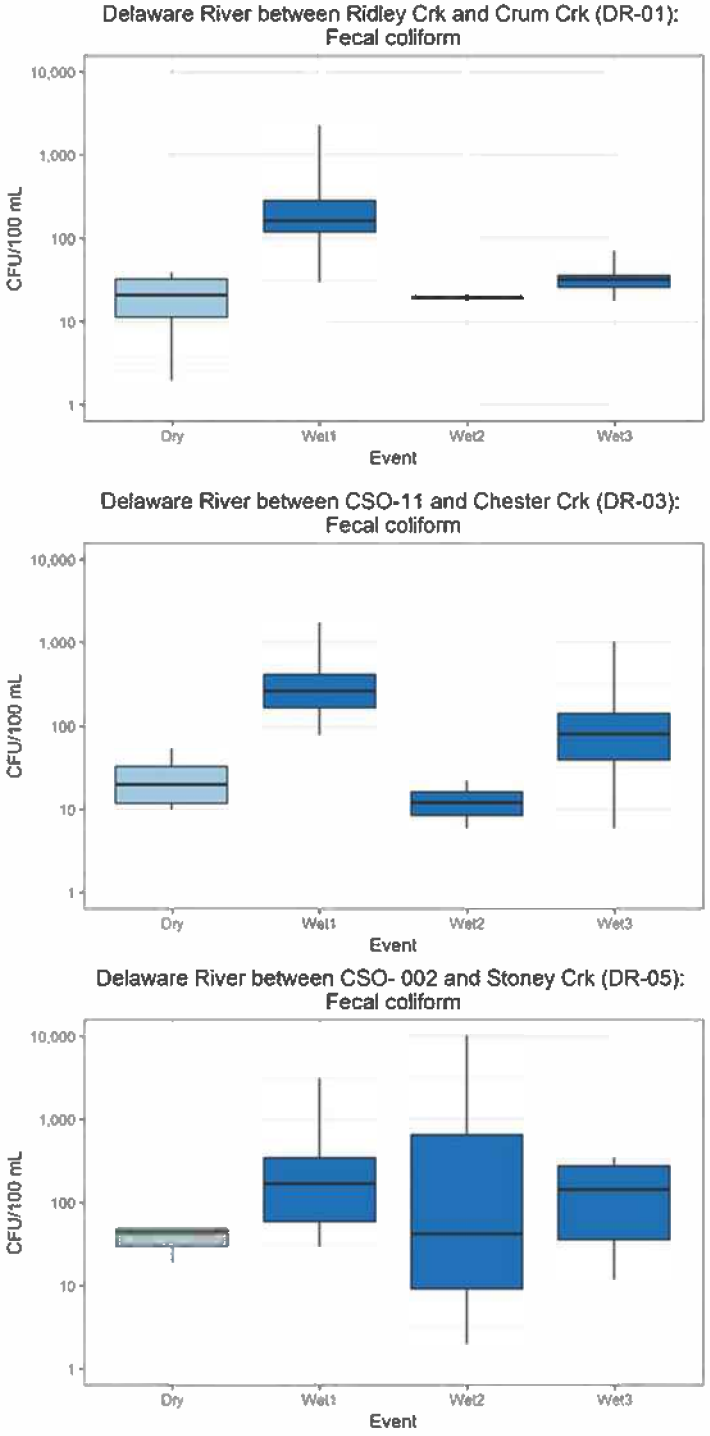


Figure 6-2: Comparison of Fecal Coliform Concentrations for the Sampling Events in the Delaware River



6.1.2 CSO and Stormwater First Flush Effect Analysis

A second analysis that was conducted across all of the event datasets was an evaluation of the CSO and stormwater data for first flush effects. A first flush effect means that pollutant concentrations that build up on the land surface between rainfall events are quickly washed off and flushed through the collection system, resulting in higher pollutant concentrations during the beginning of the discharge period compared to concentrations during the later portion of the discharge event.

Figure 6-3 presents a comparison of fecal coliform data in each of the CSOs for each of the wet weather events by sampling round. Note that the first three rounds are sampled within the first hour of discharge, with the fourth round representing the 2nd hour of discharge. If a first flush effect existed, concentrations during one or more of these rounds of sampling would be consistently higher than the later rounds. As this figure illustrates, there are combinations of events and rounds where the concentration is significantly higher than other events and/or other rounds, but no consistent pattern is discernible. Similar results were obtained for the other POCs (see Appendix H). Bacteria concentrations can be highly variable and it is typically very difficult to identify a consistent first flush for these parameters.

Figure 6-4 presents a similar analysis and result for the two stormwater outfalls for fecal coliform. Plots for the other POCs are presented in Appendix H.

This figure also shows a significant outlier data point during Wet 2 (1,500,000 cfu/100 ml) that is not believed to be representative of the quality of the stormwater runoff. The field notes, chain of custodies and laboratory analytical reports were inspected for potential explanation for the high value but none could be determined from the record set. This data point was not used in any statistical calculations or other data analyses.

6.1.3 CSO and Stormwater Event Mean Concentrations

Based on the first flush effect analysis presented in the previous section, the CSO and stormwater data were further analyzed to develop an initial estimate of representative concentration for each source type to calculate pollutant loads. These representative concentrations are referred to as event mean concentrations (EMCs) and represent the average water quality in the CSO and storm sewer systems.

Figure 6-3: CSO Fecal Coliform Concentrations by Sampling Round

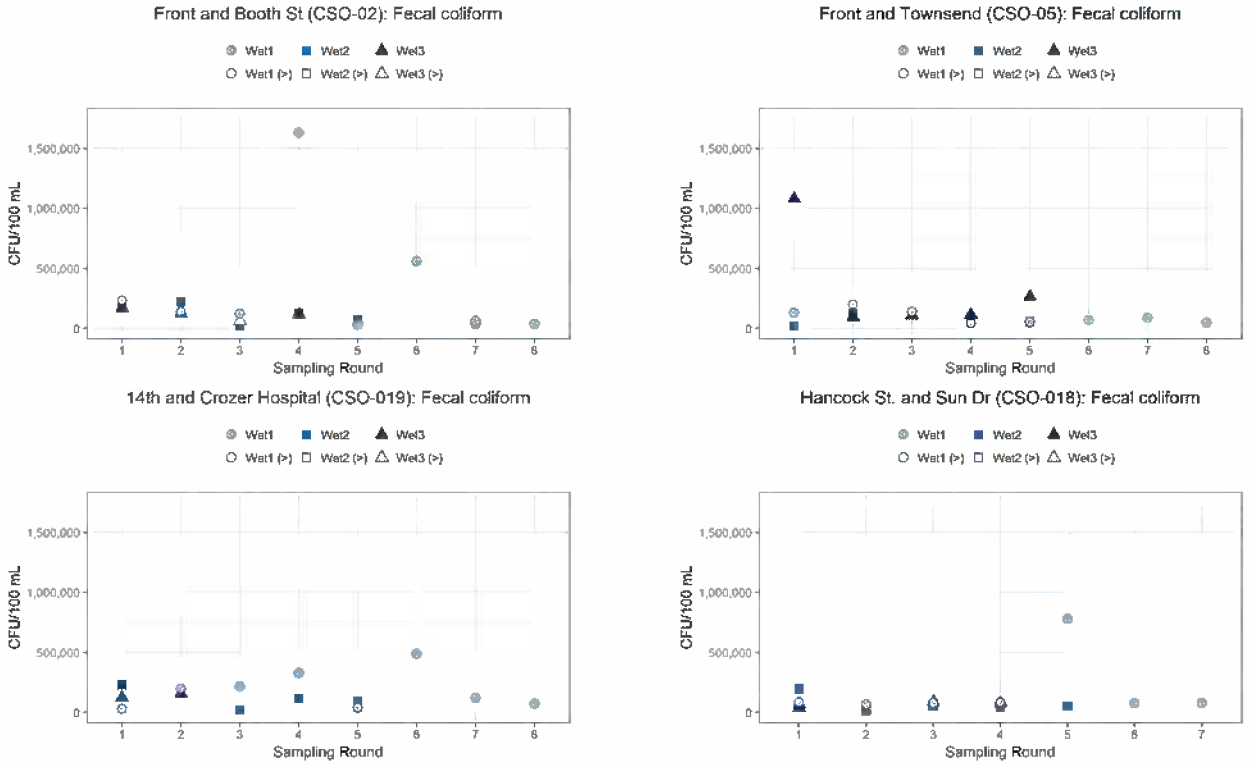
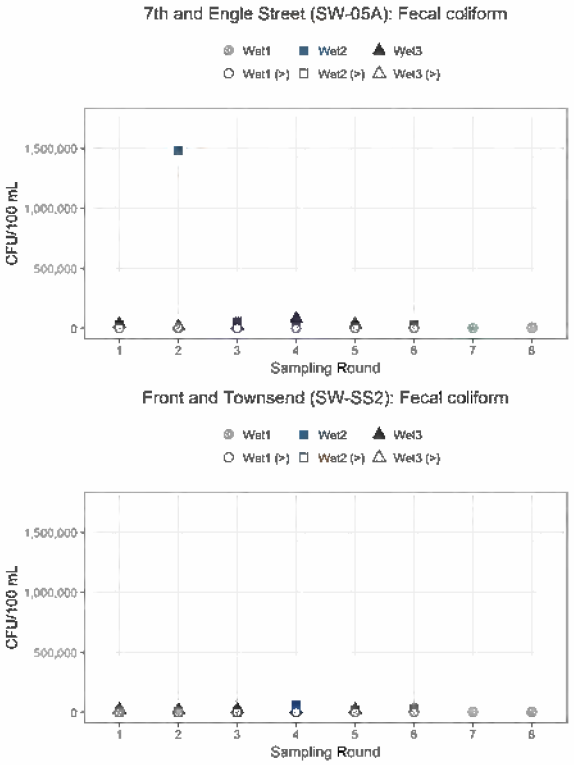


Figure 6-4: Stormwater Fecal Coliform Concentrations by Sampling Round



Flow-weighted EMCs were calculated for CSO-02, CSO-05, and CSO-019 using the metered flow data at the CSO diversion structure and the measured concentration data. Since CSO-018 was not metered, this method could not be applied for this CSO. A summary is presented in Table 6-1 for each event and POC.

Table 6-1: Flow-weighted CSO Event Mean Concentrations

	CSO-019	CSO-02	CSO-05
Fecal coliform			
Wet 1	175,264	160,758	75,948
Wet 2	97,421	95,158	72,093
Wet 3	125,183	124,408	126,934
Average	128,814	123,924	88,578
E. coli			
Wet 1	233,830	112,097	42,575
Wet 2	232,809	176,018	107,485
Wet 3	689,748	304,759	370,265
Average	334,860	181,845	119,216
Enterococcus			
Wet 1	167,891	110,237	52,790
Wet 2	149,515	141,616	119,217
Wet 3	254,176	305,311	142,677
Average	185,474	168,291	96,475

It should be noted that these calculations are a starting point for determining EMCs for use in the water quality model. The calculations shown in Table 1 present a challenge in that the E. coli values are higher than the fecal coliform values, which is not physically possible.

A statistical analysis was conducted on the CSO and stormwater data directly with results shown in Table 6-2. This analysis allows the data from locations without flow data, such as CSO-018 and the two stormwater locations, to be included for consideration. All of the data for a given location were evaluated together in developing the statistics presented in Table 6-2.

Table 6-2: Distribution of CSO and Stormwater Pollutant Concentrations

	Sample Count	Geomean	25th Percentile	75th Percentile
Fecal coliform				
CSO-02	18	116,611	60,750	205,250
CSO-05	18	99,861	56,750	126,750
CSO-018	17	74,335	53,000	85,000
CSO-019	15	116,754	83,773	206,000
SW-05A	19	5,522	883	31,000
SW-SS2	19	3,693	913	21,000
E. coli				
CSO-02	18	158,546	60,500	345,500
CSO-05	18	144,369	66,000	231,250
CSO-018	17	95,812	63,000	104,000
CSO-019	15	189,860	100,000	286,000
SW-05A	19	3,843	1,180	16,500
SW-SS2	19	2,407	625	18,000
Enterococcus				
CSO-02	18	123,582	73,250	288,750
CSO-05	18	90,052	61,250	180,000
CSO-018	17	48,669	29,000	83,000
CSO-019	15	131,911	56,500	197,000
SW-05A	19	25,118	5,700	112,000
SW-SS2	19	40,217	19,250	119,250

Results in this table for each location are slightly lower than the results using the flow-weighted method average results presented in Table 6-1. The results also show that the CSO E. coli values are higher than the CSO fecal coliform values, which is not physically possible since E. coli is a subset of fecal coliform. The 25th and 75th percentile values will be used as a basis for adjusting the EMC value used in estimating the loads from each source type. Additional analysis and interpretation of the data will be conducted as part of the water quality model development and calibration process.

6.2 Conclusion

The DELCORA Sampling Program was designed to fill data gaps necessary to characterize sources and surface waters during dry and wet weather events to support the development of water quality models for use in the development of the CSO Long Term Control Plan Update. It provides the first co-located, coordinated sampling of Chester Creek, Ridley Creek and the Delaware River for the three bacteria parameters most often used to protect recreational water quality and identified as Pollutants of Concern. This was also the first Sampling Program to capture both dry and wet weather in-stream conditions, conduct time-intensive wet weather sampling, and concurrently characterize CSO and stormwater

sources. The data are sufficient to characterize DELCORA's CSO and stormwater source loads for the water quality model. The data also span a range of environmental conditions and provide an extensive dataset for demonstrating the robustness of the water quality model. The Sampling Program fully achieved the objectives of collecting comprehensive and complete datasets needed to characterize pollutant sources, produce an appropriately calibrated watershed and water quality model, and successfully meet the quality objectives of the QAPP. No further data collection is required at this time to develop or calibrate the models for use in the development of DELCORA's Long Term Control Plan Update.

Section 7 References

Greeley and Hansen / Limnotech. (Revised July 2017). *Water Quality Monitoring and Modeling Quality Assurance Project Plan.* Originally submitted January 2017, Revised March 2017: Report prepared for Delaware County Regional Water Quality Control Authority (DELCORA).

Greeley and Hansen / Limnotech. (Revised July 2017). *Water Quality Monitoring and Modeling Work Plan.* Report prepared for Delaware County Regional Water Quality Control Authority (DELCORA).

Greeley and Hansen. (2016c). *Identification of Sensitive Areas and Pollutants of Concern Report.* Report prepared for Delaware County Regional Water Quality Control Authority (DELCORA). This report was approved by USEPA and PADEP on October 13, 2016. See approval letters in this section.

USEPA. (1999). *Combined Sewer Overflows: Guidance for Monitoring and Modeling.* Washington, DC: United States Environmental Protection Agency.

Weston Solutions, Inc. (March 2017). *Sampling Analysis Plan.* Prepared for Greeley and Hansen for submittal to Delaware County Regional Water Quality Control Authority (DELCORA).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

OCT 13 2016

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Revised Identification of Sensitive Area Analysis (RISAA) dated May 13, 2016. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA hereby approves the RISAA.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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Section 8 Abbreviations

CSO:	Combined Sewer Overflow
CSS:	Combined Sewer System
CWA:	Clean Water Act
DELCORA:	Delaware County Municipal Utilities Authority
DEP:	Pennsylvania Department of Environmental Protection
DRBC:	Delaware River Basin Commission
e-DMR:	electronic Discharge Monitoring Report
EMC:	Event Mean Concentration
GIS:	Geographic Information System
H&H:	Hydrologic and Hydraulic
KCPS:	Kimberly Clark Pump Station
LTCP:	Long Term Control Plan
LTCPU:	Long-Term Control Plan Update
MDL:	Method Detection Limit
MGD:	Million Gallons per Day
NPDES	National Pollutant Discharge Elimination System
NRCS:	Natural Resources Conservation Service
PA Integrated Report:	PA Integrated Water Quality Monitoring and Assessment Report
PADEP:	Pennsylvania Department of Environmental Protection
POC:	Pollutant of Concern
PSWPCP:	Philadelphia Water Department's Southwest Water Pollution Control Plant
QA/QC:	Quality Assurance/Quality Control
QAPP:	Quality Assurance Project Plan
R.M.:	River Mile
RHM:	Radnor Haverford Marple Authority
STORET:	Storage and Retrieval for Water Quality Data
TMDL:	Total Maximum Daily Load
UH:	Unit Hydrograph
USEPA or EPA:	United States Environmental Protection Agency
WQMP:	Water Quality Monitoring Program
WQR:	Water Quality Regulations
WQS:	Water Quality Standards
WRTP:	Western Regional Treatment Plant
WWF:	Warm Water Fishes
EMC:	Event Mean Concentration

APPENDIX A

DRY WEATHER EVENT 1 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

DRY WEATHER EVENT: 1

DATE: 3/23/2017 — **Note Temperature of Receiving Stream if below 10 °C threshhold**

EVENT START TIME: 12:55

Sampling Station	Sampling Round	Estimated Target Sample Collection (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? [1] (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? [1] (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations[2] (see notes, below)
CC-01	Incoming tide	19:30	19:34	N	-	N	-	Y	19:55	0.55	6.52	718	Dusk, clear, little debris, foam
	Outgoing tide	15:05	15:09	Y	15:10	N	-	Y	15:30	0.55	5.87	698	Sunny & clear, no debris, little foam
CC-02	Incoming tide	19:10	19:12	N	-	N	-	Y	19:55	0.55	5.37	695	Dusk, clear, no debris, little foam
	Outgoing tide	14:45	14:48	N	-	N	-	Y	15:30	0.55	5.77	698	Sunny & clear, no debris, no foam, tree branches, bark
CC-03	Incoming tide	17:45	17:44	N	-	N	-	Y	19:55	0.55	5.82	701	Sunny & clear, no debris, no foam, some scum
	Outgoing tide	13:00	13:00	N	-	Y	13:03	Y	15:30	0.55	3.36	659	Sunny & clear, mild debris, clear water, no turbidity
RC-01	Incoming tide	18:40	18:47	N	-	N	-	Y	19:55	0.41	5.66	523	Dusk, clear, no debris, foam
	Outgoing tide	14:22	14:25	N	-	N	-	Y	15:30	0.39	5.72	503	Sunny & clear, no debris, little foam, (non-tidal)
RC-02	Incoming tide	18:15	18:20	N	-	N	-	Y	19:55	0.4	6.54	532	Dusk, clear, no debris, little foam
	Outgoing tide	13:55	14:00	N	-	N	-	Y	15:30	0.41	5.34	518	Flushing hydrant, sunny clear, very mild foam
RC-03	Incoming tide	17:55	18:00	Y	18:00	N	-	Y	19:55	0.41	6.60	536	Sunny & clear, no debris, clear water
	Outgoing tide	13:30	13:35	N	-	Y	13:35	Y	15:30	0.41	3.26	496	Sunny & clear, no debris, clear water
DR-01	Incoming tide	17:30	17:25	N	-	N	-	Y	19:55	0.28/ 0.29/ 0.29	5.49/ 5.32/ 5.38	362/ 373/ 376	Total depth = 20.6 ft.
	Outgoing tide	12:55	12:55	N	-	Y	12:55	Y	15:30	0.26/ 0.27/ 0.28	5.50/ 5.40/ 5.30	345/ 349/ 357	Total depth = 25.0 ft.
DR-02	Incoming tide	17:45	17:45	N	-	N	-	Y	19:55	0.28/ 0.29/ 0.29	5.48/ 5.54/ 5.56	366/ 372/ 374	Total depth = 33.0 ft.
	Outgoing tide	13:15	13:30	Y	13:30	N	-	Y	15:30	0.27/ 0.27/ 0.27	5.5/ 5.4/ 5.4	345/ 346/ 349	Total depth = 35.0 ft.
DR-03	Incoming tide	18:00	18:00	N	-	N	-	Y	19:55	0.29/ 0.29/ 0.29	5.58/ 5.59/ 5.59	375/ 374/ 374	Total depth = 33 ft.
	Outgoing tide	13:30	13:55	N	-	N	-	Y	15:30	0.26/ 0.27/ 0.27	5.5/ 5.5/ 5.5	342/ 350/ 349	Total depth = 34 ft.
DR-04	Incoming tide	18:15	18:15	N	-	N	-	Y	19:55	0.29/ 0.28/ 0.28	6.22/ 6.21/ 6.22	363/ 364/ 365	Total depth = 25.0 ft.
	Outgoing tide	13:50	14:10	N	-	N	-	Y	15:30	0.27/ 0.28/ 0.28	5.6/ 5.6/ 5.6	357/ 358/ 359	Total depth = 19.4 ft.
DR-05	Incoming tide	18:30	18:30	N	-	N	-	Y	19:55	0.28/ 0.28/ 0.28	6.22/ 6.21/ 6.22	363/ 364/ 365	Total depth = 7.0 ft.
	Outgoing tide	14:15	14:30	N	-	N	-	Y	15:30	0.42/ 0.42/ 0.40	9.5/ 9.6/ 9.2	603/ 600/ 571	Total depth = 4.8 ft.

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6724475-1	RC-01-1	03/23/17 02:30pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6724475-1	RC-01-1	03/23/17 02:30pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6724475-1	RC-01-1	03/23/17 02:30pm	FECAL COLIFORM-MF	SM 9222D	40 E	03/23/17 06:43PM	BHS
L6724476-1	CL-02-8	03/23/17 01:00pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6724476-1	CL-02-8	03/23/17 01:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6724476-1	CL-02-8	03/23/17 01:00pm	FECAL COLIFORM-MF	SM 9222D	<10	03/23/17 06:43PM	BHS
L6729205-1	DR-05-1	03/23/17 02:30pm	E. COLI-MF (1603)	EPA 1603	30 E	03/23/17 06:26PM	BHS
L6729205-1	DR-05-1	03/23/17 02:30pm	ENTEROCOCCUS-MF 24	EPA 1600	320	03/23/17 06:33PM	BHS
L6729205-1	DR-05-1	03/23/17 02:30pm	FECAL COLIFORM-MF	SM 9222D	50 E	03/23/17 06:43PM	BHS
L6729206-1	DUP DR-02-2	03/23/17 01:30pm	E. COLI-MF (1603)	EPA 1603	10 E	03/23/17 06:26PM	BHS
L6729206-1	DUP DR-02-2	03/23/17 01:30pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729206-1	DUP DR-02-2	03/23/17 01:30pm	FECAL COLIFORM-MF	SM 9222D	50 E	03/23/17 06:43PM	BHS
L6729207-1	DR-01-1	03/23/17 01:00pm	E. COLI-MF (1603)	EPA 1603	10 E	03/23/17 06:26PM	BHS
L6729207-1	DR-01-1	03/23/17 01:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729207-1	DR-01-1	03/23/17 01:00pm	FECAL COLIFORM-MF	SM 9222D	10 E	03/23/17 06:43PM	BHS
L6729208-1	DR-02-1	03/23/17 01:30pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729208-1	DR-02-1	03/23/17 01:30pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729208-1	DR-02-1	03/23/17 01:30pm	FECAL COLIFORM-MF	SM 9222D	40 E	03/23/17 06:43PM	BHS
L6729209-1	DR-03-01	03/23/17 01:55pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729209-1	DR-03-01	03/23/17 01:55pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729209-1	DR-03-01	03/23/17 01:55pm	FECAL COLIFORM-MF	SM 9222D	10 E	03/23/17 06:43PM	BHS
L6729210-1	DR-04-1	03/23/17 02:10pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729210-1	DR-04-1	03/23/17 02:10pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729210-1	DR-04-1	03/23/17 02:10pm	FECAL COLIFORM-MF	SM 9222D	20 E	03/23/17 06:43PM	BHS
L6729211-1	BLANK	03/23/17 12:55pm	E. COLI-MF (1603)	EPA 1603	<2	03/23/17 06:26PM	BHS
L6729211-1	BLANK	03/23/17 12:55pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/23/17 06:33PM	BHS
L6729211-1	BLANK	03/23/17 12:55pm	FECAL COLIFORM-MF	SM 9222D	<2	03/23/17 06:43PM	BHS
L6729212-1	DUP CC-01-D	03/23/17 03:00pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729212-1	DUP CC-01-D	03/23/17 03:00pm	ENTEROCOCCUS-MF 24	EPA 1600	40 E	03/23/17 06:33PM	BHS
L6729212-1	DUP CC-01-D	03/23/17 03:00pm	FECAL COLIFORM-MF	SM 9222D	<10	03/23/17 06:43PM	BHS
L6729213-1	CC-01-1	03/23/17 03:00pm	E. COLI-MF (1603)	EPA 1603	10 E	03/23/17 06:26PM	BHS
L6729213-1	CC-01-1	03/23/17 03:00pm	ENTEROCOCCUS-MF 24	EPA 1600	60 E	03/23/17 06:33PM	BHS
L6729213-1	CC-01-1	03/23/17 03:00pm	FECAL COLIFORM-MF	SM 9222D	<10	03/23/17 06:43PM	BHS
L6729214-1	CC-02-1	03/23/17 02:45pm	E. COLI-MF (1603)	EPA 1603	120 E	03/23/17 06:26PM	BHS
L6729214-1	CC-02-1	03/23/17 02:45pm	ENTEROCOCCUS-MF 24	EPA 1600	70 E	03/23/17 06:33PM	BHS
L6729214-1	CC-02-1	03/23/17 02:45pm	FECAL COLIFORM-MF	SM 9222D	610 E	03/23/17 06:43PM	BHS
L6729215-1	CC-03-1	03/23/17 01:00pm	E. COLI-MF (1603)	EPA 1603	50 E	03/23/17 06:26PM	BHS
L6729215-1	CC-03-1	03/23/17 01:00pm	ENTEROCOCCUS-MF 24	EPA 1600	20 E	03/23/17 06:33PM	BHS
L6729215-1	CC-03-1	03/23/17 01:00pm	FECAL COLIFORM-MF	SM 9222D	450	03/23/17 06:43PM	BHS
L6729216-1	RC-03-B	03/23/17 01:30pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729216-1	RC-03-B	03/23/17 01:30pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729216-1	RC-03-B	03/23/17 01:30pm	FECAL COLIFORM-MF	SM 9222D	<10	03/23/17 06:43PM	BHS

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6729217-1	RC-03-1	03/23/17 01:30pm	E. COLI-MF (1603)	EPA 1603	40 E	03/23/17 06:26PM	BHS
L6729217-1	RC-03-1	03/23/17 01:30pm	ENTEROCOCCUS-MF 24	EPA 1600	10 E	03/23/17 06:33PM	BHS
L6729217-1	RC-03-1	03/23/17 01:30pm	FECAL COLIFORM-MF	SM 9222D	20 E	03/23/17 06:43PM	BHS
L6729218-1	RC-02-1	03/23/17 02:00pm	E. COLI-MF (1603)	EPA 1603	<10	03/23/17 06:26PM	BHS
L6729218-1	RC-02-1	03/23/17 02:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/23/17 06:33PM	BHS
L6729218-1	RC-02-1	03/23/17 02:00pm	FECAL COLIFORM-MF	SM 9222D	40 E	03/23/17 06:43PM	BHS
L6729227-1	DR-05-2	03/23/17 06:30pm	ENTEROCOCCUS-MF 24	EPA 1600	10 E	03/23/17 10:04PM	BHS
L6729227-1	DR-05-2	03/23/17 06:30pm	E. COLI-MF (1603)	EPA 1603	18 E	03/23/17 09:57PM	BHS
L6729227-1	DR-05-2	03/23/17 06:30pm	FECAL COLIFORM-MF	SM 9222D	48	03/23/17 10:09PM	BHS
L6729227-2	DR-04-2	03/23/17 06:15pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/23/17 10:04PM	BHS
L6729227-2	DR-04-2	03/23/17 06:15pm	E. COLI-MF (1603)	EPA 1603	6 E	03/23/17 09:57PM	BHS
L6729227-2	DR-04-2	03/23/17 06:15pm	FECAL COLIFORM-MF	SM 9222D	18 E	03/23/17 10:09PM	BHS
L6729227-3	DR-03-2	03/23/17 06:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/23/17 10:04PM	BHS
L6729227-3	DR-03-2	03/23/17 06:00pm	E. COLI-MF (1603)	EPA 1603	16 E	03/23/17 09:57PM	BHS
L6729227-3	DR-03-2	03/23/17 06:00pm	FECAL COLIFORM-MF	SM 9222D	10 E	03/23/17 10:09PM	BHS
L6729227-4	DR-01-2	03/23/17 05:25pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/23/17 10:04PM	BHS
L6729227-4	DR-01-2	03/23/17 05:25pm	E. COLI-MF (1603)	EPA 1603	2 E	03/23/17 09:57PM	BHS
L6729227-4	DR-01-2	03/23/17 05:25pm	FECAL COLIFORM-MF	SM 9222D	2 E	03/23/17 10:09PM	BHS
L6729227-5	DR-02-2	03/23/17 05:45pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/23/17 10:04PM	BHS
L6729227-5	DR-02-2	03/23/17 05:45pm	E. COLI-MF (1603)	EPA 1603	4 E	03/23/17 09:57PM	BHS
L6729227-5	DR-02-2	03/23/17 05:45pm	FECAL COLIFORM-MF	SM 9222D	8 E	03/23/17 10:09PM	BHS
L6729227-6	CC-03-2	03/23/17 05:40pm	ENTEROCOCCUS-MF 24	EPA 1600	42	03/23/17 10:04PM	BHS
L6729227-6	CC-03-2	03/23/17 05:40pm	E. COLI-MF (1603)	EPA 1603	48	03/23/17 09:57PM	BHS
L6729227-6	CC-03-2	03/23/17 05:40pm	FECAL COLIFORM-MF	SM 9222D	60 E	03/23/17 10:09PM	BHS
L6729227-7	CC-01-2	03/23/17 07:10pm	ENTEROCOCCUS-MF 24	EPA 1600	8 E	03/23/17 10:04PM	BHS
L6729227-7	CC-01-2	03/23/17 07:10pm	E. COLI-MF (1603)	EPA 1603	14 E	03/23/17 09:57PM	BHS
L6729227-7	CC-01-2	03/23/17 07:10pm	FECAL COLIFORM-MF	SM 9222D	4 E	03/23/17 10:09PM	BHS
L6729227-8	RC-03-2	03/23/17 06:10pm	ENTEROCOCCUS-MF 24	EPA 1600	6 E	03/23/17 10:04PM	BHS
L6729227-8	RC-03-2	03/23/17 06:10pm	E. COLI-MF (1603)	EPA 1603	6 E	03/23/17 09:57PM	BHS
L6729227-8	RC-03-2	03/23/17 06:10pm	FECAL COLIFORM-MF	SM 9222D	18 E	03/23/17 10:09PM	BHS
L6729227-9	CC-02-2	03/23/17 07:30pm	ENTEROCOCCUS-MF 24	EPA 1600	56	03/23/17 10:04PM	BHS
L6729227-9	CC-02-2	03/23/17 07:30pm	E. COLI-MF (1603)	EPA 1603	126	03/23/17 09:57PM	BHS
L6729227-9	CC-02-2	03/23/17 07:30pm	FECAL COLIFORM-MF	SM 9222D	750 E	03/23/17 10:09PM	BHS
L6729227-10	RC-01-2	03/23/17 06:45pm	ENTEROCOCCUS-MF 24	EPA 1600	16 E	03/23/17 10:04PM	BHS
L6729227-10	RC-01-2	03/23/17 06:45pm	E. COLI-MF (1603)	EPA 1603	2 E	03/23/17 09:57PM	BHS
L6729227-10	RC-01-2	03/23/17 06:45pm	FECAL COLIFORM-MF	SM 9222D	14 E	03/23/17 10:09PM	BHS
L6729227-11	RC-02-2	03/23/17 06:20pm	ENTEROCOCCUS-MF 24	EPA 1600	8 E	03/23/17 10:04PM	BHS
L6729227-11	RC-02-2	03/23/17 06:20pm	E. COLI-MF (1603)	EPA 1603	10 E	03/23/17 09:57PM	BHS
L6729227-11	RC-02-2	03/23/17 06:20pm	FECAL COLIFORM-MF	SM 9222D	4 E	03/23/17 10:09PM	BHS
L6729227-12	DUP RC-02-2-X	03/23/17 06:00pm	ENTEROCOCCUS-MF 24	EPA 1600	14 E	03/23/17 10:04PM	BHS
L6729227-12	DUP RC-02-2-X	03/23/17 06:00pm	E. COLI-MF (1603)	EPA 1603	16 E	03/23/17 09:57PM	BHS
L6729227-12	DUP RC-02-2-X	03/23/17 06:00pm	FECAL COLIFORM-MF	SM 9222D	16 E	03/23/17 10:09PM	BHS

APPENDIX B

DRY WEATHER EVENT 2 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

DRY WEATHER EVENT: 2

DATE: 5/10/2017 — **Note Temperature of Receiving Stream if below 10 °C threshhold**

EVENT START TIME: 10:00

Sampling Station	Sampling Round	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? [1] (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? [1] (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations[2] (see notes, below)
CC-01	Incoming tide	11:00	11:46	N	N/A	N	N/A	Y	12:07	0.02	11.33	0.330	Clear sky, 61 °F, water very clear, no debris
	Outgoing tide	17:00	17:07	N	N/A	N	N/A	Y	18:00	0.33	12.54	0.511	Clear sky 71 °F, water clear, no debris
CC-02	Incoming tide	12:00	12:07	N	N/A	N	N/A	Y	12:07	0.23	13.86	0.378	Clear sky 61 °F, water mostly clear, minimal debris
	Outgoing tide	17:25	17:30	Y	17:31	N	N/A	Y	18:00	0.30	11.69	0.464	Clear sky 71 °F, water little cloudy, no debris
CC-03	Incoming tide	10:00	10:16	N	N/A	Y	10:09	Y	12:07	0.32	10.56	0.467	Clear sky, 59 °F, water mostly clear, no debris
	Outgoing tide	15:40	15:44	N	N/A	N	N/A	Y	18:00	0.21	14.44	0.339	Clear sky 71 °F, water mostly clear, minimal debris
RC-01	Incoming tide	11:20	11:26	N	N/A	N	N/A	Y	12:07	0.34	16.73	0.590	Clear sky 60 °F, water very clear, small amount of foam
	Outgoing tide	16:40	16:45	N	N/A	N	N/A	Y	18:00	0.35	16.47	0.590	Clear sky 70 °F, water clear, some foam
RC-02	Incoming tide	11:00	11:02	Y	11:02	N	N/A	Y	12:07	0.26	16.00	0.439	Clear sky 60 °F, water clear, small amount of floating debris
	Outgoing tide	16:20	16:21	N	N/A	N	N/A	Y	18:00	0.25	16.69	0.440	Clear sky 70 °F, water clear, some floating debris
RC-03	Incoming tide	10:30	10:43	N	N/A	N	N/A	Y	12:07	0.27	16.49	0.458	Clear sky 59 °F, water mostly clear, no debris
	Outgoing tide	16:00	16:04	N	N/A	N	N/A	Y	18:00	0.22	15.93	0.378	Clear sky 71 °F, water clear, no debris
DR-01	Incoming tide	10:25	10:25	N	N/A	N	N/A	Y	12:42	0.15 /0.15/ 0.15	16.70 / 16.67/ 16.68	269/ 286/ 267	Total depth = 28 ft ; calm water
	Outgoing tide	15:30	15:30	N	N/A	N	N/A	Y	18:00	0.23/ 0.22/ 0.22	14.55/ 14.38/ 14.37	374/ 368/ 362	Total depth = 28 ft ; calm water
DR-02	Incoming tide	10:50	10:50	N	N/A	N	N/A	Y	12:42	0.16/ 0.16/ 0.16	16.78/ 16.72/ 16.71	280/ 280/ 277	Total Depth = 25 ft; calm water
	Outgoing tide	15:40	15:40	N	N/A	N	N/A	Y	18:00	0.23/ 0.22/ 0.22	14.43/ 14.42/ 14.42	371/ 370/ 366	Total Depth = 28 ft; calm water
DR-03	Incoming tide	11:15	11:15	N	N/A	N	N/A	Y	12:42	0.16/ 01.6/ 0.16	16.91/ 16.88/ 16.88	285/ 285/ 285	Total Depth = 17 ft; calm water
	Outgoing tide	15:50	15:50	N	N/A	N	N/A	Y	18:00	0.22/ 0.22/ 0.22	14.39/ 14.38/ 14.39	369/ 368/ 364	Total Depth = 19 ft; calm water
DR-04	Incoming tide	12:00	12:00	Y	12:05	N	N/A	Y	12:42	0.16/ 0.16/ 0.16	17.03/ 16.94/ 16.95	289/ 286/ 286	Total Depth = 12 ft; calm water
	Outgoing tide	16:00	16:00	N	N/A	N	N/A	Y	18:00	0.23/ 0.23/ 0.23	14.53/ 14.53/ 14.53	380/ 380/ 378	Total Depth = 9 ft; calm water
DR-05	Incoming tide	12:20	12:20	N	N/A	Y	12:25	Y	12:42	0.16/ 0.16/ 0.16	17.34/ 17.24/ 17.25	287/ 286/ 286	Total Depth = 6 ft; calm water
	Outgoing tide	16:10	16:10	N	N/A	N	N/A	Y	18:00	0.23/ 0.22/ 0.22	14.51/ 14.48/ 14.48	372/ 370/ 368	Total Depth = 7 ft; calm water

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6778952-1	CC-03-1	05/10/17 10:16am	FECAL COLIFORM-MF	SM 9222D	70 E	05/10/17 03:04PM	DYS
L6778952-1	CC-03-1	05/10/17 10:16am	ENTEROCOCCUS-MF 24	EPA 1600	35	05/10/17 03:09PM	SYM
L6778952-1	CC-03-1	05/10/17 10:16am	E. COLI-MF (1603)	EPA 1603	96 E	05/10/17 03:19PM	BHS
L6778952-2	RC-03-1	05/10/17 10:43am	FECAL COLIFORM-MF	SM 9222D	90 E	05/10/17 03:04PM	DYS
L6778952-2	RC-03-1	05/10/17 10:43am	ENTEROCOCCUS-MF 24	EPA 1600	17	05/10/17 03:09PM	SYM
L6778952-2	RC-03-1	05/10/17 10:43am	E. COLI-MF (1603)	EPA 1603	210	05/10/17 03:19PM	BHS
L6778952-3	RC-02-1	05/10/17 11:02am	FECAL COLIFORM-MF	SM 9222D	140 E	05/10/17 03:04PM	DYS
L6778952-3	RC-02-1	05/10/17 11:02am	ENTEROCOCCUS-MF 24	EPA 1600	110 E	05/10/17 03:09PM	SYM
L6778952-3	RC-02-1	05/10/17 11:02am	E. COLI-MF (1603)	EPA 1603	120 E	05/10/17 03:19PM	BHS
L6778952-4	RC-01-1	05/10/17 11:26am	FECAL COLIFORM-MF	SM 9222D	53	05/10/17 03:04PM	DYS
L6778952-4	RC-01-1	05/10/17 11:26am	ENTEROCOCCUS-MF 24	EPA 1600	43	05/10/17 03:09PM	SYM
L6778952-4	RC-01-1	05/10/17 11:26am	E. COLI-MF (1603)	EPA 1603	52	05/10/17 03:19PM	BHS
L6778952-5	CC-01-1	05/10/17 11:47am	FECAL COLIFORM-MF	SM 9222D	52	05/10/17 03:04PM	DYS
L6778952-5	CC-01-1	05/10/17 11:47am	ENTEROCOCCUS-MF 24	EPA 1600	59	05/10/17 03:09PM	SYM
L6778952-5	CC-01-1	05/10/17 11:47am	E. COLI-MF (1603)	EPA 1603	42	05/10/17 03:19PM	BHS
L6778952-6	CC-02-1	05/10/17 12:08pm	FECAL COLIFORM-MF	SM 9222D	240	05/10/17 03:04PM	DYS
L6778952-6	CC-02-1	05/10/17 12:08pm	ENTEROCOCCUS-MF 24	EPA 1600	70 E	05/10/17 03:09PM	SYM
L6778952-6	CC-02-1	05/10/17 12:08pm	E. COLI-MF (1603)	EPA 1603	240	05/10/17 03:19PM	BHS
L6778952-7	DR-01-1	05/10/17 10:25am	FECAL COLIFORM-MF	SM 9222D	26	05/10/17 03:04PM	DYS
L6778952-7	DR-01-1	05/10/17 10:25am	ENTEROCOCCUS-MF 24	EPA 1600	4	05/10/17 03:09PM	SYM
L6778952-7	DR-01-1	05/10/17 10:25am	E. COLI-MF (1603)	EPA 1603	37	05/10/17 03:19PM	BHS
L6778952-8	DR-02-1	05/10/17 10:50am	FECAL COLIFORM-MF	SM 9222D	26	05/10/17 03:04PM	DYS
L6778952-8	DR-02-1	05/10/17 10:50am	ENTEROCOCCUS-MF 24	EPA 1600	13	05/10/17 03:09PM	SYM
L6778952-8	DR-02-1	05/10/17 10:50am	E. COLI-MF (1603)	EPA 1603	45	05/10/17 03:19PM	BHS
L6778952-9	DR-03-1	05/10/17 11:15am	FECAL COLIFORM-MF	SM 9222D	39	05/10/17 03:04PM	DYS
L6778952-9	DR-03-1	05/10/17 11:15am	ENTEROCOCCUS-MF 24	EPA 1600	4	05/10/17 03:09PM	SYM
L6778952-9	DR-03-1	05/10/17 11:15am	E. COLI-MF (1603)	EPA 1603	32	05/10/17 03:19PM	BHS
L6778952-10	DR-04-1	05/10/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	52	05/10/17 03:04PM	DYS
L6778952-10	DR-04-1	05/10/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	6	05/10/17 03:09PM	SYM
L6778952-10	DR-04-1	05/10/17 12:00pm	E. COLI-MF (1603)	EPA 1603	18	05/10/17 03:19PM	BHS
L6778952-11	DR-05-1	05/10/17 12:20pm	FECAL COLIFORM-MF	SM 9222D	48	05/10/17 03:04PM	DYS
L6778952-11	DR-05-1	05/10/17 12:20pm	ENTEROCOCCUS-MF 24	EPA 1600	2	05/10/17 03:09PM	SYM
L6778952-11	DR-05-1	05/10/17 12:20pm	E. COLI-MF (1603)	EPA 1603	25	05/10/17 03:19PM	BHS
L6778952-12	DUP-DR-04-1	05/10/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	56	05/10/17 03:04PM	DYS
L6778952-12	DUP-DR-04-1	05/10/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	10 E	05/10/17 03:09PM	SYM
L6778952-12	DUP-DR-04-1	05/10/17 12:00pm	E. COLI-MF (1603)	EPA 1603	42	05/10/17 03:19PM	BHS
L6778952-13	DUP-RC-02-1	05/10/17 11:02am	FECAL COLIFORM-MF	SM 9222D	230	05/10/17 03:04PM	DYS
L6778952-13	DUP-RC-02-1	05/10/17 11:02am	ENTEROCOCCUS-MF 24	EPA 1600	72	05/10/17 03:09PM	SYM
L6778952-13	DUP-RC-02-1	05/10/17 11:02am	E. COLI-MF (1603)	EPA 1603	112	05/10/17 03:19PM	BHS
L6778952-14	BLANK-01	05/10/17 00:00am	FECAL COLIFORM-MF	SM 9222D	<2 Q	05/10/17 03:04PM	DYS
L6778952-14	BLANK-01	05/10/17 00:00am	ENTEROCOCCUS-MF 24	EPA 1600	<2 Q	05/10/17 03:09PM	SYM
L6778952-14	BLANK-01	05/10/17 00:00am	E. COLI-MF (1603)	EPA 1603	<2 Q	05/10/17 03:19PM	BHS

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6778952-15	BLANK-02	05/10/17 12:25pm	FECAL COLIFORM-MF	SM 9222D	<2	05/10/17 03:04PM	DYS
L6778952-15	BLANK-02	05/10/17 12:25pm	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/10/17 03:09PM	SYM
L6778952-15	BLANK-02	05/10/17 12:25pm	E. COLI-MF (1603)	EPA 1603	<2	05/10/17 03:19PM	BHS
L6778952-16	CC-03-2	05/10/17 03:14pm	ENTEROCOCCUS-MF 24	EPA 1600	45	05/10/17 08:47PM	BHS
L6778952-16	CC-03-2	05/10/17 03:14pm	FECAL COLIFORM-MF	SM 9222D	190 E	05/10/17 08:37PM	BHS
L6778952-16	CC-03-2	05/10/17 03:14pm	E. COLI-MF (1603)	EPA 1603	220	05/10/17 08:30PM	BHS
L6778952-17	RC-03-2	05/10/17 04:04pm	ENTEROCOCCUS-MF 24	EPA 1600	40 E	05/10/17 08:47PM	BHS
L6778952-17	RC-03-2	05/10/17 04:04pm	FECAL COLIFORM-MF	SM 9222D	490	05/10/17 08:37PM	BHS
L6778952-17	RC-03-2	05/10/17 04:04pm	E. COLI-MF (1603)	EPA 1603	1900 E	05/10/17 08:30PM	BHS
L6778952-18	RC-02-2	05/10/17 04:20pm	ENTEROCOCCUS-MF 24	EPA 1600	460	05/10/17 08:47PM	BHS
L6778952-18	RC-02-2	05/10/17 04:20pm	FECAL COLIFORM-MF	SM 9222D	140 E	05/10/17 08:37PM	BHS
L6778952-18	RC-02-2	05/10/17 04:20pm	E. COLI-MF (1603)	EPA 1603	180 E	05/10/17 08:30PM	BHS
L6778952-19	RC-01-2	05/10/17 04:45pm	ENTEROCOCCUS-MF 24	EPA 1600	20 E	05/10/17 08:47PM	BHS
L6778952-19	RC-01-2	05/10/17 04:45pm	FECAL COLIFORM-MF	SM 9222D	45	05/10/17 08:37PM	BHS
L6778952-19	RC-01-2	05/10/17 04:45pm	E. COLI-MF (1603)	EPA 1603	42	05/10/17 08:30PM	BHS
L6778952-20	CC-01-2	05/10/17 05:07pm	ENTEROCOCCUS-MF 24	EPA 1600	54	05/10/17 08:47PM	BHS
L6778952-20	CC-01-2	05/10/17 05:07pm	FECAL COLIFORM-MF	SM 9222D	25	05/10/17 08:37PM	BHS
L6778952-20	CC-01-2	05/10/17 05:07pm	E. COLI-MF (1603)	EPA 1603	39	05/10/17 08:30PM	BHS
L6778952-21	CC-02-2	05/10/17 05:28pm	ENTEROCOCCUS-MF 24	EPA 1600	41	05/10/17 08:47PM	BHS
L6778952-21	CC-02-2	05/10/17 05:28pm	FECAL COLIFORM-MF	SM 9222D	60 E	05/10/17 08:37PM	BHS
L6778952-21	CC-02-2	05/10/17 05:28pm	E. COLI-MF (1603)	EPA 1603	170 E	05/10/17 08:30PM	BHS

APPENDIX C

DRY WEATHER EVENT 3 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

DRY WEATHER EVENT: 3

DATE: 6/13/2017 **Note Temperature of Receiving Stream if below 10 °C threshhold**

EVENT START TIME: 11:40

Sampling Station	Sampling Round	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations (see notes, below)
CC-01	Incoming tide	13:19	13:23	N	N/A	N	N/A	Y	14:17	0.38	23.17	748	Clear sky, very little foam, no debris
	Outgoing tide	19:05	19:07	N	N/A	N	N/A	Y	20:06	0.38	25.02	786	Clear sky, little foam, no debris
CC-02	Incoming tide	13:36	13:41	N	N/A	N	N/A	Y	14:17	0.39	21.98	749	Clear sky, some debris, no foam
	Outgoing tide	19:25	19:24	N	N/A	N	N/A	Y	20:06	0.39	23.79	776	Clear sky, little debris, no foam little turbidity
CC-03	Incoming tide	11:57	12:00	Y	12:00	Y	11:59	Y	14:17	0.38	22.30	733	Clear sky, little debris, no foam little turbidity
	Outgoing tide	17:48	17:48	N	N/A	N	N/A	Y	20:06	0.24	21.37	455	Clear sky, 95 F, some floating debris
RC-01	Incoming tide	12:59	13:02	N	N/A	N	N/A	Y	14:17	0.32	22.08	624	Clear sky, little foam, little debris
	Outgoing tide	18:40	18:43	Y	18:43	N	N/A	Y	20:06	0.32	23.38	637	Clear sky, little foam, 94 F
RC-02	Incoming tide	12:34	12:37	N	N/A	N	N/A	Y	14:17	0.33	20.91	617	Clear sky, little debris, very little foam
	Outgoing tide	18:25	18:20	N	N/A	N	N/A	Y	20:06	0.34	23.35	675	Clear sky, 94 F, little debris, no turbidity
RC-03	Incoming tide	12:14	12:20	N	N/A	N	N/A	Y	14:17	0.32	22.08	609	Clear sky, no foam, no debris, little turbidity
	Outgoing tide	18:05	18:04	N	N/A	N	N/A	Y	20:06	0.26	22.86	512	Clear sky, 94 F, debris, little turbidity
DR-01	Incoming tide	13:00	13:00	N	N/A	Y	13:05	Y	14:17	0.14/0.14/0.14	21.82/21.8/21.7	275/274/273	Total Depth = 24 ft
	Outgoing tide	18:15	18:15	N	N/A	N	N/A	Y	20:06	0.14/0.14/0.14	22.5/22.2/22.2	287/283/282	Total Depth = 27 ft
DR-02	Incoming tide	13:25	13:25	N	N/A	N	N/A	Y	14:17	0.14/0.14/0.14	21.9/21.8/21.8	274/273/272	Total Depth = 36 ft
	Outgoing tide	18:30	18:30	N	N/A	N	N/A	Y	20:06	0.14/0.14/0.14	22.4/22.3/22.3	286/286/286	Total Depth = 33 ft
DR-03	Incoming tide	13:40	13:40	N	N/A	N	N/A	Y	14:17	0.15/0.15/0.15	22.3/22.3/22.3	291/291/289	Total Depth = 18 ft
	Outgoing tide	18:40	18:40	N	N/A	N	N/A	Y	20:06	0.14/0.14/0.14	22.4/22.4/22.3	286/286/286	Total Depth = 16 ft
DR-04	Incoming tide	13:50	13:50	N	N/A	N	N/A	Y	14:17	0.15/0.15/0.15	22.4/22.3/22.4	291/291/291	Total Depth = 17 ft
	Outgoing tide	18:50	18:50	N	N/A	N	N/A	Y	20:06	0.15/0.15/0.15	22.5/22.5/22.5	294/294/293	Total Depth = 15 ft
DR-05	Incoming tide	14:05	14:05	N	N/A	N	N/A	Y	14:17	0.14/0.14/0.14	22.5/22.3/22.3	290/289/288	Total Depth = 8 ft
	Outgoing tide	19:00	19:00	N	N/A	N	N/A	Y	20:06	0.19/0.15/0.15	23.0/22.5/22.4	376/304/291	Total Depth = 12 ft

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6851627-1	BLANK 01	06/13/17 11:48am	ENTEROCOCCUS-MF 24	EPA 1600	<1	06/13/17 05:28PM	SYM
L6851627-1	BLANK 01	06/13/17 11:48am	E. COLI-MF (1603)	EPA 1603	<1	06/13/17 05:29PM	SYM
L6851627-1	BLANK 01	06/13/17 11:48am	FECAL COLIFORM-MF	SM 9222D	<1	06/13/17 05:24PM	BHS
L6851627-2	CC-03-01	06/13/17 11:48am	ENTEROCOCCUS-MF 24	EPA 1600	85	06/13/17 05:28PM	SYM
L6851627-2	CC-03-01	06/13/17 11:48am	E. COLI-MF (1603)	EPA 1603	160 E	06/13/17 05:29PM	SYM
L6851627-2	CC-03-01	06/13/17 11:48am	FECAL COLIFORM-MF	SM 9222D	1200 E	06/13/17 05:24PM	BHS
L6851627-3	RC-03-01	06/13/17 12:19pm	ENTEROCOCCUS-MF 24	EPA 1600	130 E	06/13/17 05:28PM	SYM
L6851627-3	RC-03-01	06/13/17 12:19pm	E. COLI-MF (1603)	EPA 1603	50 E	06/13/17 05:29PM	SYM
L6851627-3	RC-03-01	06/13/17 12:19pm	FECAL COLIFORM-MF	SM 9222D	2700	06/13/17 05:24PM	BHS
L6851627-4	DUP-CC	06/13/17 00:00am	ENTEROCOCCUS-MF 24	EPA 1600	150 Q	06/13/17 05:28PM	SYM
L6851627-4	DUP-CC	06/13/17 00:00am	E. COLI-MF (1603)	EPA 1603	200 Q	06/13/17 05:29PM	SYM
L6851627-4	DUP-CC	06/13/17 00:00am	FECAL COLIFORM-MF	SM 9222D	1100 E, Q	06/13/17 05:24PM	BHS
L6851627-5	RC-02-01	06/13/17 12:37pm	ENTEROCOCCUS-MF 24	EPA 1600	460	06/13/17 05:28PM	SYM
L6851627-5	RC-02-01	06/13/17 12:37pm	E. COLI-MF (1603)	EPA 1603	440	06/13/17 05:29PM	SYM
L6851627-5	RC-02-01	06/13/17 12:37pm	FECAL COLIFORM-MF	SM 9222D	3200	06/13/17 05:24PM	BHS
L6851627-6	RC-01-01	06/13/17 01:02pm	ENTEROCOCCUS-MF 24	EPA 1600	78	06/13/17 05:28PM	SYM
L6851627-6	RC-01-01	06/13/17 01:02pm	E. COLI-MF (1603)	EPA 1603	75	06/13/17 05:29PM	SYM
L6851627-6	RC-01-01	06/13/17 01:02pm	FECAL COLIFORM-MF	SM 9222D	180 E	06/13/17 05:24PM	BHS
L6851627-7	CC-01-01	06/13/17 01:23pm	ENTEROCOCCUS-MF 24	EPA 1600	49	06/13/17 05:28PM	SYM
L6851627-7	CC-01-01	06/13/17 01:23pm	E. COLI-MF (1603)	EPA 1603	110 E	06/13/17 05:29PM	SYM
L6851627-7	CC-01-01	06/13/17 01:23pm	FECAL COLIFORM-MF	SM 9222D	180 E	06/13/17 05:24PM	BHS
L6851627-8	CC-02-01	06/13/17 01:42pm	ENTEROCOCCUS-MF 24	EPA 1600	140 E	06/13/17 05:28PM	SYM
L6851627-8	CC-02-01	06/13/17 01:42pm	E. COLI-MF (1603)	EPA 1603	470	06/13/17 05:29PM	SYM
L6851627-8	CC-02-01	06/13/17 01:42pm	FECAL COLIFORM-MF	SM 9222D	800 E	06/13/17 05:24PM	BHS
L6851627-9	DR-01-1	06/13/17 01:00pm	ENTEROCOCCUS-MF 24	EPA 1600	11	06/13/17 05:28PM	SYM
L6851627-9	DR-01-1	06/13/17 01:00pm	E. COLI-MF (1603)	EPA 1603	23	06/13/17 05:29PM	SYM
L6851627-9	DR-01-1	06/13/17 01:00pm	FECAL COLIFORM-MF	SM 9222D	39	06/13/17 05:24PM	BHS
L6851627-10	BLANK-02	06/13/17 01:05pm	ENTEROCOCCUS-MF 24	EPA 1600	<1	06/13/17 05:28PM	SYM
L6851627-10	BLANK-02	06/13/17 01:05pm	E. COLI-MF (1603)	EPA 1603	<1	06/13/17 05:29PM	SYM
L6851627-10	BLANK-02	06/13/17 01:05pm	FECAL COLIFORM-MF	SM 9222D	<1	06/13/17 05:24PM	BHS
L6851627-11	DR-02-1	06/13/17 01:25pm	ENTEROCOCCUS-MF 24	EPA 1600	9	06/13/17 05:28PM	SYM
L6851627-11	DR-02-1	06/13/17 01:25pm	E. COLI-MF (1603)	EPA 1603	11	06/13/17 05:29PM	SYM
L6851627-11	DR-02-1	06/13/17 01:25pm	FECAL COLIFORM-MF	SM 9222D	21	06/13/17 05:24PM	BHS
L6851627-12	DR-03-1	06/13/17 01:40pm	ENTEROCOCCUS-MF 24	EPA 1600	14	06/13/17 05:28PM	SYM
L6851627-12	DR-03-1	06/13/17 01:40pm	E. COLI-MF (1603)	EPA 1603	25	06/13/17 05:29PM	SYM
L6851627-12	DR-03-1	06/13/17 01:40pm	FECAL COLIFORM-MF	SM 9222D	54	06/13/17 05:24PM	BHS
L6851627-13	DR-04-1	06/13/17 01:50pm	ENTEROCOCCUS-MF 24	EPA 1600	4	06/13/17 05:28PM	SYM
L6851627-13	DR-04-1	06/13/17 01:50pm	E. COLI-MF (1603)	EPA 1603	12	06/13/17 05:29PM	SYM
L6851627-13	DR-04-1	06/13/17 01:50pm	FECAL COLIFORM-MF	SM 9222D	21	06/13/17 05:24PM	BHS
L6851627-14	DR-05-1	06/13/17 02:05pm	ENTEROCOCCUS-MF 24	EPA 1600	6	06/13/17 05:28PM	SYM
L6851627-14	DR-05-1	06/13/17 02:05pm	E. COLI-MF (1603)	EPA 1603	10	06/13/17 05:29PM	SYM
L6851627-14	DR-05-1	06/13/17 02:05pm	FECAL COLIFORM-MF	SM 9222D	40	06/13/17 05:24PM	BHS

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6851627-15	DR-01-2	06/13/17 06:15pm	ENTEROCOCCUS-MF 24	EPA 1600	6	06/13/17 10:17PM	BHS
L6851627-15	DR-01-2	06/13/17 06:15pm	E. COLI-MF (1603)	EPA 1603	12	06/13/17 10:13PM	BHS
L6851627-15	DR-01-2	06/13/17 06:15pm	FECAL COLIFORM-MF	SM 9222D	35	06/13/17 10:34PM	BHS
L6851627-16	DR-02-2	06/13/17 06:30pm	ENTEROCOCCUS-MF 24	EPA 1600	2	06/13/17 10:17PM	BHS
L6851627-16	DR-02-2	06/13/17 06:30pm	E. COLI-MF (1603)	EPA 1603	7	06/13/17 10:13PM	BHS
L6851627-16	DR-02-2	06/13/17 06:30pm	FECAL COLIFORM-MF	SM 9222D	32	06/13/17 10:34PM	BHS
L6851627-17	DR-03-2	06/13/17 06:40pm	ENTEROCOCCUS-MF 24	EPA 1600	1	06/13/17 10:17PM	BHS
L6851627-17	DR-03-2	06/13/17 06:40pm	E. COLI-MF (1603)	EPA 1603	5	06/13/17 10:13PM	BHS
L6851627-17	DR-03-2	06/13/17 06:40pm	FECAL COLIFORM-MF	SM 9222D	20	06/13/17 10:34PM	BHS
L6851627-18	DR-04-2	06/13/17 06:50pm	ENTEROCOCCUS-MF 24	EPA 1600	2	06/13/17 10:17PM	BHS
L6851627-18	DR-04-2	06/13/17 06:50pm	E. COLI-MF (1603)	EPA 1603	2	06/13/17 10:13PM	BHS
L6851627-18	DR-04-2	06/13/17 06:50pm	FECAL COLIFORM-MF	SM 9222D	34	06/13/17 10:34PM	BHS
L6851627-19	DR-05-2	06/13/17 07:00pm	ENTEROCOCCUS-MF 24	EPA 1600	2	06/13/17 10:17PM	BHS
L6851627-19	DR-05-2	06/13/17 07:00pm	E. COLI-MF (1603)	EPA 1603	1	06/13/17 10:13PM	BHS
L6851627-19	DR-05-2	06/13/17 07:00pm	FECAL COLIFORM-MF	SM 9222D	27	06/13/17 10:34PM	BHS
L6851627-20	DUP-DR	06/13/17 00:00am	ENTEROCOCCUS-MF 24	EPA 1600	5 Q	06/13/17 10:17PM	BHS
L6851627-20	DUP-DR	06/13/17 00:00am	E. COLI-MF (1603)	EPA 1603	6 Q	06/13/17 10:13PM	BHS
L6851627-20	DUP-DR	06/13/17 00:00am	FECAL COLIFORM-MF	SM 9222D	21 Q	06/13/17 10:34PM	BHS
L6851627-21	CC-03-02	06/13/17 05:48pm	ENTEROCOCCUS-MF 24	EPA 1600	87	06/13/17 10:17PM	BHS
L6851627-21	CC-03-02	06/13/17 05:48pm	E. COLI-MF (1603)	EPA 1603	90 E	06/13/17 10:13PM	BHS
L6851627-21	CC-03-02	06/13/17 05:48pm	FECAL COLIFORM-MF	SM 9222D	330	06/13/17 10:34PM	BHS
L6851627-22	RC-03-02	06/13/17 06:04pm	ENTEROCOCCUS-MF 24	EPA 1600	180 E	06/13/17 10:17PM	BHS
L6851627-22	RC-03-02	06/13/17 06:04pm	E. COLI-MF (1603)	EPA 1603	110 E	06/13/17 10:13PM	BHS
L6851627-22	RC-03-02	06/13/17 06:04pm	FECAL COLIFORM-MF	SM 9222D	1600 E	06/13/17 10:34PM	BHS
L6851627-23	RC-02-02	06/13/17 06:23pm	ENTEROCOCCUS-MF 24	EPA 1600	900 E	06/13/17 10:17PM	BHS
L6851627-23	RC-02-02	06/13/17 06:23pm	E. COLI-MF (1603)	EPA 1603	920 E	06/13/17 10:13PM	BHS
L6851627-23	RC-02-02	06/13/17 06:23pm	FECAL COLIFORM-MF	SM 9222D	3800	06/13/17 10:34PM	BHS
L6851627-24	RC-01-02	06/13/17 06:43pm	ENTEROCOCCUS-MF 24	EPA 1600	190 E	06/13/17 10:17PM	BHS
L6851627-24	RC-01-02	06/13/17 06:43pm	E. COLI-MF (1603)	EPA 1603	76	06/13/17 10:13PM	BHS
L6851627-24	RC-01-02	06/13/17 06:43pm	FECAL COLIFORM-MF	SM 9222D	190 E	06/13/17 10:34PM	BHS
L6851627-25	CC-01-02	06/13/17 07:06pm	ENTEROCOCCUS-MF 24	EPA 1600	140 E	06/13/17 10:17PM	BHS
L6851627-25	CC-01-02	06/13/17 07:06pm	E. COLI-MF (1603)	EPA 1603	67	06/13/17 10:13PM	BHS
L6851627-25	CC-01-02	06/13/17 07:06pm	FECAL COLIFORM-MF	SM 9222D	210	06/13/17 10:34PM	BHS
L6851627-26	CC-02-02	06/13/17 07:24pm	ENTEROCOCCUS-MF 24	EPA 1600	190 E	06/13/17 10:17PM	BHS
L6851627-26	CC-02-02	06/13/17 07:24pm	E. COLI-MF (1603)	EPA 1603	260	06/13/17 10:13PM	BHS
L6851627-26	CC-02-02	06/13/17 07:24pm	FECAL COLIFORM-MF	SM 9222D	900 E	06/13/17 10:34PM	BHS
L6851627-27	DUP-RC	06/13/17 00:00am	ENTEROCOCCUS-MF 24	EPA 1600	190 E, Q	06/13/17 10:17PM	BHS
L6851627-27	DUP-RC	06/13/17 00:00am	E. COLI-MF (1603)	EPA 1603	119 Q	06/13/17 10:13PM	BHS
L6851627-27	DUP-RC	06/13/17 00:00am	FECAL COLIFORM-MF	SM 9222D	210 Q	06/13/17 10:34PM	BHS

APPENDIX D

WET WEATHER EVENT 1 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

WET WEATHER EVENT: 1

IN-STREAM TRIBUTARY STATION: CC-01

DATE: *3/31/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *23:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations (see notes, below)
1	0.5-2.5	1:00	1:03	N	N/A	N	N/A	Y	3:04	0.30	9.00	431.9	Raining
2	4.5-6.5	6:00	4:54	N	N/A	N	N/A	Y	6:55	0.20	8.90	515	Raining
3	8.5-10.5	10:00	8:37	N	N/A	N	N/A	Y	10:15	0.28	8.16	567	Raining
4	14.5-16.5	16:00	16:05	N	N/A	N	N/A	Y	16:40	0.17	8.04	349	Raining
5	22-24	23:00	23:25	N	N/A	N	N/A	Y	23:45	0.11	8.01	233	Raining
IN-STREAM TRIBUTARY STATION: CC-02													
1	0.5-2.5	0:40	0:43	N	N/A	N	N/A	Y	3:04	0.3	10.30	433.4	Raining
2	4.5-6.5	5:40	4:16	N	N/A	N	N/A	Y	6:55	0.3	9.80	548	Raining
3	8.5-10.5	9:40	8:18	N	N/A	N	N/A	Y	10:15	0.26	8.59	527	Raining
4	14.5-16.5	15:40	15:40	N	N/A	N	N/A	Y	16:40	0.19	8.13	403	Raining
5	22-24	22:40	23:15	N	N/A	N	N/A	Y	23:45	0.11	8.00	228	Raining
IN-STREAM TRIBUTARY STATION: CC-03													
1	0.5-2.5	0:00	0:00	Y	0:01	Y	0:05	Y	3:04	0.20	9.00	479.3	Raining
2	4.5-6.5	5:00	4:05	N	N/A	N	N/A	Y	6:55	0.20	7.40	384.6	Raining
3	8.5-10.5	9:00	8:18	N	N/A	N	N/A	Y	10:15	0.28	9.26	574.0	Raining
4	14.5-16.5	15:00	14:40	N	N/A	N	N/A	Y	16:40	0.25	8.20	520.0	Raining
5	22-24	22:00	22:15	N	N/A	N	N/A	Y	23:45	0.12	8.01	120.0	Raining
IN-STREAM TRIBUTARY STATION: RC-01													
1	0.5-2.5	1:30	1:30	N	N/A	N	N/A	Y	3:04	0.20	8.80	419.4	Raining
2	4.5-6.5	6:30	5:22	N	N/A	N	N/A	Y	6:55	0.20	8.40	404.2	Raining
3	8.5-10.5	10:30	9:15	N	N/A	N	N/A	Y	10:15	0.19	7.94	399.0	Raining
4	14.5-16.5	16:30	15:25	Y	15:26	N	N/A	Y	16:40	0.13	8.09	270.0	Raining
5	22-24	23:30	22:55	N	N/A	N	N/A	Y	23:45	0.10	7.65	216.0	Raining
IN-STREAM TRIBUTARY STATION: RC-02													
1	0.5-2.5	2:00	2:10	N	N/A	N	N/A	Y	3:04	0.20	9.60	474.8	Raining
2	4.5-6.5	7:00	6:43	N	N/A	N	N/A	Y	6:55	0.17	8.17	353.0	Raining
3	8.5-10.5	11:00	9:36	N	N/A	N	N/A	Y	10:15	0.20	7.97	421.0	Raining
4	14.5-16.5	17:00	15:10	N	N/A	N	N/A	Y	16:40	0.13	8.06	273.0	Raining
5	22-24	0:00	22:40	N	N/A	N	N/A	Y	23:45	0.11	7.75	224.0	Raining
IN-STREAM TRIBUTARY STATION: RC-03													
1	0.5-2.5	2:30	2:39	N	N/A	N	N/A	Y	3:04	0.10	7.40	373.6	Raining
2	4.5-6.5	7:30	7:00	N	N/A	N	N/A	Y	6:55	0.20	8.33	423.0	Raining
3	8.5-10.5	11:30	9:56	N	N/A	N	N/A	Y	10:15	0.19	8.01	391.0	Raining
4	14.5-16.5	17:30	14:55	N	N/A	N	N/A	Y	16:40	0.19	8.00	395.0	Raining
5	22-24	0:30	22:25	N	N/A	N	N/A	Y	23:45	0.00	7.40	228.0	Raining

WET WEATHER EVENT: 1
DELAWARE RIVER STATION: DR-01

DATE: *3/31/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *23:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (‰)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	1:00	1:10	N	N/A	N	N/A	Y	2:54	0.18/ 0.18/	3.33/ 3.32/	0.376/ 0.372/	Mid depth = 12 ft
2	2	3:00		N	N/A	N	N/A	N		/ /	/ /	/ /	Weather delay
3	4	5:00	7:45	N	N/A	N	N/A	Y	9:56	/ /	/ /	/ /	No logs
4	6	7:00	9:20	N	N/A	N	N/A	Y	10:40	0.18/ 0.17/ 0.17	3.39/ 3.38/ 3.37	0.366/ 0.361/ 0.359	Mid depth = 13 ft, Bottom depth = 26 ft
5	9	10:00	13:03	N	N/A	N	N/A	Y	14:35	0.17/ 0.17/ 0.17	3.44/ 3.50/ 3.50	0.363/ 0.363/ 0.364	Mid depth = 10 ft, Bottom depth = 25 ft
6	12	13:00	15:20	N	N/A	N	N/A	Y	17:07	0.17/ 0.17/ 0.17	3.37/ 3.38/ 3.38	0.362/ 0.362/ 0.362	Mid depth = 15 ft, Bottom depth = 27 ft
7	15	16:00	17:55	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	3.36/ 3.36/ 3.37	0.363/ 0.363/ 0.363	Mid depth = 15 ft, Bottom depth = 26 ft
8	18	19:00	19:50	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.44/ 3.45/ 3.46	0.354/ 0.355/ 0.355	Mid depth = 13 ft, Bottom depth = 25 ft
9	21	22:00	23:35	N	N/A	N	N/A	Y	0:52	0.16/ 0.16/ 0.16	3.58/ 3.59/ 3.59	0.333/ 0.334/ 0.335	Mid depth = 11 ft, Bottom depth = 10 ft
10	24	1:00		N	N/A	N	N/A	Y		/ /	/ /	/ /	
DELAWARE RIVER STATION: DR-02													
1	0	1:30	1:31	N	N/A	N	N/A	Y	2:54	0.18/ 0.18/	3.23/ 3.22/	0.371/ 0.370/	Mid depth = 12 ft
2	2	3:30	4:50	Y	4:50	N	N/A	Y	6:34	0.18/ 0.18/ 0.18	3.05/ 3.12/ 3.12	0.380/ 0.381/ 0.381	Mid depth = 16 ft, Bottom depth = 28.65 ft
3	4	5:30		N	N/A	N	N/A	Y		/ /	/ /	/ /	Weather delay
4	6	7:30	9:35	N	N/A	N	N/A	Y	10:40	0.17/ 0.17/ 0.17	3.31/ 3.32/ 3.34	0.361/ 0.362/ 0.363	Mid depth = 18 ft, Bottom depth = 35 ft
5	9	10:30	13:20	N	N/A	N	N/A	Y	14:35	0.17/ 0.17/ 0.17	3.33/ 3.33/ 3.34	0.351/ 0.357/ 0.351	Mid depth = 15 ft, Bottom depth = 34 ft
6	12	13:30	15:30	N	N/A	N	N/A	Y	17:07	0.17/ 0.17/ 0.17	3.31/ 3.31/ 3.31	0.362/ 0.363/ 0.363	Mid depth = 15 ft, Bottom depth = 30 ft
7	15	16:30	18:05	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	3.39/ 3.39/ 3.40	0.350/ 0.350/ 0.352	Mid depth = 20 ft, Bottom depth = 35 ft
8	18	19:30	19:55	N	N/A	N	N/A	Y	21:20	0.16/ 0.17/ 0.16	3.36/ 3.37/ 3.38	0.343/ 0.343/ 0.344	Mid depth = 17 ft., Bottom depth = 35 ft
9	21	22:30	23:45	N	N/A	N	N/A	Y	0:52	0.15/ 0.15/ 0.15	3.35/ 3.35/ 3.36	0.317/ 0.317/ 0.316	Mid depth = 15 ft, Bottom depth = 30 ft
10	24	1:30		N	N/A	N	N/A	Y		/ /	/ /	/ /	
DELAWARE RIVER STATION: DR-03													
1	0	1:40	1:40	N	N/A	N	N/A	Y	2:54	0.19/ 0.19/	3.41/ 3.44/	0.390/ 0.391/	Mid depth = 7.6 ft
2	2	3:40	4:30	N	N/A	Y	4:33	Y	6:34	0.19/ 0.18/ 0.18	3.05/ 3.06/ 3.04	0.388/ 0.386/ 0.386	Mide depth = 10 ft, Bottom depth = 18 ft
3	4	5:40		N	N/A	N	N/A	Y		/ /	/ /	/ /	Weather delay
4	6	7:40	9:45	N	N/A	N	N/A	Y	10:40	0.18/ 0.18/ 0.18	3.32/ 3.33/ 3.34	0.367/ 0.365/ 0.362	Mid depth = 13 ft, Bottom depth = 24 ft
5	9	10:40	13:35	N	N/A	N	N/A	Y	14:35	0.18/ 0.18/ 0.18	3.42/ 3.42/ 3.44	0.371/ 0.371/ 0.372	Mid depth = 7.5 ft, Bottom depth = 13 ft
6	12	13:40	15:40	N	N/A	N	N/A	Y	17:07	0.18/ 0.18/ 0.18	3.33/ 3.34/ 3.34	0.370/ 0.370/ 0.370	Mid depth = 8 ft, Botto depth = 16 ft
7	15	16:40	18:10	N	N/A	N	N/A	Y	18:00	0.18/ 0.18/ 0.18	3.36/ 3.37/ 3.37	0.377/ 0.377/ 0.378	Mid depth = 15, Bottom depth = 30 ft
8	18	19:40	20:00	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.37/ 3.38/ 3.38	0.353/ 0.353/ 0.353	Mid depth = 15 ft, Bottom depth = 29 ft
9	21	22:40	23:55	N	N/A	N	N/A	Y	0:52	0.16/ 0.16/ 0.16	3.59/ 3.60/ 3.60	0.341/ 0.341/ 0.341	Mid depth = 12 ft, Bottom depth = 22 ft
10	24	1:40		N	N/A	N	N/A	Y		/ /	/ /	/ /	
DELAWARE RIVER STATION: DR-04													
1	0	1:35	1:35	Y	1:35	N	N/A	Y	2:54	0.19/ 0.19/ 0.19	7.52/7.53/ 7.54	0.386/ 0.387/ 0.388	Mid depth = 16.12 ft, Bottom depth = 32.5 ft
2	2	3:35	4:00	N	N/A	N	N/A	Y	6:35	0.19/ 0.19/ 0.18	3.12/ 3.10/ 3.08	0.389/ 0.386/ 0.385	Mid depth = 11 ft, Bottom depth = 22 ft
3	4	5:35	7:30	N	N/A	N	N/A	Y	9:56	0.18	3.71	0.385	Only one reading recorded
4	6	7:35	9:55	N	N/A	N	N/A	Y	10:40	0.18/ 0.18/ 0.18	3.33/ 3.35/ 3.35	0.381/ 0.382/ 0.383	Mid depth = 13 ft, Bottom depth = 25 ft
5	9	10:35	13:15	N	N/A	N	N/A	Y	14:35	0.17/ 0.17/ 0.17	3.39/ 3.40/ 3.40	0.363/ 0.364/ 0.363	Mid depth = 10 ft, Bottom depth = 16 ft
6	12	13:35	15:55	N	N/A	N	N/A	Y	17:07	0.18/ 0.18/ 0.18	3.15/ 3.15/ 3.11	0.368/ 0.369/ 0.368	Mid depth = 11 ft, Bottom depth = 20 ft
7	15	16:35	18:15	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	3.01/ 3.02/ 3.02	0.365/ 0.365/ 0.365	Mid depth = 15 ft , Bottom depth = 29 ft
8	18	19:35	20:05	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.49/ 3.49/ 3.49	0.354/ 0.355/ 0.355	Mid dpeth = 15 ft, Bottom depth = 27 ft
9	21	22:35	0:10	N	N/A	N	N/A	Y	0:52	0.17/ 0.16/ 0.16	3.59/ 3.59/ 3.60	0.344/ 0.344/ 0.345	Mid dpeth = 12 ft, Bottom depth = 22 ft
10	24	1:35		N	N/A	N	N/A	Y		/ /	/ /	/ /	

WET WEATHER EVENT: 1
DELAWARE RIVER STATION: DR-05

DATE: *3/31/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *23:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (%)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	2:10	2:10	N	N/A	N	N/A	Y	2:54	0.18/ 0.18/ 0.18	3.11/ 3.14/ 3.14	0.383/ 0.383/ 0.383	Mid depth = 4 ft, Bottom depth = 7.5 ft
2	2	4:10	3:45	N	N/A	N	N/A	Y	6:35	0.18/ 0.18/ 0.18	3.06/ 3.06/ 3.06	0.384/ 0.384/ 0.384	Mid depth = 4 ft, Bottom depth = 8 ft
3	4	6:10	7:00	N	N/A	N	N/A	Y	9:56	0.29	5.88	0.596	Only one reading recorded
4	6	8:10	10:05	N	N/A	N	N/A	Y	10:40	0.18/ 0.18/ 0.18	3.36/ 3.36/ 3.37	0.382/ 0.383/ 0.383	Mid depth = 5 ft, Mid depth = 11 ft
5	9	11:10	13:50	N	N/A	N	N/A	Y	14:35	0.17/ 0.17/ 0.17	3.41/ 3.41/ 3.42	0.372/ 0.372/ 0.372	Mid depth = 4 ft, Bottom depth = 7 ft
6	12	14:10	16:05	N	N/A	N	N/A	Y	17:07	0.18/ 0.18/ 0.18	3.17/ 3.17/ 3.17	0.380/ 0.380/ 0.380	Mid depth = 7 ft, Bottom depth = 13 ft
7	15	17:10	18:25	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	3.19/ 3.18/ 3.19	0.378/ 0.378/ 0.378	Mid depth = 10 ft, Bottom depth = 15 ft
8	18	20:10	20:15	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.30/ 3.31/ 3.32	0.360/ 0.360/ 0.360	Mid depth = 9 ft, Bottom depth = 15 ft
9	21	23:10	0:20	N	N/A	N	N/A	Y	0:52	0.16/ .016/ 0.16	3.47/ 3.48/ 3.48	0.336/ 0.337/ 0.337	Mid dpeth = 9 ft, Bottom depth = 15 ft
10	24	2:10		N	N/A	N	N/A	Y		/ /	/ /	/ /	
DELAWARE RIVER STATION: DR-06													
1	0	2:00								/ /	/ /	/ /	Missed station / time delay
2	2	4:00	3:45	N	N/A	N	N/A	Y	6:35	0.18/ 0.18/ 0.18	2.92/ 2.91/ 2.91	0.375/ 0.375/ 0.375	Mid depth = 15 ft, Bottom Depth = 30 ft
3	4	6:00		N	N/A	N	N/A	Y		/ /	/ /	/ /	Weather delay
4	6	8:00	10:15	N	N/A	N	N/A	Y	10:40	0.17/ 0.17/ 0.17	2.90/ 2.91/ 2.91	0.354/ 0.355/ 0.356	Mid depth = 11 ft, Bottom depth = 21 ft
5	9	11:00	12:22	N	N/A	N	N/A	Y	14:35	0.16/ 0.16/ 0.15	3.0/ 2.9/ 2.9	0.349/ 0.350/ 0.351	Mid depth = 10 ft, Bottom depth = 24 ft
6	12	14:00	14:45	N	N/A	N	N/A	Y	17:07	0.17/ 0.17/ 0.17	3.00/ 3.01/ 3.01	0.357/ 0.357/ 0.358	Mid depth = 15 ft, Bottom depth = 25 ft
7	15	17:00	17:25	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	2.93/ 2.93/ 2.93	0.365/ 0.366/ 0.366	Mid depth = 15 ft, Bottom depth = 28 ft
8	18	20:00	19:25	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.04/ 3.05/ 3.08	0.354/ 0.355/ 0.355	Mid depth - 15 ft, Bottom depth = 25 ft
9	21	23:00	23:00	N	N/A	N	N/A	Y	0:52	0.16/ 0.16/ 0.16	3.21/ 3.21/ 3.21	0.335/ 0.335/ 0.335	Mid depth = 10 ft, Bottom depth = 19 ft
10	24	2:00		N	N/A	N	N/A	Y		/ /	/ /	/ /	
DELAWARE RIVER STATION: DR-07													
1	0	1:50								/ /	/ /	/ /	Missed station / time delay
2	2	3:50	3:20	N	N/A	N	N/A	Y	6:35	0.17/ 0.17/ 0.17	3.05/ 3.05/ 3.05	0.364/ 0.364/ 0.364	Mid depth = 3.5 ft, Bottom depth = 7.2 ft
3	4	5:50		N	N/A	N	N/A	Y		/ /	/ /	/ /	Weather delay
4	6	7:50	10:25	N	N/A	N	N/A	Y	10:40	0.18/ 0.18	3.15/ 3.16	0.370/ 0.370	Bottom depth = 2.5 ft, Mid too shallow
5	9	10:50	12:15	N	N/A	N	N/A	Y	14:35	0.17/ 0.17	2.94/ 2.94	0.353/ 0.354	Bottom depth = 4.05 ft, Mid too shallow
6	12	13:50	14:55	N	N/A	N	N/A	Y	17:07	0.17	3.04	0.352	Total depth = ft, too shallow fro multiple readings
7	15	16:50	17:30	N	N/A	N	N/A	Y	18:00	0.17/ 0.17/ 0.17	3.08/ 3.08/ 3.09	0.354/ 0.354/ 0.355	Mid depth = 7 ft, Bottom depth = 13 ft
8	18	19:50	19:30	N	N/A	N	N/A	Y	21:20	0.17/ 0.17/ 0.17	3.18/ 3.18/ 3.18	0.361/ 0.360/ 0.362	Mid depth = 6 ft, Bottom depth = 10 ft
9	21	22:50	23:15	N	N/A	N	N/A	Y	0:52	0.16/ 0.16/ 0.16	3.24/ 3.24/ 3.24	0.343/ 0.343/ 0.344	Mid depth = 3 ft, Bottom depth = 6 ft
10	24	1:50		N	N/A	N	N/A	Y		/ /	/ /	/ /	

WET WEATHER EVENT: 1
CSO STATION: CSO-02

DATE: *3/31/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *23:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Filed Observations (see notes, below)
1	T=0 (First Flush)	23:54	23:54	N	N/A	Y	23:48	Y	2:20	
2	30 Min	0:24	1:35	N	N/A	N	N/A	Y	3:42	NO OVERFLOW UNTIL 01:30
3	60 Min	0:54	2:08	N	N/A	N	N/A	Y	3:42	
4	2 Hours	1:54	3:09	N	N/A	N	N/A	Y	3:42	
5	4 Hours	3:54	5:15	N	N/A	N	N/A	Y	7:10	
6	8 Hours	7:54	9:25	Y	N/A	N	N/A	Y	10:12	
7	12 Hours	11:54	12:30	N	N/A	N	N/A	Y	13:37	
7-X	16 Hours		16:55	N	N/A	N	N/A	Y	18:00	
8	24 Hours	23:54	0:00	N	N/A	N	N/A	Y	1:10	
CSO STATION: CSO-05										
1	T=0 (First Flush)	0:17	0:17	N	N/A	Y	12:08	Y	2:20	
2	30 Min	0:47	1:45	N	N/A	N	N/A	Y	3:42	NO OVERFLOW UNTIL 01:45
3	60 Min	1:17	2:20	N	N/A	N	N/A	Y	3:42	
4	2 Hours	2:17	3:20	N	N/A	N	N/A	Y	3:42	
5	4 Hours	4:17	9:55	N	N/A	N	N/A	Y	10:12	NO OVERFLOW UNTIL 09:55
6	8 Hours	8:17	12:45	N	N/A	N	N/A	Y	13:37	
7	12 Hours	12:17	17:15	N	N/A	N	N/A	Y	18:00	
8	24 Hours	0:17	0:15	N	N/A	N	N/A	Y	1:10	
CSO STATION: CSO-18										
1	T=0 (First Flush)	0:07	0:07	N	N/A	Y	0:03	Y	3:29	
2	30 Min	0:37	1:45	N	N/A	N	N\A	Y	3:29	NO OVERFLOW UNTIL 01:45
3	60 Min	1:07	2:10	N	N/A	N	N\A	Y	3:29	
4	2 Hours	2:07	3:10	N	N/A	N	N\A	Y	3:29	
5	4 Hours	4:07	9:40	N	N/A	N	N\A	Y	9:52	NO OVERFLOW UNTIL 09:40
6	8 Hours	8:07	13:00	N	N/A	N	N\A	Y	13:37	
7	12 Hours	12:07	17:25	N	N/A	N	N\A	Y	18:00	
8	24 Hours	0:07	0:35	N	N/A	N	N\A	-	-	NO OVERFLOW
CSO STATION: CSO-19										
1	T=0 (First Flush)	0:25	0:25	N	N/A	Y		Y	3:29	
2	30 Min	0:55	1:35	N	N/A	N	N/A	Y	3:29	NO OVERFLOW UNTIL 01:35
3	60 Min	1:25	1:58	N	N/A	N	N/A	Y	3:29	
4	2 Hours	2:25	2:55	N	N/A	N	N/A	Y	3:29	
5	4 Hours	4:25	4:55	N	N/A	N	N/A	Y	6:35	
6	8 Hours	8:25	8:50	N	N/A	N	N/A	Y	9:52	
7	12 Hours	12:25	17:40	N	N/A	N	N/A	Y	18:00	NO OVERFLOW UNTIL 17:40
8	24 Hours	0:25	0:40	N	N/A	N	N/A	Y	1:10	

WET WEATHER EVENT: 1

STORM WATER STATION: SW-05A

DATE: *3/31/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *23:30*

Sampling	Sample Interval (Hours)	Target Sample (hh:mm)	Actual Sample (hh:mm)	Duplicate (Y/N)	Duplicate (hh:mm)	Field Blank (Y/N)	Field Blank (hh:mm)	Chain of (Y/N)	Time Sample (hh:mm)	Filed Observations (see notes, below)
1	T=0 (First Flush)	0:00	0:00					Y	2:19	43°F, Rain
2	30 Min	0:30	0:30					Y	2:19	
3	60 Min	1:00	1:00					Y	2:19	
4	2 Hours	2:00	2:00					Y	2:18	
5	4 Hours	4:00	4:00					Y	6:20	
6	8 Hours	8:00	8:00					Y	8:07	
7	12 Hours	12:00	12:00					Y	13:37	
8	24 Hours	0:00	0:15					Y	1:10	
STORM WATER STATION: SW-SS2										
1	T=0 (First Flush)	23:50	23:50					Y	2:19	43°F, Rain
2	30 Min	0:20	0:20					Y	2:19	
3	60 Min	0:50	0:50					Y	2:19	
4	2 Hours	1:50	1:50					Y	2:18	
5	4 Hours	3:50	3:50					Y	6:20	
6	8 Hours	7:50	7:50					Y	8:07	
7	12 Hours	11:50	11:50					Y	13:37	
8	24 Hours	23:50	0:20					Y	1:10	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6732900-1	SW-SS2-4	03/31/17 01:50am	ENTEROCOCCUS-MF 24	EPA 1600	19000 E	03/31/17 09:25AM	ARD
L6732900-1	SW-SS2-4	03/31/17 01:50am	FECAL COLIFORM-MF	SM 9222D	1280 E	03/31/17 09:09AM	ARD
L6732900-1	SW-SS2-4	03/31/17 01:50am	E. COLI-MF (1603)	EPA 1603	790 E, Q	03/31/17 10:34AM	ARD
L6732900-2	SW-05A-4	03/31/17 02:00am	ENTEROCOCCUS-MF 24	EPA 1600	5300	03/31/17 09:25AM	ARD
L6732900-2	SW-05A-4	03/31/17 02:00am	FECAL COLIFORM-MF	SM 9222D	180 E	03/31/17 09:09AM	ARD
L6732900-2	SW-05A-4	03/31/17 02:00am	E. COLI-MF (1603)	EPA 1603	144 E, Q	03/31/17 10:34AM	ARD
L6732900-3	SW-SS2-1	03/30/17 11:50pm	ENTEROCOCCUS-MF 24	EPA 1600	44000	03/31/17 07:36AM	ARD
L6732900-3	SW-SS2-1	03/30/17 11:50pm	FECAL COLIFORM-MF	SM 9222D	2100	03/31/17 07:43AM	ARD
L6732900-3	SW-SS2-1	03/30/17 11:50pm	E. COLI-MF (1603)	EPA 1603	900 E, Q	03/31/17 10:34AM	ARD
L6732900-4	SW-05A-1	03/31/17 12:00am	FECAL COLIFORM-MF	SM 9222D	140 E	03/31/17 07:43AM	ARD
L6732900-4	SW-05A-1	03/31/17 12:00am	E. COLI-MF (1603)	EPA 1603	120 E,Q	03/31/17 08:04AM	BHS
L6732900-4	SW-05A-1	03/31/17 12:00am	ENTEROCOCCUS-MF 24	EPA 1600	3100 Q	03/31/17 09:25AM	ARD
L6732900-5	SW-S52-2	03/31/17 12:20am	E. COLI-MF (1603)	EPA 1603	660 E	03/31/17 08:04AM	BHS
L6732900-5	SW-S52-2	03/31/17 12:20am	ENTEROCOCCUS-MF 24	EPA 1600	20000 Q	03/31/17 09:25AM	ARD
L6732900-5	SW-S52-2	03/31/17 12:20am	FECAL COLIFORM-MF	SM 9222D	503 E, Q	03/31/17 08:59AM	ARD
L6732900-6	SW-05A-2	03/31/17 12:30am	ENTEROCOCCUS-MF 24	EPA 1600	1455 E, Q	03/31/17 09:25AM	ARD
L6732900-6	SW-05A-2	03/31/17 12:30am	FECAL COLIFORM-MF	SM 9222D	130 E, Q	03/31/17 09:09AM	ARD
L6732900-6	SW-05A-2	03/31/17 12:30am	E. COLI-MF (1603)	EPA 1603	720 E, Q	03/31/17 10:34AM	ARD
L6732900-7	SW-SS2-3	03/31/17 12:50am	ENTEROCOCCUS-MF 24	EPA 1600	46000 Q	03/31/17 09:25AM	ARD
L6732900-7	SW-SS2-3	03/31/17 12:50am	FECAL COLIFORM-MF	SM 9222D	1140 E, Q	03/31/17 09:09AM	ARD
L6732900-7	SW-SS2-3	03/31/17 12:50am	E. COLI-MF (1603)	EPA 1603	50 E, Q	03/31/17 10:34AM	ARD
L6732900-8	SW-SSA-3	03/31/17 01:00am	FECAL COLIFORM-MF	SM 9222D	20	03/31/17 08:02AM	ARD
L6732900-8	SW-SSA-3	03/31/17 01:00am	ENTEROCOCCUS-MF 24	EPA 1600	1091 E,Q	03/31/17 09:25AM	ARD
L6732900-8	SW-SSA-3	03/31/17 01:00am	E. COLI-MF (1603)	EPA 1603	36 E, Q	03/31/17 10:34AM	ARD
L6732900-9	CS0-02-B	03/30/17 11:48pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/31/17 07:36AM	ARD
L6732900-9	CS0-02-B	03/30/17 11:48pm	FECAL COLIFORM-MF	SM 9222D	<10	03/31/17 07:43AM	ARD
L6732900-9	CS0-02-B	03/30/17 11:48pm	E. COLI-MF (1603)	EPA 1603	81 E, Q	03/31/17 10:34AM	ARD
L6732904-1	SW-SS2-5	03/31/17 03:50am	ENTEROCOCCUS-MF 24	EPA 1600	6600 E	03/31/17 11:26AM	GNM
L6732904-1	SW-SS2-5	03/31/17 03:50am	E. COLI-MF (1603)	EPA 1603	490	03/31/17 11:46AM	BHS
L6732904-1	SW-SS2-5	03/31/17 03:50am	FECAL COLIFORM-MF	SM 9222D	550	03/31/17 11:36AM	ARD
L6732904-2	SW-05A-5	03/31/17 04:00am	ENTEROCOCCUS-MF 24	EPA 1600	6100 E	03/31/17 11:26AM	GNM
L6732904-2	SW-05A-5	03/31/17 04:00am	E. COLI-MF (1603)	EPA 1603	100 E	03/31/17 11:46AM	BHS
L6732904-2	SW-05A-5	03/31/17 04:00am	FECAL COLIFORM-MF	SM 9222D	146 E	03/31/17 11:36AM	ARD
L6732904-3	DR-03-2	03/31/17 04:30am	ENTEROCOCCUS-MF 24	EPA 1600	20 E	03/31/17 11:26AM	GNM
L6732904-3	DR-03-2	03/31/17 04:30am	E. COLI-MF (1603)	EPA 1603	80 E	03/31/17 11:46AM	BHS
L6732904-3	DR-03-2	03/31/17 04:30am	FECAL COLIFORM-MF	SM 9222D	80 E	03/31/17 11:50AM	GNM
L6732904-4	DR-02-2-D	03/31/17 04:50am	ENTEROCOCCUS-MF 24	EPA 1600	20 E	03/31/17 11:26AM	GNM
L6732904-4	DR-02-2-D	03/31/17 04:50am	E. COLI-MF (1603)	EPA 1603	40 E	03/31/17 11:46AM	BHS
L6732904-4	DR-02-2-D	03/31/17 04:50am	FECAL COLIFORM-MF	SM 9222D	91 E	03/31/17 11:36AM	ARD
L6732904-5	DR-02-2	03/31/17 04:50am	ENTEROCOCCUS-MF 24	EPA 1600	10 E	03/31/17 11:26AM	GNM
L6732904-5	DR-02-2	03/31/17 04:50am	E. COLI-MF (1603)	EPA 1603	70 E	03/31/17 11:46AM	BHS
L6732904-5	DR-02-2	03/31/17 04:50am	FECAL COLIFORM-MF	SM 9222D	60 E	03/31/17 11:11AM	ARD
L6732904-6	BLANK-DR	03/31/17 04:33am	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/31/17 11:26AM	GNM
L6732904-6	BLANK-DR	03/31/17 04:33am	E. COLI-MF (1603)	EPA 1603	<2	03/31/17 11:46AM	BHS
L6732904-6	BLANK-DR	03/31/17 04:33am	FECAL COLIFORM-MF	SM 9222D	<2	03/31/17 11:36AM	ARD
L6732904-7	DR-04-2	03/31/17 04:00am	ENTEROCOCCUS-MF 24	EPA 1600	60 E	03/31/17 11:26AM	GNM
L6732904-7	DR-04-2	03/31/17 04:00am	E. COLI-MF (1603)	EPA 1603	30 E	03/31/17 11:46AM	BHS
L6732904-7	DR-04-2	03/31/17 04:00am	FECAL COLIFORM-MF	SM 9222D	100 E	03/31/17 11:11AM	ARD

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6732904-8	DR-05-2	03/31/17 03:45am	ENTEROCOCCUS-MF 24	EPA 1600	40 E	03/31/17 11:26AM	GNM
L6732904-8	DR-05-2	03/31/17 03:45am	FECAL COLIFORM-MF	SM 9222D	60 E	03/31/17 11:11AM	ARD
L6732904-8	DR-05-2	03/31/17 03:45am	E. COLI-MF (1603)	EPA 1603	73 E, Q	03/31/17 11:46AM	BHS
L6732904-9	DR-06-2	03/31/17 03:30am	ENTEROCOCCUS-MF 24	EPA 1600	<10	03/31/17 11:26AM	GNM
L6732904-9	DR-06-2	03/31/17 03:30am	FECAL COLIFORM-MF	SM 9222D	20 E	03/31/17 11:11AM	ARD
L6732904-9	DR-06-2	03/31/17 03:30am	E. COLI-MF (1603)	EPA 1603	E, Q	03/31/17 11:46AM	BHS
L6732905-1	DR-05-3	03/31/17 07:00am	E. COLI-MF (1603)	EPA 1603	<10 Q	03/31/17 04:29PM	BHS
L6732905-1	DR-05-3	03/31/17 07:00am	FECAL COLIFORM-MF	SM 9222D	30 E, Q	03/31/17 04:36PM	BHS
L6732905-1	DR-05-3	03/31/17 07:00am	ENTEROCOCCUS-MF 24	EPA 1600	<10 Q	03/31/17 04:37PM	BHS
L6732905-2	DR-04-3	03/31/17 07:30am	E. COLI-MF (1603)	EPA 1603	91 E, Q	03/31/17 04:29PM	BHS
L6732905-2	DR-04-3	03/31/17 07:30am	FECAL COLIFORM-MF	SM 9222D	100 E, Q	03/31/17 04:36PM	BHS
L6732905-2	DR-04-3	03/31/17 07:30am	ENTEROCOCCUS-MF 24	EPA 1600	40 E, Q	03/31/17 04:37PM	BHS
L6732905-3	SW-SS2-6	03/31/17 07:00am	E. COLI-MF (1603)	EPA 1603	838 E, Q	03/31/17 04:29PM	BHS
L6732905-3	SW-SS2-6	03/31/17 07:00am	FECAL COLIFORM-MF	SM 9222D	685 E, Q	03/31/17 04:36PM	BHS
L6732905-3	SW-SS2-6	03/31/17 07:00am	ENTEROCOCCUS-MF 24	EPA 1600	20000 Q	03/31/17 04:37PM	BHS
L6732905-4	SW-05A-6	03/31/17 08:00am	E. COLI-MF (1603)	EPA 1603	1640 E, Q	03/31/17 04:29PM	BHS
L6732905-4	SW-05A-6	03/31/17 08:00am	FECAL COLIFORM-MF	SM 9222D	1586 E, Q	03/31/17 04:36PM	BHS
L6732905-4	SW-05A-6	03/31/17 08:00am	ENTEROCOCCUS-MF 24	EPA 1600	42000 Q	03/31/17 04:37PM	BHS
L6732905-5	DR-01-3	03/31/17 07:45am	E. COLI-MF (1603)	EPA 1603	164 E, Q	03/31/17 08:39PM	BHS
L6732905-5	DR-01-3	03/31/17 07:45am	ENTEROCOCCUS-MF 24	EPA 1600	200 Q	03/31/17 08:51PM	BHS
L6732905-5	DR-01-3	03/31/17 07:45am	FECAL COLIFORM-MF	SM 9222D	73 E, Q	03/31/17 09:05PM	BHS
L6732905-6	CS0-19-6	03/31/17 08:50am	E. COLI-MF (1603)	EPA 1603	1380000 E	03/31/17 04:29PM	BHS
L6732905-6	CS0-19-6	03/31/17 08:50am	FECAL COLIFORM-MF	SM 9222D	490000	03/31/17 04:36PM	BHS
L6732905-6	CS0-19-6	03/31/17 08:50am	ENTEROCOCCUS-MF 24	EPA 1600	132000 E	03/31/17 04:37PM	BHS
L6732905-7	CS0-18-5	03/31/17 09:40am	E. COLI-MF (1603)	EPA 1603	267000 E	03/31/17 04:29PM	BHS
L6732905-7	CS0-18-5	03/31/17 09:40am	FECAL COLIFORM-MF	SM 9222D	780000 E	03/31/17 04:36PM	BHS
L6732905-7	CS0-18-5	03/31/17 09:40am	ENTEROCOCCUS-MF 24	EPA 1600	160000 E	03/31/17 04:37PM	BHS
L6732905-8	CS0-02-6	03/31/17 09:25am	E. COLI-MF (1603)	EPA 1603	265000 E	03/31/17 04:29PM	BHS
L6732905-8	CS0-02-6	03/31/17 09:25am	FECAL COLIFORM-MF	SM 9222D	560000	03/31/17 04:36PM	BHS
L6732905-8	CS0-02-6	03/31/17 09:25am	ENTEROCOCCUS-MF 24	EPA 1600	550000	03/31/17 04:37PM	BHS
L6732905-9	DUPCS0-02	03/31/17 09:25am	E. COLI-MF (1603)	EPA 1603	168000 E	03/31/17 04:29PM	BHS
L6732905-9	DUPCS0-02	03/31/17 09:25am	FECAL COLIFORM-MF	SM 9222D	170000 E	03/31/17 04:36PM	BHS
L6732905-9	DUPCS0-02	03/31/17 09:25am	ENTEROCOCCUS-MF 24	EPA 1600	450000	03/31/17 04:37PM	BHS
L6735514-1	CS0-02-8	04/01/17 12:00am	FECAL COLIFORM-MF	SM 9222D	39000 Q	04/01/17 08:18AM	ARD
L6735514-1	CS0-02-8	04/01/17 12:00am	E. COLI-MF (1603)	EPA 1603	25000	04/01/17 07:44AM	ARD
L6735514-1	CS0-02-8	04/01/17 12:00am	ENTEROCOCCUS-MF 24	EPA 1600	5600	04/01/17 07:00AM	ARD
L6735514-2	CS0-02-8	04/01/17 12:15am	FECAL COLIFORM-MF	SM 9222D	50000	04/01/17 07:23AM	ARD
L6735514-2	CS0-02-8	04/01/17 12:15am	E. COLI-MF (1603)	EPA 1603	33000	04/01/17 07:44AM	ARD
L6735514-2	CS0-02-8	04/01/17 12:15am	ENTEROCOCCUS-MF 24	EPA 1600	28000	04/01/17 07:00AM	ARD
L6735514-3	CS0-05-8	04/01/17 12:20am	FECAL COLIFORM-MF	SM 9222D	126 E	04/01/17 08:18AM	ARD
L6735514-3	CS0-05-8	04/01/17 12:20am	E. COLI-MF (1603)	EPA 1603	100 E	04/01/17 06:55AM	ARD
L6735514-3	CS0-05-8	04/01/17 12:20am	ENTEROCOCCUS-MF 24	EPA 1600	2300	04/01/17 07:00AM	ARD
L6735514-4	150-19-8	04/01/17 12:40am	FECAL COLIFORM-MF	SM 9222D	74546 E	04/01/17 08:18AM	ARD
L6735514-4	150-19-8	04/01/17 12:40am	E. COLI-MF (1603)	EPA 1603	80000 E	04/01/17 07:44AM	ARD
L6735514-4	150-19-8	04/01/17 12:40am	ENTEROCOCCUS-MF 24	EPA 1600	46000	04/01/17 07:00AM	ARD
L6735514-5	SW-05A-8	04/01/17 12:55am	FECAL COLIFORM-MF	SM 9222D	6937 E	04/01/17 08:18AM	ARD
L6735514-5	SW-05A-8	04/01/17 12:55am	E. COLI-MF (1603)	EPA 1603	6100	04/01/17 07:44AM	ARD
L6735514-5	SW-05A-8	04/01/17 12:55am	ENTEROCOCCUS-MF 24	EPA 1600	150000 E	04/01/17 07:00AM	ARD
L6735514-6	DR-06-09	03/31/17 11:00pm	E. COLI-MF (1603)	EPA 1603	90 E	04/01/17 06:55AM	ARD
L6735514-6	DR-06-09	03/31/17 11:00pm	FECAL COLIFORM-MF	SM 9222D	60 Q,E	04/01/17 07:23AM	ARD
L6735514-6	DR-06-09	03/31/17 11:00pm	ENTEROCOCCUS-MF 24	EPA 1600	20 E	04/01/17 07:00AM	ARD

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6735514-7	DR-07-09	03/31/17 11:15pm	E. COLI-MF (1603)	EPA 1603	20 E	04/01/17 06:55AM	ARD
L6735514-7	DR-07-09	03/31/17 11:15pm	FECAL COLIFORM-MF	SM 9222D	18 Q, E	04/01/17 07:23AM	ARD
L6735514-7	DR-07-09	03/31/17 11:15pm	ENTEROCOCCUS-MF 24	EPA 1600	20 E	04/01/17 07:00AM	ARD
L6735514-8	DR-01-09	03/31/17 11:35pm	E. COLI-MF (1603)	EPA 1603	1700 E	04/01/17 06:55AM	ARD
L6735514-8	DR-01-09	03/31/17 11:35pm	FECAL COLIFORM-MF	SM 9222D	700 E	04/01/17 07:23AM	ARD
L6735514-8	DR-01-09	03/31/17 11:35pm	ENTEROCOCCUS-MF 24	EPA 1600	3300	04/01/17 07:00AM	ARD
L6735514-9	DR-02-09	03/31/17 11:45pm	E. COLI-MF (1603)	EPA 1603	80 E	04/01/17 06:55AM	ARD
L6735514-9	DR-02-09	03/31/17 11:45pm	FECAL COLIFORM-MF	SM 9222D	60 E	04/01/17 07:23AM	ARD
L6735514-9	DR-02-09	03/31/17 11:45pm	ENTEROCOCCUS-MF 24	EPA 1600	90 E	04/01/17 07:00AM	ARD
L6732900-10	CS0-02-1	03/30/17 11:54pm	ENTEROCOCCUS-MF 24	EPA 1600	100000 E	03/31/17 07:36AM	ARD
L6732900-10	CS0-02-1	03/30/17 11:54pm	FECAL COLIFORM-MF	SM 9222D	234000 E	03/31/17 07:43AM	ARD
L6732900-10	CS0-02-1	03/30/17 11:54pm	E. COLI-MF (1603)	EPA 1603	35000 Q	03/31/17 10:34AM	ARD
L6732900-11	CS0-05-1	03/31/17 12:17am	E. COLI-MF (1603)	EPA 1603	115000 E	03/31/17 08:04AM	BHS
L6732900-11	CS0-05-1	03/31/17 12:17am	ENTEROCOCCUS-MF 24	EPA 1600	57000 Q	03/31/17 09:25AM	ARD
L6732900-11	CS0-05-1	03/31/17 12:17am	FECAL COLIFORM-MF	SM 9222D	128000 E, Q	03/31/17 09:09AM	ARD
L6732900-12	DR-01-1	03/31/17 01:10am	FECAL COLIFORM-MF	SM 9222D	153 E	03/31/17 08:02AM	ARD
L6732900-12	DR-01-1	03/31/17 01:10am	ENTEROCOCCUS-MF 24	EPA 1600	72 E, Q	03/31/17 09:25AM	ARD
L6732900-12	DR-01-1	03/31/17 01:10am	E. COLI-MF (1603)	EPA 1603	390 Q	03/31/17 10:34AM	ARD
L6732900-13	DR-02-1	03/31/17 01:31am	FECAL COLIFORM-MF	SM 9222D	137 E	03/31/17 08:02AM	ARD
L6732900-13	DR-02-1	03/31/17 01:31am	ENTEROCOCCUS-MF 24	EPA 1600	40 E	03/31/17 09:25AM	ARD
L6732900-13	DR-02-1	03/31/17 01:31am	E. COLI-MF (1603)	EPA 1603	182 E, Q	03/31/17 10:34AM	ARD
L6732900-14	DR-03-1	03/31/17 01:40am	ENTEROCOCCUS-MF 24	EPA 1600	90 E	03/31/17 07:36AM	ARD
L6732900-14	DR-03-1	03/31/17 01:40am	FECAL COLIFORM-MF	SM 9222D	130 E	03/31/17 08:02AM	ARD
L6732900-14	DR-03-1	03/31/17 01:40am	E. COLI-MF (1603)	EPA 1603	153 E, Q	03/31/17 10:34AM	ARD
L6732900-15	DR-04-1	03/31/17 01:35am	ENTEROCOCCUS-MF 24	EPA 1600	170 E	03/31/17 07:36AM	ARD
L6732900-15	DR-04-1	03/31/17 01:35am	FECAL COLIFORM-MF	SM 9222D	1300 E	03/31/17 08:02AM	ARD
L6732900-15	DR-04-1	03/31/17 01:35am	E. COLI-MF (1603)	EPA 1603	91 E, Q	03/31/17 10:34AM	ARD
L6732900-16	DR-05-1	03/31/17 02:10am	ENTEROCOCCUS-MF 24	EPA 1600	30 E	03/31/17 07:36AM	ARD
L6732900-16	DR-05-1	03/31/17 02:10am	E. COLI-MF (1603)	EPA 1603	60 E	03/31/17 08:04AM	BHS
L6732900-16	DR-05-1	03/31/17 02:10am	FECAL COLIFORM-MF	SM 9222D	112 E	03/31/17 08:02AM	ARD
L6732900-17	DUP DR-04-HR15	03/31/17 01:35am	ENTEROCOCCUS-MF 24	EPA 1600	100 E	03/31/17 07:36AM	ARD
L6732900-17	DUP DR-04-HR15	03/31/17 01:35am	E. COLI-MF (1603)	EPA 1603	450	03/31/17 08:04AM	BHS
L6732900-17	DUP DR-04-HR15	03/31/17 01:35am	FECAL COLIFORM-MF	SM 9222D	1300 E	03/31/17 08:02AM	ARD
L6732900-18	CC-03-01	03/31/17 12:00am	ENTEROCOCCUS-MF 24	EPA 1600	230	03/31/17 07:36AM	ARD
L6732900-18	CC-03-01	03/31/17 12:00am	FECAL COLIFORM-MF	SM 9222D	430	03/31/17 07:43AM	ARD
L6732900-18	CC-03-01	03/31/17 12:00am	E. COLI-MF (1603)	EPA 1603	330 Q	03/31/17 08:04AM	BHS
L6732900-19	CC-03-DUP	03/31/17 12:00am	ENTEROCOCCUS-MF 24	EPA 1600	130 E	03/31/17 07:36AM	ARD
L6732900-19	CC-03-DUP	03/31/17 12:00am	FECAL COLIFORM-MF	SM 9222D	300	03/31/17 07:43AM	ARD
L6732900-19	CC-03-DUP	03/31/17 12:00am	E. COLI-MF (1603)	EPA 1603	210 Q	03/31/17 08:04AM	BHS
L6732900-20	CC-02-01	03/31/17 12:40am	ENTEROCOCCUS-MF 24	EPA 1600	1700 E	03/31/17 07:36AM	ARD
L6732900-20	CC-02-01	03/31/17 12:40am	E. COLI-MF (1603)	EPA 1603	5700	03/31/17 08:04AM	BHS
L6732900-20	CC-02-01	03/31/17 12:40am	FECAL COLIFORM-MF	SM 9222D	12500 E	03/31/17 08:02AM	ARD
L6732900-21	BLANK CC	03/31/17 12:05am	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/31/17 07:36AM	ARD
L6732900-21	BLANK CC	03/31/17 12:05am	E. COLI-MF (1603)	EPA 1603	<2	03/31/17 08:04AM	BHS
L6732900-21	BLANK CC	03/31/17 12:05am	FECAL COLIFORM-MF	SM 9222D	<2 Q	03/31/17 09:09AM	ARD
L6732900-22	CC-01-01	03/31/17 01:00am	E. COLI-MF (1603)	EPA 1603	40 E	03/31/17 08:04AM	BHS
L6732900-22	CC-01-01	03/31/17 01:00am	FECAL COLIFORM-MF	SM 9222D	59	03/31/17 08:59AM	ARD
L6732900-22	CC-01-01	03/31/17 01:00am	ENTEROCOCCUS-MF 24	EPA 1600	260 Q	03/31/17 09:25AM	ARD
L6732900-23	RC-01-01	03/31/17 01:35am	E. COLI-MF (1603)	EPA 1603	380	03/31/17 08:04AM	BHS
L6732900-23	RC-01-01	03/31/17 01:35am	FECAL COLIFORM-MF	SM 9222D	2200	03/31/17 08:02AM	ARD
L6732900-23	RC-01-01	03/31/17 01:35am	ENTEROCOCCUS-MF 24	EPA 1600	1700 E	03/31/17 09:25AM	ARD

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6732900-24	RC-02-01	03/31/17 02:06am	FECAL COLIFORM-MF	SM 9222D	15700 E	03/31/17 08:02AM	ARD
L6732900-24	RC-02-01	03/31/17 02:06am	ENTEROCOCCUS-MF 24	EPA 1600	2800	03/31/17 09:25AM	ARD
L6732900-24	RC-02-01	03/31/17 02:06am	E. COLI-MF (1603)	EPA 1603	6000 Q	03/31/17 10:34AM	ARD
L6732900-25	RC-03-01	03/31/17 02:37am	ENTEROCOCCUS-MF 24	EPA 1600	20 E	03/31/17 09:25AM	ARD
L6732900-25	RC-03-01	03/31/17 02:37am	FECAL COLIFORM-MF	SM 9222D	250	03/31/17 09:09AM	ARD
L6732900-25	RC-03-01	03/31/17 02:37am	E. COLI-MF (1603)	EPA 1603	100 E	03/31/17 10:34AM	ARD
L6732900-26	CS0-18-1	03/31/17 12:07am	ENTEROCOCCUS-MF 24	EPA 1600	19000 E	03/31/17 07:36AM	ARD
L6732900-26	CS0-18-1	03/31/17 12:07am	E. COLI-MF (1603)	EPA 1603	63000 E	03/31/17 08:04AM	BHS
L6732900-26	CS0-18-1	03/31/17 12:07am	FECAL COLIFORM-MF	SM 9222D	85000 E, Q	03/31/17 09:34AM	ARD
L6732900-27	CS0-19-1	03/31/17 12:25am	ENTEROCOCCUS-MF 24	EPA 1600	3220000 E	03/31/17 07:36AM	ARD
L6732900-27	CS0-19-1	03/31/17 12:25am	E. COLI-MF (1603)	EPA 1603	160000 E	03/31/17 08:04AM	BHS
L6732900-27	CS0-19-1	03/31/17 12:25am	FECAL COLIFORM-MF	SM 9222D	30100 E, Q	03/31/17 09:09AM	ARD
L6732900-28	CS0-19-2	03/31/17 01:55am	ENTEROCOCCUS-MF 24	EPA 1600	200000	03/31/17 09:25AM	ARD
L6732900-28	CS0-19-2	03/31/17 01:55am	FECAL COLIFORM-MF	SM 9222D	197000 E	03/31/17 09:09AM	ARD
L6732900-28	CS0-19-2	03/31/17 01:55am	E. COLI-MF (1603)	EPA 1603	80000 Q	03/31/17 10:34AM	ARD
L6732900-29	CS0-18-2	03/31/17 01:45am	ENTEROCOCCUS-MF 24	EPA 1600	29000	03/31/17 09:25AM	ARD
L6732900-29	CS0-18-2	03/31/17 01:45am	FECAL COLIFORM-MF	SM 9222D	69000 E	03/31/17 09:34AM	ARD
L6732900-29	CS0-18-2	03/31/17 01:45am	E. COLI-MF (1603)	EPA 1603	51000 Q	03/31/17 10:34AM	ARD
L6732900-30	CS0-19-3	03/31/17 01:58am	ENTEROCOCCUS-MF 24	EPA 1600	53000	03/31/17 09:25AM	ARD
L6732900-30	CS0-19-3	03/31/17 01:58am	FECAL COLIFORM-MF	SM 9222D	215000 E	03/31/17 09:09AM	ARD
L6732900-30	CS0-19-3	03/31/17 01:58am	E. COLI-MF (1603)	EPA 1603	52000 Q	03/31/17 10:34AM	ARD
L6732900-31	CS0-18-3	03/31/17 02:10am	ENTEROCOCCUS-MF 24	EPA 1600	17000 E	03/31/17 09:25AM	ARD
L6732900-31	CS0-18-3	03/31/17 02:10am	FECAL COLIFORM-MF	SM 9222D	78000 E	03/31/17 09:34AM	ARD
L6732900-31	CS0-18-3	03/31/17 02:10am	E. COLI-MF (1603)	EPA 1603	67000 Q	03/31/17 10:34AM	ARD
L6732900-32	CS0-19-4	03/31/17 02:55am	ENTEROCOCCUS-MF 24	EPA 1600	>600000	03/31/17 09:25AM	ARD
L6732900-32	CS0-19-4	03/31/17 02:55am	E. COLI-MF (1603)	EPA 1603	120000 E	03/31/17 10:34AM	ARD
L6732900-32	CS0-19-4	03/31/17 02:55am	FECAL COLIFORM-MF	SM 9222D	330000	03/31/17 09:34AM	ARD
L6732900-33	CS0-18-4	03/31/17 03:10am	ENTEROCOCCUS-MF 24	EPA 1600	20000	03/31/17 09:25AM	ARD
L6732900-33	CS0-18-4	03/31/17 03:10am	E. COLI-MF (1603)	EPA 1603	69000	03/31/17 10:34AM	ARD
L6732900-33	CS0-18-4	03/31/17 03:10am	FECAL COLIFORM-MF	SM 9222D	85000 E	03/31/17 09:34AM	ARD
L6732900-34	BLANK CS0-18	03/31/17 12:03am	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/31/17 07:36AM	ARD
L6732900-34	BLANK CS0-18	03/31/17 12:03am	E. COLI-MF (1603)	EPA 1603	<2 Q	03/31/17 08:04AM	BHS
L6732900-34	BLANK CS0-18	03/31/17 12:03am	FECAL COLIFORM-MF	SM 9222D	<2 Q	03/31/17 09:09AM	ARD
L6732900-35	CS0-02-2	03/31/17 01:35am	ENTEROCOCCUS-MF 24	EPA 1600	43000	03/31/17 09:25AM	ARD
L6732900-35	CS0-02-2	03/31/17 01:35am	FECAL COLIFORM-MF	SM 9222D	140000 E	03/31/17 09:09AM	ARD
L6732900-35	CS0-02-2	03/31/17 01:35am	E. COLI-MF (1603)	EPA 1603	89000 E, Q	03/31/17 10:34AM	ARD
L6732900-36	CS0-05-02	03/31/17 01:45am	ENTEROCOCCUS-MF 24	EPA 1600	135000 E	03/31/17 09:25AM	ARD
L6732900-36	CS0-05-02	03/31/17 01:45am	FECAL COLIFORM-MF	SM 9222D	199000 E	03/31/17 09:09AM	ARD
L6732900-36	CS0-05-02	03/31/17 01:45am	E. COLI-MF (1603)	EPA 1603	240000 Q	03/31/17 10:34AM	ARD
L6732900-37	CS0-02-3	03/31/17 02:08am	ENTEROCOCCUS-MF 24	EPA 1600	37000	03/31/17 09:25AM	ARD
L6732900-37	CS0-02-3	03/31/17 02:08am	FECAL COLIFORM-MF	SM 9222D	123000 E	03/31/17 09:09AM	ARD
L6732900-37	CS0-02-3	03/31/17 02:08am	E. COLI-MF (1603)	EPA 1603	30000 E, Q	03/31/17 10:34AM	ARD
L6732900-38	CS0-05-3	03/31/17 02:20am	ENTEROCOCCUS-MF 24	EPA 1600	19000 E	03/31/17 09:25AM	ARD
L6732900-38	CS0-05-3	03/31/17 02:20am	FECAL COLIFORM-MF	SM 9222D	140000 E	03/31/17 08:59AM	ARD
L6732900-38	CS0-05-3	03/31/17 02:20am	E. COLI-MF (1603)	EPA 1603	90000 E, Q	03/31/17 10:34AM	ARD
L6732900-39	CS0-02-4	03/31/17 03:09am	ENTEROCOCCUS-MF 24	EPA 1600	410000	03/31/17 09:25AM	ARD
L6732900-39	CS0-02-4	03/31/17 03:09am	FECAL COLIFORM-MF	SM 9222D	1630000 E	03/31/17 08:59AM	ARD
L6732900-39	CS0-02-4	03/31/17 03:09am	E. COLI-MF (1603)	EPA 1603	1130000 E	03/31/17 10:34AM	ARD
L6732900-40	CS0-05-4	03/31/17 03:20am	ENTEROCOCCUS-MF 24	EPA 1600	27000	03/31/17 09:25AM	ARD
L6732900-40	CS0-05-4	03/31/17 03:20am	FECAL COLIFORM-MF	SM 9222D	43000	03/31/17 08:59AM	ARD
L6732900-40	CS0-05-4	03/31/17 03:20am	E. COLI-MF (1603)	EPA 1603	29000	03/31/17 10:34AM	ARD

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6732900-41	CS0-05-B	03/31/17 12:08am	ENTEROCOCCUS-MF 24	EPA 1600	<2	03/31/17 07:36AM	ARD
L6732900-41	CS0-05-B	03/31/17 12:08am	E. COLI-MF (1603)	EPA 1603	<2	03/31/17 08:04AM	BHS
L6732900-41	CS0-05-B	03/31/17 12:08am	FECAL COLIFORM-MF	SM 9222D	<2 Q	03/31/17 09:09AM	ARD
L6732904-10	DR-07-2	03/31/17 03:20am	FECAL COLIFORM-MF	SM 9222D	80 E	03/31/17 11:11AM	ARD
L6732904-10	DR-07-2	03/31/17 03:20am	ENTEROCOCCUS-MF 24	EPA 1600	30 E, Q	03/31/17 11:26AM	GNM
L6732904-10	DR-07-2	03/31/17 03:20am	E. COLI-MF (1603)	EPA 1603	60 E, Q	03/31/17 11:46AM	BHS
L6732904-11	CS0-19-5	03/31/17 04:55am	ENTEROCOCCUS-MF 24	EPA 1600	15000 E	03/31/17 11:26AM	GNM
L6732904-11	CS0-19-5	03/31/17 04:55am	E. COLI-MF (1603)	EPA 1603	151000 E	03/31/17 11:46AM	BHS
L6732904-11	CS0-19-5	03/31/17 04:55am	FECAL COLIFORM-MF	SM 9222D	38000	03/31/17 11:36AM	ARD
L6732904-12	CC-03-2	03/31/17 04:00am	ENTEROCOCCUS-MF 24	EPA 1600	40 E	03/31/17 11:26AM	GNM
L6732904-12	CC-03-2	03/31/17 04:00am	E. COLI-MF (1603)	EPA 1603	140 E	03/31/17 11:46AM	BHS
L6732904-12	CC-03-2	03/31/17 04:00am	FECAL COLIFORM-MF	SM 9222D	300 E	03/31/17 11:50AM	GNM
L6732904-13	CC-02-2	03/31/17 04:15am	ENTEROCOCCUS-MF 24	EPA 1600	660 E	03/31/17 11:26AM	GNM
L6732904-13	CC-02-2	03/31/17 04:15am	E. COLI-MF (1603)	EPA 1603	3100	03/31/17 11:46AM	BHS
L6732904-13	CC-02-2	03/31/17 04:15am	FECAL COLIFORM-MF	SM 9222D	3500	03/31/17 11:36AM	ARD
L6732904-14	CC-01-2	03/31/17 04:52am	ENTEROCOCCUS-MF 24	EPA 1600	1500 E	03/31/17 11:26AM	GNM
L6732904-14	CC-01-2	03/31/17 04:52am	E. COLI-MF (1603)	EPA 1603	330	03/31/17 11:46AM	BHS
L6732904-14	CC-01-2	03/31/17 04:52am	FECAL COLIFORM-MF	SM 9222D	270	03/31/17 11:36AM	ARD
L6732904-15	RC-01-2	03/31/17 05:19am	ENTEROCOCCUS-MF 24	EPA 1600	3500	03/31/17 11:26AM	GNM
L6732904-15	RC-01-2	03/31/17 05:19am	E. COLI-MF (1603)	EPA 1603	310	03/31/17 11:46AM	BHS
L6732904-15	RC-01-2	03/31/17 05:19am	FECAL COLIFORM-MF	SM 9222D	310	03/31/17 11:50AM	GNM

APPENDIX E

WET WEATHER EVENT 2 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

WET WEATHER EVENT: 2

IN-STREAM TRIBUTARY STATION: CC-01

DATE: *5/5/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *7:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations (see notes, below)
1	0.5-2.5	8:42	8:45	N	N/A	Y	8:35	Y	9:15	0.30	15.50	512	Raining
2	4.5-6.5	12:49	12:55	N	N/A	N	N/A	Y	13:15	0.10	25.80	222.5	Raining
3	8.5-10.5	16:58	17:05	N	N/A	N	N/A	Y	17:30	0.10	24.90	203.5	Raining
4	14.5-16.5	22:35	22:40	N	N/A	N	N/A	Y	23:15	0.18	12.98	291	Raining
5	22-24	5:30	5:35	N	N/A	N	N/A	Y	5:55	0.24	13.24	377	Raining
IN-STREAM TRIBUTARY STATION: CC-02													
1	0.5-2.5	7:44	7:45	Y	7:45	N	N/A	Y	8:15	0.2	16.60	415.3	Raining
2	4.5-6.5	12:33	12:35	N	N/A	N	N/A	Y	13:15	0.2	23.80	353.7	Raining
3	8.5-10.5	16:43	16:48	N	N/A	N	N/A	Y	17:30	0.1	25.80	228.6	Raining
4	14.5-16.5	22:20	22:25	N	N/A	N	N/A	Y	23:15	0.24	12.66	375	Raining
5	22-24	5:15	5:20	N	N/A	N	N/A	Y	5:55	0.24	13.25	381	Raining
IN-STREAM TRIBUTARY STATION: CC-03													
1	0.5-2.5	7:10	7:20	N	N/A	N	N/A	Y	7:55	0.20	16.70	321.4	Raining
2	4.5-6.5	11:37	11:40	N	N/A	N	N/A	Y	13:15	0.20	20.30	351.5	Raining
3	8.5-10.5	15:40	15:45	N	N/A	N	N/A	Y	17:30	0.10	25.40	255.2	Raining
4	14.5-16.5	21:15	21:20	N	N/A	N	N/A	Y	23:15	0.33	27.10	597.0	Raining
5	22-24	4:20	4:25	N	N/A	N	N/A	Y	5:55	0.20	13.15	316.0	Raining
IN-STREAM TRIBUTARY STATION: RC-01													
1	0.5-2.5	1:30	1:30	N	N/A	N	N/A	Y	3:04	0.20	8.80	419.4	Raining
2	4.5-6.5	6:30	5:22	N	N/A	N	N/A	Y	6:55	0.20	8.40	404.2	Raining
3	8.5-10.5	10:30	9:15	N	N/A	N	N/A	Y	10:15	0.19	7.94	399.0	Raining
4	14.5-16.5	16:30	15:25	Y	15:26	N	N/A	Y	16:40	0.13	8.09	270.0	Raining
5	22-24	23:30	22:55	N	N/A	N	N/A	Y	23:45	0.10	7.65	216.0	Raining
IN-STREAM TRIBUTARY STATION: RC-02													
1	0.5-2.5	8:26	8:30	N	N/A	N	N/A	Y	9:15	0.20	14.70	495.5	Raining
2	4.5-6.5	12:12	12:15	N	N/A	N	N/A	Y	13:15	0.10	23.60	188.8	Raining
3	8.5-10.5	16:25	16:30	N	N/A	N	N/A	Y	17:30	0.10	25.30	185.2	Raining
4	14.5-16.5	22:05	22:10	N	N/A	N	N/A	Y	23:15	0.27	34.90	433.0	Raining
5	22-24	5:05	5:10	N	N/A	N	N/A	Y	5:55	0.19	12.73	308.0	Raining
IN-STREAM TRIBUTARY STATION: RC-03													
1	0.5-2.5	7:30	7:35	N	N/A	N	N/A	Y	7:55	0.10	16.70	308.7	Used Bailer to collect sample
2	4.5-6.5	11:44	11:47	N	N/A	N	N/A	Y	13:15	0.20	20.30	351.5	Used Bailer to collect sample
3	8.5-10.5	15:53	16:00	N	N/A	N	N/A	Y	17:30	0.10	23.50	188.0	Used Bailer to collect sample
4	14.5-16.5	21:35	21:40	N	N/A	N	N/A	Y	23:15	0.48	31.30	846.0	Used Bailer to collect sample
5	22-24	4:30	4:35	N	N/A	N	N/A	Y	5:55	0.21	12.79	327.0	Used Bailer to collect sample

WET WEATHER EVENT: 2
DELAWARE RIVER STATION: DR-01

DATE: *5/5/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *7:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (%)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	7:36	7:36	N	N/A	Y	7:34	Y		0.19/ 0.19/ 0.19	14.36/ 14.35/ 14.36	322/ 321/ 320	
2	2	9:36	9:50	N	N/A	N	N/A	Y		0.15/ 0.15/ 0.15	16.89/ 16.81/ 16.80	271/ 271/ 271	Total Depth = 20.1 ft
3	4	11:36	12:00	N	N/A	N	N/A	Y		0.15/ 0.15/ 0.15	16.82/ 16.82/ 16.83	270/ 270/ 271	Total Depth = 20.4 ft
4	6												Round skipped due to boat issues
5	9												Round skipped due to boat issues
6	12												Round skipped due to boat issues
7	15												Round skipped due to boat issues
8	18												Round skipped due to boat issues
9	21												Round skipped due to boat issues
10	24												Round skipped due to boat issues
DELAWARE RIVER STATION: DR-02													
1	0	8:00	8:00	N	N/A	N	N/A	Y		0.20/ 0.20/ 0.20	14.50/ 14.47/ 14.45	328/ 326/ 324	
2	2	10:00	10:00	N	N/A	N	N/A	Y		0.15/ 0.15/ 0.15	16.96/ 16.96/ 16.96	264/ 263/ 262	Total Depth = 28 ft
3	4	12:00	12:10	N	N/A	N	N/A	Y		0.15/0.15/0.15	16.92/16.92/16.89	264/264/265	Total Depth = 28.2 ft
4	6												Round skipped due to boat issues
5	9												Round skipped due to boat issues
6	12												Round skipped due to boat issues
7	15												Round skipped due to boat issues
8	18												Round skipped due to boat issues
9	21												Round skipped due to boat issues
10	24												Round skipped due to boat issues
DELAWARE RIVER STATION: DR-03													
1	0	8:14	8:14	N	N/A	N	N/A	Y		0.20/ 0.20/ 0.20	14.51/ 14.51/ 14.52	334/ 333/333	
2	2	10:05	10:05	N	N/A	N	N/A	Y		0.16/ 0.16/ 0.16	17.00/ 17.00/ 16.49	276/ 276/ 275	Total Depth = 30.1
3	4	12:15	12:15	N	N/A	N	N/A	Y		0.15/0.15/0.15	16.95/16.95/16.94	265/264/264	Total Depth = 30.0
4	6	-											Round skipped due to boat issues
5	9	-											Round skipped due to boat issues
6	12	20:30	20:35	N	N/A	N	N/A	Y	23:30	0.1	23.9	246.2	Sample collected from shore near Norris Street due to boat issues
7	15	23:00	23:05	N	N/A	N	N/A	Y	23:30	0.22	14.88	363	Sample collected from shore near Norris Street due to boat issues
8	18	2:00	2:05	N	N/A	N	N/A	Y	5:55	0.2	14.4	339	Sample collected from shore near Norris Street due to boat issues
9	21	4:00	4:05	Y	4:05	N	N/A	Y	5:55	0.19	14.34	321	Sample collected from shore near Norris Street due to boat issues
10	24	6:00	6:05	N	N/A	N	N/A	Y	5:55	0.2	14.29	323	Sample collected from shore near Norris Street due to boat issues
DELAWARE RIVER STATION: DR-04													
1	0	8:05	8:05	N	N/A	N	N/A	Y		0.16/ 0.16/ 0.16	16.98/ 17.00/ 17.00	278/ 280/ 284	Total Depth = 22.5 ft
2	2	9:50	9:50	N	N/A	N	N/A	Y		0.20/ 0.20/ 0.20	14.69/ 14.67/ 14.69	327/ 332/ 335	Total Depth = 15 ft
3	4	12:10	12:10	N	N/A	N	N/A	Y		0.19/ 0.19/ 0.19	14.60/ 14.61/ 14.60	323/ 321/ 322	Total Depth = 14 ft
4	6	-											Round skipped due to boat issues
5	9	-											Round skipped due to boat issues
6	12	20:50	20:50	N	N/A	N	N/A	Y	23:30	0.1	23.6	256.1	Sample collected from shore near boat launch ramp due to boat issues
7	15	23:10	23:15	N	N/A	N	N/A	Y	23:30	0.22	14.92	371	Sample collected from shore near boat launch ramp due to boat issues
8	18	2:15	2:20	N	N/A	N	N/A	Y	5:55	0.21	14.51	340	Sample collected from shore near boat launch ramp due to boat issues
9	21	4:10	4:15	N	N/A	N	N/A	Y	5:55	0.2	14.37	331	Sample collected from shore near boat launch ramp due to boat issues
10	24	6:10	6:15	N	N/A	N	N/A	Y	5:55	0.2	14.27	324	Sample collected from shore near boat launch ramp due to boat issues

WET WEATHER EVENT: 2
DELAWARE RIVER STATION: DR-05

DATE: *5/5/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *7:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (%)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	7:55	7:55	N	N/A	N	N/A	Y		0.17/ 0.17/ 0.17	17.02/ 17.02/ 17.02	293/ 295/ 295	
2	2	10:05	10:05	N	N/A	N	N/A	Y		0.19/ 0.19/ 0.19	14.65/ 14.65/ 14.65	320/ 320/ 320	
3	4	12:17	12:17	N	N/A	N	N/A	Y		0.24/ 0.21/ 0.20	15.37/ 14.82/ 14.69	415/ 350/ 331	Total Depth = 10 ft
4	6												Round skipped due to boat issues
5	9												Round skipped due to boat issues
6	12												Round skipped due to boat issues
7	15												Round skipped due to boat issues
8	18												Round skipped due to boat issues
9	21												Round skipped due to boat issues
10	24												Round skipped due to boat issues
DELAWARE RIVER STATION: DR-06													
1	0	7:45	7:45	N	N/A	N	N/A	Y		0.14/ 0.14/ 0.14	16.88/ 16.89/ 16.89	255/ 255/ 255	Total Depth = 16 ft
2	2	9:40	9:40	N	N/A	N	N/A	Y		0.19/ 0.19/ 0.19	14.62/ 14.61/ 14.60	309/ 309/ 310	Total Depth = 27 ft
3	4	12:00	12:00	N	N/A	N	N/A	Y		0.18/ 0.18/ 0.18	14.48/ 14.48/ 14.47	306/ 306/ 307	Total Depth = 27 ft
4	6												Round skipped due to boat issues
5	9												Round skipped due to boat issues
6	12												Round skipped due to boat issues
7	15												Round skipped due to boat issues
8	18												Round skipped due to boat issues
9	21												Round skipped due to boat issues
10	24												Round skipped due to boat issues
DELAWARE RIVER STATION: DR-07													
1	0	7:30	7:30	N	N/A	N	N/A	Y		0.14/ 0.14/ 0.14	16.58/ 16.59/ 16.59	253/ 253/ 253	Total Depth = 15 ft
2	2	9:30	9:30	N	N/A	N	N/A	Y		0.19/ 0.19/ 0.18	14.33/ 14.33/ 14.33	306/ 306/ 305	Total Depth = 9.5 ft
3	4	11:50	11:50	N	N/A	N	N/A	Y		0.18/ 0.18/ 0.18	14.15/ 14.14/ 14.15	301/ 301/ 301	Total Depth = 4 ft
4	6												Round skipped due to boat issues
5	9												Round skipped due to boat issues
6	12												Round skipped due to boat issues
7	15												Round skipped due to boat issues
8	18												Round skipped due to boat issues
9	21												Round skipped due to boat issues
10	24												Round skipped due to boat issues

WET WEATHER EVENT: 2
CSO STATION: CSO-02

DATE: *5/5/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *7:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Filed Observations (see notes, below)
1	T=0 (First Flush)	8:20	8:20	N	N/A	N	N/A	Y	9:20	
2	30 Min	8:50	8:50	N	N/A	N	N/A	Y	9:20	
3	60 Min	9:30	9:30	N	N/A	N	N/A	Y	9:50	
4	2 Hours	10:30	10:30	N	N/A	N	N/A	Y	10:55	
5	4 Hours	12:30	12:30	N	N/A	N	N/A	Y	12:55	
6	8 Hours	16:20	-	-	-	-	-	-	-	No overflow over weir
7	12 Hours	20:20	-	-	-	-	-	-	-	No overflow over weir
8	24 Hours	8:20	-	-	-	-	-	-	-	No overflow over weir
CSO STATION: CSO-05										
1	T=0 (First Flush)	8:40	8:40	N	N/A	N	N/A	Y	9:20	
2	30 Min	9:05	9:05	N	N/A	N	N/A	Y	9:20	
3	60 Min	9:40	9:40	N	N/A	N	N/A	Y	9:50	
4	2 Hours	10:40	10:40	N	N/A	N	N/A	Y	10:55	
5	4 Hours	12:40	12:40	N	N/A	N	N/A	Y	12:55	
6	8 Hours	16:40	-	-	-	-	-	-	-	No overflow over weir
7	12 Hours	20:40	-	-	-	-	-	-	-	No overflow over weir
8	24 Hours	8:40	-	-	-	-	-	-	-	No overflow over weir
CSO STATION: CSO-18										
1	T=0 (First Flush)	8:40	8:42	N	N/A	N	N/A	Y	8:54	Overflowing to Creek
2	30 Min	9:17	9:19	N	N/A	N	N/A	Y	9:35	
3	60 Min	9:42	9:47	Y	9:47	Y	9:45	Y	9:55	
4	2 Hours	10:40	10:45	N	N/A	N	N/A	Y	10:55	
5	4 Hours	12:40	12:47	N	N/A	N	N/A	Y	12:57	
6	8 Hours	16:40	-	-	-	-	-	-	-	No overflow over weir
7	12 Hours	20:40	-	-	-	-	-	-	-	No overflow over weir
8	24 Hours	8:40	-	-	-	-	-	-	-	No overflow over weir
CSO STATION: CSO-19										
1	T=0 (First Flush)	8:35	8:27	N	N/A	N	N/A	Y	8:54	Weir not overflowing until 8:27; Water level just at top of weir wall
2	30 Min	9:05	9:07	N	N/A	N	N/A	Y	9:35	
3	60 Min	9:35	9:37	N	N/A	N	N/A	Y	9:35	
4	2 Hours	10:35	10:34	N	N/A	N	N/A	Y	10:55	
5	4 Hours	12:35	12:35	N	N/A	N	N/A	Y	12:57	
6	8 Hours	16:35	-	-	-	-	-	-	-	No overflow over weir.
7	12 Hours	20:35	-	-	-	-	-	-	-	No overflow over weir
8	24 Hours	8:35	-	-	-	-	-	-	-	No overflow over weir

WET WEATHER EVENT: 2
STORM WATER STATION: SW-05A

DATE: *5/5/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *7:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Filed Observations (see notes, below)
1	T=0 (First Flush)	6:45	6:45					Y	7:00	
2	30 Min	7:20	7:20					Y	8:00	
3	60 Min	7:45	7:50					Y	8:00	
4	2 Hours	8:45	8:50					Y	9:00	
5	4 Hours	10:45	10:50					Y	11:00	
6	8 Hours	14:45	14:45					Y	15:00	
7	12 Hours	18:45	-					-	-	No flow to collect sample
8	24 Hours	6:45	-					-	-	No flow to collect sample
STORM WATER STATION: SW-SS2										
1	T=0 (First Flush)	6:40	6:40					Y	7:00	
2	30 Min	7:10	7:10					Y	8:00	
3	60 Min	7:40	7:40					Y	8:00	
4	2 Hours	8:40	8:40					Y	9:00	
5	4 Hours	10:40	10:40					Y	11:00	
6	8 Hours	14:40	14:35					Y	15:00	
7	12 Hours	18:40	-					-	-	No flow to collect sample
8	24 Hours	6:40	-					-	-	No flow to collect sample

Login Number	Sample ID	Sample Date/Time	Parameter Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6794156-1	SW-SS2-1	05/05/17 06:40am	ENTEROCOCCUS-MF 24	EPA 1600	10000 E	05/05/17 12:31PM	
L6794156-1	SW-SS2-1	05/05/17 06:40am	E. COLI-MF (1603)	EPA 1603	690	05/05/17 12:26PM	
L6794156-1	SW-SS2-1	05/05/17 06:40am	FECAL COLIFORM-MF	SM 9222D	1300 E	05/05/17 12:44PM	
L6794156-2	SW-05A-1	05/05/17 06:45am	ENTEROCOCCUS-MF 24	EPA 1600	12000 E	05/05/17 12:31PM	
L6794156-2	SW-05A-1	05/05/17 06:45am	E. COLI-MF (1603)	EPA 1603	6600	05/05/17 12:26PM	
L6794156-2	SW-05A-1	05/05/17 06:45am	FECAL COLIFORM-MF	SM 9222D	27000	05/05/17 12:44PM	
L6794156-3	SW-SS2-2	05/05/17 07:10am	ENTEROCOCCUS-MF 24	EPA 1600	8000 E	05/05/17 12:31PM	
L6794156-3	SW-SS2-2	05/05/17 07:10am	E. COLI-MF (1603)	EPA 1603	580	05/05/17 12:26PM	
L6794156-3	SW-SS2-2	05/05/17 07:10am	FECAL COLIFORM-MF	SM 9222D	3300	05/05/17 12:44PM	
L6794156-4	SW-05A-2	05/05/17 07:20am	ENTEROCOCCUS-MF 24	EPA 1600	5000 E	05/05/17 12:31PM	
L6794156-4	SW-05A-2	05/05/17 07:20am	E. COLI-MF (1603)	EPA 1603	96000 E	05/05/17 12:26PM	
L6794156-4	SW-05A-2	05/05/17 07:20am	FECAL COLIFORM-MF	SM 9222D	1480000 E	05/05/17 12:44PM	
L6794156-5	SW-SS2-3	05/05/17 07:40am	ENTEROCOCCUS-MF 24	EPA 1600	6900 E	05/05/17 12:31PM	
L6794156-5	SW-SS2-3	05/05/17 07:40am	E. COLI-MF (1603)	EPA 1603	590	05/05/17 12:26PM	
L6794156-5	SW-SS2-3	05/05/17 07:40am	FECAL COLIFORM-MF	SM 9222D	650 E	05/05/17 12:44PM	
L6794156-6	SW-05A-3	05/05/17 07:50am	ENTEROCOCCUS-MF 24	EPA 1600	38000	05/05/17 12:31PM	
L6794156-6	SW-05A-3	05/05/17 07:50am	E. COLI-MF (1603)	EPA 1603	9600 E	05/05/17 12:26PM	
L6794156-6	SW-05A-3	05/05/17 07:50am	FECAL COLIFORM-MF	SM 9222D	55000	05/05/17 12:44PM	
L6794156-7	CC-02-1	05/05/17 07:45am	ENTEROCOCCUS-MF 24	EPA 1600	132 E	05/05/17 12:31PM	
L6794156-7	CC-02-1	05/05/17 07:45am	E. COLI-MF (1603)	EPA 1603	210	05/05/17 12:26PM	
L6794156-7	CC-02-1	05/05/17 07:45am	FECAL COLIFORM-MF	SM 9222D	54	05/05/17 12:44PM	
L6794156-8	CC-03-1	05/05/17 07:20am	ENTEROCOCCUS-MF 24	EPA 1600	84	05/05/17 12:31PM	
L6794156-8	CC-03-1	05/05/17 07:20am	E. COLI-MF (1603)	EPA 1603	54	05/05/17 12:26PM	
L6794156-8	CC-03-1	05/05/17 07:20am	FECAL COLIFORM-MF	SM 9222D	52	05/05/17 12:44PM	
L6794156-9	RC-03-1	05/05/17 07:35am	ENTEROCOCCUS-MF 24	EPA 1600	72	05/05/17 12:31PM	
L6794156-9	RC-03-1	05/05/17 07:35am	E. COLI-MF (1603)	EPA 1603	250	05/05/17 01:06PM	
L6794156-9	RC-03-1	05/05/17 07:35am	FECAL COLIFORM-MF	SM 9222D	126 E	05/05/17 12:44PM	
L6794156-10	DR-01-1	05/05/17 07:36am	ENTEROCOCCUS-MF 24	EPA 1600	25 E	05/05/17 12:31PM	
L6794156-10	DR-01-1	05/05/17 07:36am	E. COLI-MF (1603)	EPA 1603	26 E	05/05/17 01:06PM	
L6794156-10	DR-01-1	05/05/17 07:36am	FECAL COLIFORM-MF	SM 9222D	20 E	05/05/17 12:44PM	
L6794156-11	DR-02-1	05/05/17 08:00am	ENTEROCOCCUS-MF 24	EPA 1600	18 E	05/05/17 12:31PM	
L6794156-11	DR-02-1	05/05/17 08:00am	E. COLI-MF (1603)	EPA 1603	20 E	05/05/17 01:06PM	
L6794156-11	DR-02-1	05/05/17 08:00am	FECAL COLIFORM-MF	SM 9222D	22 E	05/05/17 12:44PM	
L6794156-12	DR-03-1	05/05/17 08:14am	ENTEROCOCCUS-MF 24	EPA 1600	8 E	05/05/17 12:31PM	
L6794156-12	DR-03-1	05/05/17 08:14am	E. COLI-MF (1603)	EPA 1603	100	05/05/17 01:06PM	
L6794156-12	DR-03-1	05/05/17 08:14am	FECAL COLIFORM-MF	SM 9222D	22 E	05/05/17 12:44PM	
L6794156-13	BLANK-DR-2	05/05/17 07:24am	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/05/17 12:31PM	
L6794156-13	BLANK-DR-2	05/05/17 07:24am	E. COLI-MF (1603)	EPA 1603	<2	05/05/17 01:06PM	
L6794156-13	BLANK-DR-2	05/05/17 07:24am	FECAL COLIFORM-MF	SM 9222D	2 E	05/05/17 12:44PM	
L6794156-14	DR-04-1	05/05/17 08:05am	ENTEROCOCCUS-MF 24	EPA 1600	12 E	05/05/17 12:31PM	
L6794156-14	DR-04-1	05/05/17 08:05am	E. COLI-MF (1603)	EPA 1603	12 E	05/05/17 01:06PM	
L6794156-14	DR-04-1	05/05/17 08:05am	FECAL COLIFORM-MF	SM 9222D	20 E	05/05/17 12:44PM	
L6794156-15	DR-05-1	05/05/17 07:55am	ENTEROCOCCUS-MF 24	EPA 1600	6 E	05/05/17 12:31PM	
L6794156-15	DR-05-1	05/05/17 07:55am	E. COLI-MF (1603)	EPA 1603	13 E	05/05/17 01:06PM	
L6794156-15	DR-05-1	05/05/17 07:55am	FECAL COLIFORM-MF	SM 9222D	42	05/05/17 12:44PM	
L6794156-16	DR-06-1	05/05/17 07:45am	ENTEROCOCCUS-MF 24	EPA 1600	4 E	05/05/17 12:31PM	
L6794156-16	DR-06-1	05/05/17 07:45am	E. COLI-MF (1603)	EPA 1603	6	05/05/17 12:26PM	
L6794156-16	DR-06-1	05/05/17 07:45am	FECAL COLIFORM-MF	SM 9222D	4 E	05/05/17 12:44PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6794156-17	DR-07-1	05/05/17 07:30am	ENTEROCOCCUS-MF 24	EPA 1600	12 E	05/05/17 12:31PM	
L6794156-17	DR-07-1	05/05/17 07:30am	E. COLI-MF (1603)	EPA 1603	5 E	05/05/17 01:06PM	
L6794156-17	DR-07-1	05/05/17 07:30am	FECAL COLIFORM-MF	SM 9222D	6 E	05/05/17 12:44PM	
L6794156-18	RC-02-01	05/05/17 08:15am	ENTEROCOCCUS-MF 24	EPA 1600	1500 E	05/05/17 12:31PM	
L6794156-18	RC-02-01	05/05/17 08:15am	E. COLI-MF (1603)	EPA 1603	730	05/05/17 12:26PM	
L6794156-18	RC-02-01	05/05/17 08:15am	FECAL COLIFORM-MF	SM 9222D	1600 E	05/05/17 12:44PM	
L6794156-19	RC-01-01	05/05/17 08:30am	ENTEROCOCCUS-MF 24	EPA 1600	380	05/05/17 12:31PM	
L6794156-19	RC-01-01	05/05/17 08:30am	E. COLI-MF (1603)	EPA 1603	440	05/05/17 01:06PM	
L6794156-19	RC-01-01	05/05/17 08:30am	FECAL COLIFORM-MF	SM 9222D	330	05/05/17 12:44PM	
L6794156-20	CC-01-01	05/05/17 08:45am	ENTEROCOCCUS-MF 24	EPA 1600	580	05/05/17 12:31PM	
L6794156-20	CC-01-01	05/05/17 08:45am	E. COLI-MF (1603)	EPA 1603	230	05/05/17 01:06PM	
L6794156-20	CC-01-01	05/05/17 08:45am	FECAL COLIFORM-MF	SM 9222D	230	05/05/17 12:44PM	
L6794156-21	BLANK-CREEK-1	05/05/17 08:35am	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/05/17 12:31PM	
L6794156-21	BLANK-CREEK-1	05/05/17 08:35am	E. COLI-MF (1603)	EPA 1603	<1	05/05/17 01:06PM	
L6794156-21	BLANK-CREEK-1	05/05/17 08:35am	FECAL COLIFORM-MF	SM 9222D	<2	05/05/17 12:44PM	
L6794156-22	DUP-RC1	05/05/17 08:15am	ENTEROCOCCUS-MF 24	EPA 1600	1800 E	05/05/17 12:31PM	
L6794156-22	DUP-RC1	05/05/17 08:15am	E. COLI-MF (1603)	EPA 1603	520	05/05/17 01:06PM	
L6794156-22	DUP-RC1	05/05/17 08:15am	FECAL COLIFORM-MF	SM 9222D	1500 E	05/05/17 12:44PM	
L6794156-23	CSO-19-1	05/05/17 08:27am	ENTEROCOCCUS-MF 24	EPA 1600	>60000	05/05/17 12:31PM	
L6794156-23	CSO-19-1	05/05/17 08:27am	E. COLI-MF (1603)	EPA 1603	229000 E	05/05/17 01:06PM	
L6794156-23	CSO-19-1	05/05/17 08:27am	FECAL COLIFORM-MF	SM 9222D	230000 E	05/05/17 12:44PM	
L6794156-24	CSO-18-1	05/05/17 08:42am	ENTEROCOCCUS-MF 24	EPA 1600	127000 E	05/05/17 12:31PM	
L6794156-24	CSO-18-1	05/05/17 08:42am	E. COLI-MF (1603)	EPA 1603	>80000	05/05/17 12:26PM	
L6794156-24	CSO-18-1	05/05/17 08:42am	FECAL COLIFORM-MF	SM 9222D	196000 E	05/05/17 12:44PM	
L6794156-25	SW-SS2-4	05/05/17 08:40am	ENTEROCOCCUS-MF 24	EPA 1600	>60000	05/05/17 12:31PM	
L6794156-25	SW-SS2-4	05/05/17 08:40am	E. COLI-MF (1603)	EPA 1603	49000	05/05/17 01:06PM	
L6794156-25	SW-SS2-4	05/05/17 08:40am	FECAL COLIFORM-MF	SM 9222D	63000 E	05/05/17 12:44PM	
L6794156-26	SW-05A-4	05/05/17 08:50am	ENTEROCOCCUS-MF 24	EPA 1600	59000	05/05/17 12:31PM	
L6794156-26	SW-05A-4	05/05/17 08:50am	E. COLI-MF (1603)	EPA 1603	8000	05/05/17 01:06PM	
L6794156-26	SW-05A-4	05/05/17 08:50am	FECAL COLIFORM-MF	SM 9222D	22000	05/05/17 12:44PM	
L6794156-27	CSO-19-2	05/05/17 09:07am	ENTEROCOCCUS-MF 24	EPA 1600	152000 E	05/05/17 02:21PM	
L6794156-27	CSO-19-2	05/05/17 09:07am	E. COLI-MF (1603)	EPA 1603	504000 E	05/05/17 02:51PM	
L6794156-27	CSO-19-2	05/05/17 09:07am	FECAL COLIFORM-MF	SM 9222D	160000 E	05/05/17 01:05PM	
L6794156-28	CSO-18-2	05/05/17 09:19am	ENTEROCOCCUS-MF 24	EPA 1600	90000 E	05/05/17 02:21PM	
L6794156-28	CSO-18-2	05/05/17 09:19am	E. COLI-MF (1603)	EPA 1603	150000 E	05/05/17 02:51PM	
L6794156-28	CSO-18-2	05/05/17 09:19am	FECAL COLIFORM-MF	SM 9222D	15300 E	05/05/17 02:50PM	
L6794156-29	CSO-19-3	05/05/17 09:34am	ENTEROCOCCUS-MF 24	EPA 1600	189000 E	05/05/17 02:21PM	
L6794156-29	CSO-19-3	05/05/17 09:34am	E. COLI-MF (1603)	EPA 1603	272000 E	05/05/17 02:51PM	
L6794156-29	CSO-19-3	05/05/17 09:34am	FECAL COLIFORM-MF	SM 9222D	18800 E	05/05/17 02:50PM	
L6794156-30	CSO-18-3	05/05/17 09:47am	ENTEROCOCCUS-MF 24	EPA 1600	54000	05/05/17 02:21PM	
L6794156-30	CSO-18-3	05/05/17 09:47am	E. COLI-MF (1603)	EPA 1603	53000	05/05/17 02:51PM	
L6794156-30	CSO-18-3	05/05/17 09:47am	FECAL COLIFORM-MF	SM 9222D	53000	05/05/17 01:05PM	
L6794156-31	DUP-CSO	05/05/17 09:47am	ENTEROCOCCUS-MF 24	EPA 1600	45000	05/05/17 02:21PM	
L6794156-31	DUP-CSO	05/05/17 09:47am	E. COLI-MF (1603)	EPA 1603	52000	05/05/17 02:51PM	
L6794156-31	DUP-CSO	05/05/17 09:47am	FECAL COLIFORM-MF	SM 9222D	44000	05/05/17 01:05PM	
L6794156-32	BLANK-04	05/05/17 09:45am	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/05/17 02:21PM	
L6794156-32	BLANK-04	05/05/17 09:45am	E. COLI-MF (1603)	EPA 1603	2	05/05/17 02:51PM	
L6794156-32	BLANK-04	05/05/17 09:45am	FECAL COLIFORM-MF	SM 9222D	<2	05/05/17 01:05PM	
L6794156-33	CSO-02-03	05/05/17 09:30am	ENTEROCOCCUS-MF 24	EPA 1600	211000 E	05/05/17 02:21PM	
L6794156-33	CSO-02-03	05/05/17 09:30am	E. COLI-MF (1603)	EPA 1603	468000 E	05/05/17 02:51PM	
L6794156-33	CSO-02-03	05/05/17 09:30am	FECAL COLIFORM-MF	SM 9222D	24300 E	05/05/17 02:50PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6794156-34	CSO-05-03	05/05/17 09:40am	ENTEROCOCCUS-MF 24	EPA 1600	306000 E	05/05/17 02:21PM	
L6794156-34	CSO-05-03	05/05/17 09:40am	E. COLI-MF (1603)	EPA 1603	177000 E	05/05/17 02:51PM	
L6794156-34	CSO-05-03	05/05/17 09:40am	FECAL COLIFORM-MF	SM 9222D	123000 E	05/05/17 01:05PM	
L6794156-35	CSO-02-01	05/05/17 08:20am	ENTEROCOCCUS-MF 24	EPA 1600	187000 E	05/05/17 02:21PM	
L6794156-35	CSO-02-01	05/05/17 08:20am	E. COLI-MF (1603)	EPA 1603	364000 E	05/05/17 02:51PM	
L6794156-35	CSO-02-01	05/05/17 08:20am	FECAL COLIFORM-MF	SM 9222D	217000 E	05/05/17 01:05PM	
L6794156-36	CSO-05-01	05/05/17 08:40am	ENTEROCOCCUS-MF 24	EPA 1600	213000 E	05/05/17 02:21PM	
L6794156-36	CSO-05-01	05/05/17 08:40am	E. COLI-MF (1603)	EPA 1603	568000 E	05/05/17 02:51PM	
L6794156-36	CSO-05-01	05/05/17 08:40am	FECAL COLIFORM-MF	SM 9222D	23500 E	05/05/17 02:50PM	
L6794156-37	BLANK-S	05/05/17 08:20am	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/05/17 02:21PM	
L6794156-37	BLANK-S	05/05/17 08:20am	E. COLI-MF (1603)	EPA 1603	7 E	05/05/17 02:51PM	
L6794156-37	BLANK-S	05/05/17 08:20am	FECAL COLIFORM-MF	SM 9222D	2 E	05/05/17 01:05PM	
L6794156-38	CSO-02-02	05/05/17 08:50am	ENTEROCOCCUS-MF 24	EPA 1600	243000 E	05/05/17 02:21PM	
L6794156-38	CSO-02-02	05/05/17 08:50am	E. COLI-MF (1603)	EPA 1603	253000 E	05/05/17 02:51PM	
L6794156-38	CSO-02-02	05/05/17 08:50am	FECAL COLIFORM-MF	SM 9222D	219000 E	05/05/17 01:05PM	
L6794156-39	CSO-05-02	05/05/17 09:05am	ENTEROCOCCUS-MF 24	EPA 1600	195000 E	05/05/17 02:21PM	
L6794156-39	CSO-05-02	05/05/17 09:05am	E. COLI-MF (1603)	EPA 1603	141000 E	05/05/17 02:51PM	
L6794156-39	CSO-05-02	05/05/17 09:05am	FECAL COLIFORM-MF	SM 9222D	120000 E	05/05/17 01:05PM	
L6794156-40	DR-01-2	05/05/17 09:50am	ENTEROCOCCUS-MF 24	EPA 1600	6 E	05/05/17 05:20PM	
L6794156-40	DR-01-2	05/05/17 09:50am	E. COLI-MF (1603)	EPA 1603	10 E	05/05/17 05:45PM	
L6794156-40	DR-01-2	05/05/17 09:50am	FECAL COLIFORM-MF	SM 9222D	18 E	05/05/17 05:30PM	
L6794156-41	DR-02-2	05/05/17 10:00am	ENTEROCOCCUS-MF 24	EPA 1600	3 E	05/05/17 05:20PM	
L6794156-41	DR-02-2	05/05/17 10:00am	E. COLI-MF (1603)	EPA 1603	8 E	05/05/17 05:20PM	
L6794156-41	DR-02-2	05/05/17 10:00am	FECAL COLIFORM-MF	SM 9222D	12 E	05/05/17 05:30PM	
L6794156-42	DR-03-2	05/05/17 10:05am	ENTEROCOCCUS-MF 24	EPA 1600	8 E	05/05/17 05:20PM	
L6794156-42	DR-03-2	05/05/17 10:05am	E. COLI-MF (1603)	EPA 1603	12 E	05/05/17 05:20PM	
L6794156-42	DR-03-2	05/05/17 10:05am	FECAL COLIFORM-MF	SM 9222D	6 E	05/05/17 05:30PM	
L6794156-43	DR-04-2	05/05/17 09:50am	ENTEROCOCCUS-MF 24	EPA 1600	4 E	05/05/17 05:20PM	
L6794156-43	DR-04-2	05/05/17 09:50am	E. COLI-MF (1603)	EPA 1603	12 E	05/05/17 05:45PM	
L6794156-43	DR-04-2	05/05/17 09:50am	FECAL COLIFORM-MF	SM 9222D	18 E	05/05/17 05:30PM	
L6794156-44	DR-05-2	05/05/17 10:05am	ENTEROCOCCUS-MF 24	EPA 1600	4 E	05/05/17 05:20PM	
L6794156-44	DR-05-2	05/05/17 10:05am	E. COLI-MF (1603)	EPA 1603	18 E	05/05/17 05:45PM	
L6794156-44	DR-05-2	05/05/17 10:05am	FECAL COLIFORM-MF	SM 9222D	2 E	05/05/17 05:30PM	
L6794156-45	DR-06-2	05/05/17 09:40am	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/05/17 05:20PM	
L6794156-45	DR-06-2	05/05/17 09:40am	E. COLI-MF (1603)	EPA 1603	4 E	05/05/17 05:20PM	
L6794156-45	DR-06-2	05/05/17 09:40am	FECAL COLIFORM-MF	SM 9222D	9 E	05/05/17 05:30PM	
L6794156-46	DR-07-2	05/05/17 09:30am	ENTEROCOCCUS-MF 24	EPA 1600	6 E	05/05/17 05:20PM	
L6794156-46	DR-07-2	05/05/17 09:30am	E. COLI-MF (1603)	EPA 1603	2 E	05/05/17 05:20PM	
L6794156-46	DR-07-2	05/05/17 09:30am	FECAL COLIFORM-MF	SM 9222D	6 E	05/05/17 05:30PM	
L6794156-47	CSO-02-04	05/05/17 10:30am	ENTEROCOCCUS-MF 24	EPA 1600	145000 E	05/05/17 05:20PM	
L6794156-47	CSO-02-04	05/05/17 10:30am	E. COLI-MF (1603)	EPA 1603	132000 E	05/05/17 05:20PM	
L6794156-47	CSO-02-04	05/05/17 10:30am	FECAL COLIFORM-MF	SM 9222D	122000 E	05/05/17 05:30PM	
L6794156-48	CSO-05-04	05/05/17 10:40am	ENTEROCOCCUS-MF 24	EPA 1600	77000 E	05/05/17 05:20PM	
L6794156-48	CSO-05-04	05/05/17 10:40am	E. COLI-MF (1603)	EPA 1603	95000 E	05/05/17 05:20PM	
L6794156-48	CSO-05-04	05/05/17 10:40am	FECAL COLIFORM-MF	SM 9222D	68000 E	05/05/17 05:30PM	
L6794156-49	CSO-18-4	05/05/17 10:34am	ENTEROCOCCUS-MF 24	EPA 1600	109000 E	05/05/17 05:20PM	
L6794156-49	CSO-18-4	05/05/17 10:34am	E. COLI-MF (1603)	EPA 1603	163000 E	05/05/17 05:20PM	
L6794156-49	CSO-18-4	05/05/17 10:34am	FECAL COLIFORM-MF	SM 9222D	119000 E	05/05/17 05:30PM	
L6794156-50	CSO-18-4	05/05/17 10:45am	ENTEROCOCCUS-MF 24	EPA 1600	59000	05/05/17 05:20PM	
L6794156-50	CSO-18-4	05/05/17 10:45am	E. COLI-MF (1603)	EPA 1603	80000	05/05/17 05:20PM	
L6794156-50	CSO-18-4	05/05/17 10:45am	FECAL COLIFORM-MF	SM 9222D	47000	05/05/17 05:30PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6794156-51	SW-SS2-5	05/05/17 10:40am	ENTEROCOCCUS-MF 24	EPA 1600	114000 E	05/05/17 05:20PM	
L6794156-51	SW-SS2-5	05/05/17 10:40am	E. COLI-MF (1603)	EPA 1603	15000 E	05/05/17 05:20PM	
L6794156-51	SW-SS2-5	05/05/17 10:40am	FECAL COLIFORM-MF	SM 9222D	13000 E	05/05/17 05:30PM	
L6794156-52	SW-05A-5	05/05/17 10:50am	ENTEROCOCCUS-MF 24	EPA 1600	95000 E	05/05/17 05:20PM	
L6794156-52	SW-05A-5	05/05/17 10:50am	E. COLI-MF (1603)	EPA 1603	50000	05/05/17 05:20PM	
L6794156-52	SW-05A-5	05/05/17 10:50am	FECAL COLIFORM-MF	SM 9222D	15000 E	05/05/17 05:30PM	
L6794156-53	DR-04-3	05/05/17 12:10pm	ENTEROCOCCUS-MF 24	EPA 1600	12 E	05/05/17 05:20PM	
L6794156-53	DR-04-3	05/05/17 12:10pm	E. COLI-MF (1603)	EPA 1603	8 E	05/05/17 05:45PM	
L6794156-53	DR-04-3	05/05/17 12:10pm	FECAL COLIFORM-MF	SM 9222D	24 E	05/05/17 05:30PM	
L6794156-54	DR-05-3	05/05/17 12:17pm	ENTEROCOCCUS-MF 24	EPA 1600	40000	05/05/17 05:20PM	
L6794156-54	DR-05-3	05/05/17 12:17pm	E. COLI-MF (1603)	EPA 1603	6900	05/05/17 06:11PM	
L6794156-54	DR-05-3	05/05/17 12:17pm	FECAL COLIFORM-MF	SM 9222D	10000 E	05/05/17 05:30PM	
L6794156-55	DR-06-3	05/05/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/05/17 05:20PM	
L6794156-55	DR-06-3	05/05/17 12:00pm	E. COLI-MF (1603)	EPA 1603	2 E	05/05/17 05:20PM	
L6794156-55	DR-06-3	05/05/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	6 E	05/05/17 05:30PM	
L6794156-56	DR-07-3	05/05/17 11:50am	ENTEROCOCCUS-MF 24	EPA 1600	10 E	05/05/17 05:20PM	
L6794156-56	DR-07-3	05/05/17 11:50am	E. COLI-MF (1603)	EPA 1603	20 E	05/05/17 05:45PM	
L6794156-56	DR-07-3	05/05/17 11:50am	FECAL COLIFORM-MF	SM 9222D	10 E	05/05/17 05:30PM	
L6794156-57	DR-01-3	05/05/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	30 E	05/05/17 05:20PM	
L6794156-57	DR-01-3	05/05/17 12:00pm	E. COLI-MF (1603)	EPA 1603	16 E	05/05/17 05:20PM	
L6794156-57	DR-01-3	05/05/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	20 E	05/05/17 05:30PM	
L6794156-58	DR-02-3	05/05/17 12:10pm	ENTEROCOCCUS-MF 24	EPA 1600	8 E	05/05/17 05:20PM	
L6794156-58	DR-02-3	05/05/17 12:10pm	E. COLI-MF (1603)	EPA 1603	6 E	05/05/17 05:20PM	
L6794156-58	DR-02-3	05/05/17 12:10pm	FECAL COLIFORM-MF	SM 9222D	18 E	05/05/17 05:30PM	
L6794156-59	DR-03-3	05/05/17 12:15pm	ENTEROCOCCUS-MF 24	EPA 1600	56	05/05/17 05:20PM	
L6794156-59	DR-03-3	05/05/17 12:15pm	E. COLI-MF (1603)	EPA 1603	14 E	05/05/17 05:20PM	
L6794156-59	DR-03-3	05/05/17 12:15pm	FECAL COLIFORM-MF	SM 9222D	12 E	05/05/17 05:30PM	
L6794156-60	CSO-02-05	05/05/17 12:15pm	ENTEROCOCCUS-MF 24	EPA 1600	89000 E	05/05/17 05:20PM	
L6794156-60	CSO-02-05	05/05/17 12:15pm	E. COLI-MF (1603)	EPA 1603	96000 E	05/05/17 05:45PM	
L6794156-60	CSO-02-05	05/05/17 12:15pm	FECAL COLIFORM-MF	SM 9222D	68000 E	05/05/17 05:30PM	
L6794156-61	CSO-05-05	05/05/17 12:40pm	ENTEROCOCCUS-MF 24	EPA 1600	75000 E	05/05/17 05:20PM	
L6794156-61	CSO-05-05	05/05/17 12:40pm	E. COLI-MF (1603)	EPA 1603	55000	05/05/17 06:11PM	
L6794156-61	CSO-05-05	05/05/17 12:40pm	FECAL COLIFORM-MF	SM 9222D	53000	05/05/17 05:30PM	
L6794156-62	CC-01-02	05/05/17 12:55pm	ENTEROCOCCUS-MF 24	EPA 1600	LA Q	05/05/17 05:20PM	
L6794156-62	CC-01-02	05/05/17 12:55pm	E. COLI-MF (1603)	EPA 1603	12000 E	05/05/17 05:20PM	
L6794156-62	CC-01-02	05/05/17 12:55pm	FECAL COLIFORM-MF	SM 9222D	10000 E	05/05/17 05:30PM	
L6794156-63	CC-02-2	05/05/17 12:35pm	ENTEROCOCCUS-MF 24	EPA 1600	15000 E	05/05/17 05:20PM	
L6794156-63	CC-02-2	05/05/17 12:35pm	E. COLI-MF (1603)	EPA 1603	15000 E	05/05/17 05:20PM	
L6794156-63	CC-02-2	05/05/17 12:35pm	FECAL COLIFORM-MF	SM 9222D	6900 E	05/05/17 05:30PM	
L6794156-64	CC-03-2	05/05/17 11:40am	ENTEROCOCCUS-MF 24	EPA 1600	3400	05/05/17 05:20PM	
L6794156-64	CC-03-2	05/05/17 11:40am	E. COLI-MF (1603)	EPA 1603	5700	05/05/17 06:11PM	
L6794156-64	CC-03-2	05/05/17 11:40am	FECAL COLIFORM-MF	SM 9222D	6700 E	05/05/17 05:30PM	
L6794156-65	RC-01-2	05/05/17 12:15pm	ENTEROCOCCUS-MF 24	EPA 1600	28000	05/05/17 05:20PM	
L6794156-65	RC-01-2	05/05/17 12:15pm	E. COLI-MF (1603)	EPA 1603	7900	05/05/17 05:20PM	
L6794156-65	RC-01-2	05/05/17 12:15pm	FECAL COLIFORM-MF	SM 9222D	3100	05/05/17 05:30PM	
L6794156-66	RC-02-2	05/05/17 11:55am	ENTEROCOCCUS-MF 24	EPA 1600	18000 E	05/05/17 05:20PM	
L6794156-66	RC-02-2	05/05/17 11:55am	E. COLI-MF (1603)	EPA 1603	13000 E	05/05/17 06:11PM	
L6794156-66	RC-02-2	05/05/17 11:55am	FECAL COLIFORM-MF	SM 9222D	16000 E	05/05/17 05:30PM	
L6794156-67	RC-03-2	05/05/17 11:47am	ENTEROCOCCUS-MF 24	EPA 1600	10000 E	05/05/17 05:20PM	
L6794156-67	RC-03-2	05/05/17 11:47am	E. COLI-MF (1603)	EPA 1603	20000	05/05/17 06:11PM	
L6794156-67	RC-03-2	05/05/17 11:47am	FECAL COLIFORM-MF	SM 9222D	13000 E	05/05/17 05:30PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6794156-68	CSO-19-5	05/05/17 12:35pm	ENTEROCOCCUS-MF 24	EPA 1600	194000 E	05/05/17 05:20PM	
L6794156-68	CSO-19-5	05/05/17 12:35pm	E. COLI-MF (1603)	EPA 1603	234000 E	05/05/17 06:11PM	
L6794156-68	CSO-19-5	05/05/17 12:35pm	FECAL COLIFORM-MF	SM 9222D	93000 E	05/05/17 05:30PM	
L6794156-69	CSO-18-5	05/05/17 12:47pm	ENTEROCOCCUS-MF 24	EPA 1600	37000	05/05/17 05:20PM	
L6794156-69	CSO-18-5	05/05/17 12:47pm	E. COLI-MF (1603)	EPA 1603	104000 E	05/05/17 05:20PM	
L6794156-69	CSO-18-5	05/05/17 12:47pm	FECAL COLIFORM-MF	SM 9222D	53000	05/05/17 05:30PM	
L6794156-70	CC-01-3	05/05/17 05:05pm	ENTEROCOCCUS-MF 24	EPA 1600	39000	05/05/17 07:49PM	
L6794156-70	CC-01-3	05/05/17 05:05pm	E. COLI-MF (1603)	EPA 1603	13000 E	05/05/17 07:41PM	
L6794156-70	CC-01-3	05/05/17 05:05pm	FECAL COLIFORM-MF	SM 9222D	44000	05/05/17 07:49PM	
L6794156-71	CC-02-3	05/05/17 04:48pm	ENTEROCOCCUS-MF 24	EPA 1600	17000 E	05/05/17 07:49PM	
L6794156-71	CC-02-3	05/05/17 04:48pm	E. COLI-MF (1603)	EPA 1603	7300	05/05/17 07:41PM	
L6794156-71	CC-02-3	05/05/17 04:48pm	FECAL COLIFORM-MF	SM 9222D	13000 E	05/05/17 07:49PM	
L6794156-72	CC-03-3	05/05/17 03:45pm	ENTEROCOCCUS-MF 24	EPA 1600	27000	05/05/17 07:49PM	
L6794156-72	CC-03-3	05/05/17 03:45pm	E. COLI-MF (1603)	EPA 1603	6500	05/05/17 07:41PM	
L6794156-72	CC-03-3	05/05/17 03:45pm	FECAL COLIFORM-MF	SM 9222D	21000	05/05/17 07:49PM	
L6794156-73	RC-01-3	05/05/17 04:30pm	ENTEROCOCCUS-MF 24	EPA 1600	23000	05/05/17 07:49PM	
L6794156-73	RC-01-3	05/05/17 04:30pm	E. COLI-MF (1603)	EPA 1603	6100	05/05/17 07:41PM	
L6794156-73	RC-01-3	05/05/17 04:30pm	FECAL COLIFORM-MF	SM 9222D	6700 E	05/05/17 07:49PM	
L6794156-74	RC-02-3	05/05/17 04:10pm	ENTEROCOCCUS-MF 24	EPA 1600	19000 E	05/05/17 07:49PM	
L6794156-74	RC-02-3	05/05/17 04:10pm	E. COLI-MF (1603)	EPA 1603	5900	05/05/17 07:41PM	
L6794156-74	RC-02-3	05/05/17 04:10pm	FECAL COLIFORM-MF	SM 9222D	4300	05/05/17 07:49PM	
L6794156-75	RC-03-3	05/05/17 04:00pm	ENTEROCOCCUS-MF 24	EPA 1600	30000	05/05/17 07:49PM	
L6794156-75	RC-03-3	05/05/17 04:00pm	E. COLI-MF (1603)	EPA 1603	6800	05/05/17 07:41PM	
L6794156-75	RC-03-3	05/05/17 04:00pm	FECAL COLIFORM-MF	SM 9222D	34000	05/05/17 07:49PM	
L6794156-76	SW-SS2-6	05/05/17 04:35pm	ENTEROCOCCUS-MF 24	EPA 1600	57000	05/05/17 07:49PM	
L6794156-76	SW-SS2-6	05/05/17 04:35pm	E. COLI-MF (1603)	EPA 1603	6200	05/05/17 07:41PM	
L6794156-76	SW-SS2-6	05/05/17 04:35pm	FECAL COLIFORM-MF	SM 9222D	33000	05/05/17 07:49PM	
L6794156-77	SW-05A-6	05/05/17 04:45pm	ENTEROCOCCUS-MF 24	EPA 1600	44000	05/05/17 07:49PM	
L6794156-77	SW-05A-6	05/05/17 04:45pm	E. COLI-MF (1603)	EPA 1603	13000 E	05/05/17 07:41PM	
L6794156-77	SW-05A-6	05/05/17 04:45pm	FECAL COLIFORM-MF	SM 9222D	30000	05/05/17 07:49PM	
L6794156-78	DUP-CC	05/05/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	40000 Q	05/05/17 07:49PM	
L6794156-78	DUP-CC	05/05/17 00:00pm	E. COLI-MF (1603)	EPA 1603	17000 E, Q	05/05/17 07:41PM	
L6794156-78	DUP-CC	05/05/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	31000 Q	05/05/17 07:49PM	
L6794156-79	DR-03-07 (LAND)	05/05/17 11:00pm	ENTEROCOCCUS-MF 24	EPA 1600	15000 E	05/06/17 01:05AM	
L6794156-79	DR-03-07 (LAND)	05/05/17 11:00pm	E. COLI-MF (1603)	EPA 1603	5500	05/06/17 12:40AM	
L6794156-79	DR-03-07 (LAND)	05/05/17 11:00pm	FECAL COLIFORM-MF	SM 9222D	23000	05/06/17 12:50AM	
L6794156-80	DR-04-07 (LAND)	05/05/17 11:10pm	ENTEROCOCCUS-MF 24	EPA 1600	12000 E	05/06/17 01:05AM	
L6794156-80	DR-04-07 (LAND)	05/05/17 11:10pm	E. COLI-MF (1603)	EPA 1603	4500	05/06/17 12:40AM	
L6794156-80	DR-04-07 (LAND)	05/05/17 11:10pm	FECAL COLIFORM-MF	SM 9222D	3800	05/06/17 12:50AM	
L6794156-81	CC-01-04	05/05/17 10:35pm	ENTEROCOCCUS-MF 24	EPA 1600	41000	05/06/17 01:05AM	
L6794156-81	CC-01-04	05/05/17 10:35pm	E. COLI-MF (1603)	EPA 1603	15000 E	05/06/17 12:40AM	
L6794156-81	CC-01-04	05/05/17 10:35pm	FECAL COLIFORM-MF	SM 9222D	15000 E	05/06/17 12:50AM	
L6794156-82	CC-02-04	05/05/17 10:20pm	ENTEROCOCCUS-MF 24	EPA 1600	38000	05/06/17 01:05AM	
L6794156-82	CC-02-04	05/05/17 10:20pm	E. COLI-MF (1603)	EPA 1603	8000 E	05/06/17 12:40AM	
L6794156-82	CC-02-04	05/05/17 10:20pm	FECAL COLIFORM-MF	SM 9222D	29000	05/06/17 12:50AM	
L6794156-83	CC-03-04	05/05/17 09:30pm	ENTEROCOCCUS-MF 24	EPA 1600	24000	05/06/17 01:05AM	
L6794156-83	CC-03-04	05/05/17 09:30pm	E. COLI-MF (1603)	EPA 1603	11000 E	05/06/17 12:40AM	
L6794156-83	CC-03-04	05/05/17 09:30pm	FECAL COLIFORM-MF	SM 9222D	11000 E	05/06/17 12:50AM	
L6794156-84	RC-01-04	05/05/17 10:05pm	ENTEROCOCCUS-MF 24	EPA 1600	28000	05/06/17 01:05AM	
L6794156-84	RC-01-04	05/05/17 10:05pm	E. COLI-MF (1603)	EPA 1603	9000 E	05/06/17 12:40AM	
L6794156-84	RC-01-04	05/05/17 10:05pm	FECAL COLIFORM-MF	SM 9222D	12000 E	05/06/17 12:50AM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6794156-85	RC-02-04	05/05/17 09:50pm	ENTEROCOCCUS-MF 24	EPA 1600	17000 E	05/06/17 01:05AM	
L6794156-85	RC-02-04	05/05/17 09:50pm	E. COLI-MF (1603)	EPA 1603	16000 E	05/06/17 12:40AM	
L6794156-85	RC-02-04	05/05/17 09:50pm	FECAL COLIFORM-MF	SM 9222D	25000	05/06/17 12:50AM	
L6794156-86	RC-03-04	05/05/17 09:40pm	ENTEROCOCCUS-MF 24	EPA 1600	31000	05/06/17 01:05AM	
L6794156-86	RC-03-04	05/05/17 09:40pm	E. COLI-MF (1603)	EPA 1603	6100 E	05/06/17 12:40AM	
L6794156-86	RC-03-04	05/05/17 09:40pm	FECAL COLIFORM-MF	SM 9222D	47000	05/06/17 12:50AM	
L6794156-87	DR-03-06 (LAND)	05/05/17 08:35pm	ENTEROCOCCUS-MF 24	EPA 1600	28000	05/06/17 01:05AM	
L6794156-87	DR-03-06 (LAND)	05/05/17 08:35pm	E. COLI-MF (1603)	EPA 1603	6700 E	05/06/17 12:40AM	
L6794156-87	DR-03-06 (LAND)	05/05/17 08:35pm	FECAL COLIFORM-MF	SM 9222D	18000 E	05/06/17 12:50AM	
L6794156-88	DR-04-06 (LAND)	05/05/17 08:50pm	ENTEROCOCCUS-MF 24	EPA 1600	24000	05/06/17 01:05AM	
L6794156-88	DR-04-06 (LAND)	05/05/17 08:50pm	E. COLI-MF (1603)	EPA 1603	5700	05/06/17 12:40AM	
L6794156-88	DR-04-06 (LAND)	05/05/17 08:50pm	FECAL COLIFORM-MF	SM 9222D	32000	05/06/17 12:50AM	
L6794156-89	DR-03-08 (LAND)	05/06/17 02:00am	ENTEROCOCCUS-MF 24	EPA 1600	4700	05/06/17 09:18AM	
L6794156-89	DR-03-08 (LAND)	05/06/17 02:00am	E. COLI-MF (1603)	EPA 1603	2000	05/06/17 09:48AM	
L6794156-89	DR-03-08 (LAND)	05/06/17 02:00am	FECAL COLIFORM-MF	SM 9222D	2800	05/06/17 09:44AM	
L6794156-90	DR-04-08 (LAND)	05/06/17 02:15am	ENTEROCOCCUS-MF 24	EPA 1600	6100 E	05/06/17 09:18AM	
L6794156-90	DR-04-08 (LAND)	05/06/17 02:15am	E. COLI-MF (1603)	EPA 1603	2100	05/06/17 09:48AM	
L6794156-90	DR-04-08 (LAND)	05/06/17 02:15am	FECAL COLIFORM-MF	SM 9222D	3900	05/06/17 09:44AM	
L6794156-91	RC-01-05	05/06/17 05:05am	ENTEROCOCCUS-MF 24	EPA 1600	22000	05/06/17 09:18AM	
L6794156-91	RC-01-05	05/06/17 05:05am	E. COLI-MF (1603)	EPA 1603	8000	05/06/17 09:48AM	
L6794156-91	RC-01-05	05/06/17 05:05am	FECAL COLIFORM-MF	SM 9222D	5600	05/06/17 09:44AM	
L6794156-92	RC-02-05	05/06/17 04:50am	ENTEROCOCCUS-MF 24	EPA 1600	3400	05/06/17 09:18AM	
L6794156-92	RC-02-05	05/06/17 04:50am	E. COLI-MF (1603)	EPA 1603	5800	05/06/17 09:48AM	
L6794156-92	RC-02-05	05/06/17 04:50am	FECAL COLIFORM-MF	SM 9222D	4000	05/06/17 09:44AM	
L6794156-93	RC-03-05	05/06/17 04:30am	ENTEROCOCCUS-MF 24	EPA 1600	15000 E	05/06/17 09:18AM	
L6794156-93	RC-03-05	05/06/17 04:30am	E. COLI-MF (1603)	EPA 1603	6500	05/06/17 09:48AM	
L6794156-93	RC-03-05	05/06/17 04:30am	FECAL COLIFORM-MF	SM 9222D	6400	05/06/17 09:44AM	
L6794156-94	CC-01-05	05/06/17 05:30am	ENTEROCOCCUS-MF 24	EPA 1600	26000	05/06/17 09:18AM	
L6794156-94	CC-01-05	05/06/17 05:30am	E. COLI-MF (1603)	EPA 1603	5500	05/06/17 09:48AM	
L6794156-94	CC-01-05	05/06/17 05:30am	FECAL COLIFORM-MF	SM 9222D	3200	05/06/17 09:44AM	
L6794156-95	CC-02-05	05/06/17 05:15am	ENTEROCOCCUS-MF 24	EPA 1600	22000	05/06/17 09:18AM	
L6794156-95	CC-02-05	05/06/17 05:15am	E. COLI-MF (1603)	EPA 1603	7900	05/06/17 09:48AM	
L6794156-95	CC-02-05	05/06/17 05:15am	FECAL COLIFORM-MF	SM 9222D	21000	05/06/17 09:44AM	
L6794156-96	CC-03-05	05/06/17 04:20am	ENTEROCOCCUS-MF 24	EPA 1600	35000	05/06/17 09:18AM	
L6794156-96	CC-03-05	05/06/17 04:20am	E. COLI-MF (1603)	EPA 1603	14000 E	05/06/17 09:48AM	
L6794156-96	CC-03-05	05/06/17 04:20am	FECAL COLIFORM-MF	SM 9222D	4400	05/06/17 09:44AM	
L6794156-97	DR-03-09 (LAND)	05/06/17 04:00am	ENTEROCOCCUS-MF 24	EPA 1600	5000	05/06/17 09:18AM	
L6794156-97	DR-03-09 (LAND)	05/06/17 04:00am	E. COLI-MF (1603)	EPA 1603	1500 E	05/06/17 09:48AM	
L6794156-97	DR-03-09 (LAND)	05/06/17 04:00am	FECAL COLIFORM-MF	SM 9222D	2000	05/06/17 09:44AM	
L6794156-98	DR-04-09 (LAND)	05/06/17 04:10am	ENTEROCOCCUS-MF 24	EPA 1600	5000	05/06/17 09:18AM	
L6794156-98	DR-04-09 (LAND)	05/06/17 04:10am	E. COLI-MF (1603)	EPA 1603	1200 E	05/06/17 09:48AM	
L6794156-98	DR-04-09 (LAND)	05/06/17 04:10am	FECAL COLIFORM-MF	SM 9222D	2100	05/06/17 09:44AM	
L6794156-99	DUP-DR	05/06/17 00:00am	ENTEROCOCCUS-MF 24	EPA 1600	4300 Q	05/06/17 09:18AM	
L6794156-99	DUP-DR	05/06/17 00:00am	E. COLI-MF (1603)	EPA 1603	3300 Q	05/06/17 09:48AM	
L6794156-99	DUP-DR	05/06/17 00:00am	FECAL COLIFORM-MF	SM 9222D	13000 E, Q	05/06/17 09:44AM	
L6794156-100	DR-04-10 (LAND)	05/06/17 06:10am	ENTEROCOCCUS-MF 24	EPA 1600	5500	05/06/17 09:18AM	
L6794156-100	DR-04-10 (LAND)	05/06/17 06:10am	E. COLI-MF (1603)	EPA 1603	2300	05/06/17 09:48AM	
L6794156-100	DR-04-10 (LAND)	05/06/17 06:10am	FECAL COLIFORM-MF	SM 9222D	23000	05/06/17 09:44AM	
L6794156-101	DR-03-10 (LAND)	05/06/17 06:00am	ENTEROCOCCUS-MF 24	EPA 1600	3700	05/06/17 09:18AM	
L6794156-101	DR-03-10 (LAND)	05/06/17 06:00am	E. COLI-MF (1603)	EPA 1603	1700 E	05/06/17 09:48AM	
L6794156-101	DR-03-10 (LAND)	05/06/17 06:00am	FECAL COLIFORM-MF	SM 9222D	3300	05/06/17 09:44AM	

APPENDIX F

WET WEATHER EVENT 3 – FIELD LOGS AND LAB RESULTS SUMMARY

(Chain of Custody Forms and Complete Lab Results provided in digital form only on CD attached to this report)

WET WEATHER EVENT: 3

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Water Salinity Reading (%)	Water Temperature Reading (°C)	Conductivity Reading (umhos/cm)	Field Observations (see notes, below)
IN-STREAM TRIBUTARY STATION: CC-01													
DATE: *5/22/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**													
START OF RAINFALL TIME: *10:30*													
1	0.5-2.5	10:30	11:42	N	N/A	N	N/A	Y	12:28	0.27	16.18	465	Raining
2	4.5-6.5	14:30	15:40	N	N/A	N	N/A	Y	17:48	0.26	16.21	439	Raining
3	8.5-10.5	18:30	18:46	N	N/A	N	N/A	Y	19:50	0.27	16.36	462	Raining
4	14.5-16.5	0:30	2:17	N	N/A	N	N/A	Y	3:52	0.28	16.13	483	Raining
5	22-24	8:30	10:20	N	N/A	N	N/A	Y	10:45	0.28	15.88	479	Raining
IN-STREAM TRIBUTARY STATION: CC-02													
1	0.5-2.5	10:30	12:00	N	N/A	N	N/A	Y	12:28	0.3	16.85	520	Raining
2	4.5-6.5	14:30	15:50	Y	15:50	N	N/A	Y	17:48	0.126	16.67	450	Raining
3	8.5-10.5	18:30	19:00	N	N/A	N	N/A	Y	19:50	0.26	16.81	454	Raining
4	14.5-16.5	0:30	2:05	N	N/A	N	N/A	Y	3:52	0.27	16.36	467	Raining
5	22-24	8:30	10:05	N	N/A	N	N/A	Y	10:45	0.23	16.65	395	Raining
IN-STREAM TRIBUTARY STATION: CC-03													
1	0.5-2.5	10:30	10:42	N	N/A	N	N/A	Y	12:28	0.13	17.66	233.0	Raining
2	4.5-6.5	14:30	14:40	N	N/A	N	N/A	Y	17:48	0.29	16.69	497.0	Raining
3	8.5-10.5	18:30	18:00	N	N/A	N	N/A	Y	19:50	0.27	16.73	465.0	Raining
4	14.5-16.5	0:30	1:05	N	N/A	N	N/A	Y	3:52	0.20	17.33	352.0	Raining
5	22-24	8:30	9:05	N	N/A	N	N/A	Y	10:45	0.13	17.58	244.0	Raining
IN-STREAM TRIBUTARY STATION: RC-01													
1	0.5-2.5	10:30	11:26	N	N/A	N	N/A	Y	12:28	0.18	16.43	307.0	Raining
2	4.5-6.5	14:30	15:18	N	N/A	N	N/A	Y	17:48	0.19	16.46	336.0	Raining
3	8.5-10.5	18:30	18:40	N	N/A	N	N/A	Y	19:50	0.22	16.49	375.0	Raining
4	14.5-16.5	0:30	1:52	N	N/A	N	N/A	Y	3:52	0.22	16.13	373.0	Raining
5	22-24	8:30	9:50	N	N/A	N	N/A	Y	10:45	0.21	15.90	367.0	Raining
IN-STREAM TRIBUTARY STATION: RC-02													
1	0.5-2.5	10:30	11:10	N	N/A	N	N/A	Y	12:28	0.23	16.09	398.0	Raining
2	4.5-6.5	14:30	15:05	N	N/A	N	N/A	Y	17:48	0.20	16.35	353.0	Raining
3	8.5-10.5	18:30	18:18	N	N/A	N	N/A	Y	19:50	0.20	16.68	345.0	Raining
4	14.5-16.5	0:30	1:35	N	N/A	N	N/A	Y	3:52	0.23	16.38	393.0	Raining
5	22-24	8:30	9:35	N	N/A	N	N/A	Y	10:45	0.23	15.85	384.0	Raining
IN-STREAM TRIBUTARY STATION: RC-03													
1	0.5-2.5	10:30	11:00	N	N/A	N	N/A	Y	12:28	0.13	17.57	226.0	Used Bailer to collect sample
2	4.5-6.5	14:30	14:50	Y	14:50	N	N/A	Y	17:48	0.22	16.27	371.0	Used Bailer to collect sample
3	8.5-10.5	18:30	18:12	N	N/A	N	N/A	Y	19:50	0.20	16.72	357.0	Used Bailer to collect sample
4	14.5-16.5	0:30	1:20	N	N/A	N	N/A	Y	3:52	0.19	16.91	332.0	Used Bailer to collect sample
5	22-24	8:30	9:22	N	N/A	N	N/A	Y	10:45	0.13	17.61	229.0	Used Bailer to collect sample

WET WEATHER EVENT: 3
DELAWARE RIVER STATION: DR-01

DATE: *5/22/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**
START OF RAINFALL TIME: *10:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (%)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	9:30	9:25	N	N/A	N	N/A	Y	10:38	-	17.8/17.8/17.8	205/205/205	TOTAL DEPTH = 27 FEET
2	2	11:30	11:10	N	N/A	Y	11:05	Y	12:28	-	17.83/17.83/17.84	205/204/205	TOTAL DEPTH = 25 FEET
3	4	13:30	13:15	Y	13:15	N	N/A	Y	15:35	-	17.82/17.81/17.81	207/207/206	TOTAL DEPTH = 25 FEET
4	6	15:30	15:15	N	N/A	N	N/A	Y	17:40	0.19/0.19/0.19	15.80/15.79/15.79	318/318/319	TOTAL DEPTH = 24.7 FEET
5	9	18:30	18:15	N	N/A	N	N/A	Y	19:30	0.19/0.19/0.19	15.82/15.81/15.81	327/326/326	TOTAL DEPTH = 23.26 FEET
6	12	21:30	21:15	N	N/A	N	N/A	Y	22:15	0.19/0.19/0.19	15.85/15.87/15.88	320/322/323	TOTAL DEPTH = 28 FEET
7	15	0:30	0:05	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	15.90/15.90/15.90	309/310/310	TOTAL DEPTH = 27 FEET
8	18	3:30	3:00	N	N/A	N	N/A	Y	5:35	0.18/0.18/0.18	15.72/15.73/15.73	308/308/308	TOTAL DEPTH = 25 FEET
9	21	6:30	6:00	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.68/15.68/15.68	299/303/307	TOTAL DEPTH = 23 FEET
10	24	9:30	9:00	N	N/A	N	N/A	Y	10:45	0.16/0.17/0.17	15.69/15.69/15.68	281/284/287	TOTAL DEPTH = 26 FEET
DELAWARE RIVER STATION: DR-02													
1	0	9:30	9:30	N	N/A	N	N/A	Y	10:38	-	17.85/17.85/17.85	209/206/206	TOTAL DEPTH = 37 FEET
2	2	11:30	11:15	N	N/A	N	N/A	Y	12:28	-	17.87/17.87/17.87	203/204/207	TOTAL DEPTH = 35 FEET
3	4	13:30	13:20	N	N/A	N	N/A	Y	15:35	-	17.79/17.80/17.80	210/210/210	TOTAL DEPTH = 30 FEET
4	6	15:30	15:20	N	N/A	N	N/A	Y	17:40	0.18/0.18/0.18	15.73/15.74/15.75	309/311/312	TOTAL DEPTH = 36 FEET
5	9	18:30	18:20	N	N/A	N	N/A	Y	19:30	0.18/0.18/0.18	15.74/15.76/15.76	314/314/314	TOTAL DEPTH = 33 FEET
6	12	21:30	21:25	Y	21:25	N	N/A	Y	22:15	0.19/0.19/0.19	15.92/15.92/15.93	322/322/322	TOTAL DEPTH = 28 FEET
7	15	0:30	0:20	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	15.93/15.93/15.93	313/313/313	TOTAL DEPTH = 40 FEET
8	18	3:30	3:15	N	N/A	N	N/A	Y	5:35	0.18/0.18/0.18	15.77/15.78/15.78	310/312/315	TOTAL DEPTH = 31 FEET
9	21	6:30	6:13	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.70/15.70/15.70	314/315/313	TOTAL DEPTH = 34 FEET
10	24	9:30	9:12	N	N/A	N	N/A	Y	10:45	0.17/0.17/0.17	15.79/15.79/15.79	295/297/300	TOTAL DEPTH = 38 FEET
DELAWARE RIVER STATION: DR-03													
1	0	9:30	9:35	N	N/A	N	N/A	Y	10:38	-	17.91/17.91/17.91	213/212/212	TOTAL DEPTH = 20 FEET
2	2	11:30	11:20	N	N/A	N	N/A	Y	12:28	-	17.86/17.91/17.91	206/207/207	TOTAL DEPTH = 20 FEET
3	4	13:30	13:30	N	N/A	N	N/A	Y	15:35	-	17.83/17.84/17.84	207/207/207	TOTAL DEPTH = 22 FEET
4	6	15:30	15:25	N	N/A	N	N/A	Y	17:40	0.19/0.19/0.19	15.75/15.80/15.82	319/328/320	TOTAL DEPTH = 13.3 FEET
5	9	18:30	18:25	N	N/A	N	N/A	Y	19:30	0.19/0.20/0.21	15.79/15.79/15.79	341/353/353	TOTAL DEPTH = 11.5 FEET
6	12	21:30	21:30	N	N/A	N	N/A	Y	22:15	0.19/0.19/0.19	15.97/15.98/15.98	325/323/323	TOTAL DEPTH = 19 FEET
7	15	0:30	0:34	N	N/A	N	N/A	Y	3:52	0.18/0.19/0.19	15.99/15.99/15.98	317/318/320	TOTAL DEPTH = 23 FEET
8	18	3:30	3:25	N	N/A	N	N/A	Y	5:35	0.18/0.19/0.19	15.78/15.78/15.78	316/317/318	TOTAL DEPTH = 22 FEET
9	21	6:30	6:26	N	N/A	N	N/A	Y	10:45	0.19/0.19/0.19	15.69/15.69/15.69	319/320/323	TOTAL DEPTH = 20 FEET
10	24	9:30	9:24	N	N/A	N	N/A	Y	10:45	0.18/0.19/0.19	15.75/15.75/15.73	314/316/319	TOTAL DEPTH = 21 FEET
DELAWARE RIVER STATION: DR-04													
1	0	9:30	9:05	N	N/A	N	N/A	Y	10:38	0.18/0.18/0.18	15.97/15.95/15.95	306/308/309	TOTAL DEPTH = 14 FEET
2	2	11:30	11:00	N	N/A	N	N/A	Y	12:28	0.19/0.19/0.19	16.08/16.09/16.10	320/322/324	TOTAL DEPTH = 11 FEET
3	4	13:30	13:05	N	N/A	N	N/A	Y	15:35	0.18/0.18/0.18	15.91/15.92/15.92	311/312/312	TOTAL DEPTH = 8.5 FEET
4	6	15:30	15:30	N	N/A	N	N/A	Y	17:40	0.19/0.19/0.19	15.78/15.88/15.85	328/328/328	TOTAL DEPTH = 10 FEET
5	9	18:30	18:30	N	N/A	N	N/A	Y	19:30	0.19/0.19/0.19	15.81/15.82/15.83	327/327/328	TOTAL DEPTH = 9.3 FEET
6	12	21:30	21:40	N	N/A	N	N/A	Y	22:15	0.19/0.19/0.19	16.17/16.17/16.18	327/329/329	TOTAL DEPTH = 11.4 FEET
7	15	0:30	0:48	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	16.02/16.02/16.01	313/313/313	TOTAL DEPTH = 19 FEET
8	18	3:30	3:37	N	N/A	N	N/A	Y	5:35	0.19/0.19/0.19	15.80/15.82/15.82	320/322/322	TOTAL DEPTH = 26 FEET
9	21	6:30	6:38	N	N/A	N	N/A	Y	10:45	0.19/0.19/0.19	15.66/15.66/15.67	329/331/331	TOTAL DEPTH = 24 FEET
10	24	9:30	9:40	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.87/15.86/15.86	301/302/303	TOTAL DEPTH = 22 FEET

WET WEATHER EVENT: 3
DELAWARE RIVER STATION: DR-05

DATE: *5/22/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *10:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Surface, Mid-depth & Bottom Water Salinity Reading(s) (%)	Surface, Mid-depth & Bottom Water Temperature Reading(s) (°C)	Surface, Mid-depth & Bottom Water Conductivity Reading(s) (umhos/cm)	Field Observations (see notes, below)
1	0	9:30	9:30	N	N/A	N	N/A	Y	10:38	0.18/0.18/0.18	16.15/16.15/16.10	312/317/318	TOTAL DEPTH = 9 FEET
2	2	11:30	11:20	N	N/A	N	N/A	Y	12:28	0.22/0.22/0.18	16.69/16.43/16.23	383/380/317	TOTAL DEPTH = 10 FEET
3	4	13:30	13:30	N	N/A	N	N/A	Y	15:35	0.18/0.18/0.18	15.94/15.94/15.94	307/308/310	TOTAL DEPTH = 11.6 FEET
4	6	15:30	15:35	N	N/A	N	N/A	Y	17:40	0.24/0.20/0.20	16.56/16.25/16.08	383/341/343	TOTAL DEPTH = 9.2 FEET
5	9	18:30	18:35	N	N/A	N	N/A	Y	19:30	0.19/0.19/0.19	16.84/16.40/16.39	334/340/343	TOTAL DEPTH = 11.3 FEET
6	12	21:30	21:45	N	N/A	N	N/A	Y	22:15	0.19/0.19/0.19	16.15/16.19/16.19	323/319/319	TOTAL DEPTH = 12.2 FEET
7	15	0:30	1:02	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	16.04/16.04/16.03	313/313/313	TOTAL DEPTH = 16 FEET
8	18	3:30	3:50	N	N/A	N	N/A	Y	5:35	0.18/0.19/0.19	15.85/15.86/15.86	316/320/320	TOTAL DEPTH = 11 FEET
9	21	6:30	6:52	N	N/A	N	N/A	Y	10:45	0.20/0.20/0.19	16.33/15.88/15.75	345/335/325	TOTAL DEPTH = 10 FEET
10	24	9:30	9:53	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.97/15.97/15.97	309/310/311	TOTAL DEPTH = 10 FEET
DELAWARE RIVER STATION: DR-06													
1	0	9:30	9:10	N	N/A	N	N/A	Y	10:38	0.17/0.17/0.18	15.81/15.84/15.85	295/300/300	TOTAL DEPTH = 28 FEET
2	2	11:30	11:05	N	N/A	N	N/A	Y	12:28	0.18/0.18/0.18	15.88/15.88/15.88	301/302/303	TOTAL DEPTH = 29 FEET
3	4	13:30	13:12	N	N/A	N	N/A	Y	15:35	0.17/0.17/0.17	15.82/15.84/15.85	298/299/299	TOTAL DEPTH = 25.1 FEET
4	6	15:30	14:55	N	N/A	N	N/A	Y	17:40	0.17/0.18/0.18	15.82/15.85/15.86	299/301/302	TOTAL DEPTH = 23.5 FEET
5	9	18:30	17:55	N	N/A	N	N/A	Y	19:30	0.17/0.17/0.17	15.73/15.71/15.70	293/294/294	TOTAL DEPTH = 24 FEET
6	12	21:30	20:55	N	N/A	N	N/A	Y	22:15	0.17/0.17/0.17	15.84/15.85/15.85	298/299/299	TOTAL DEPTH = 27 FEET
7	15	0:30	1:15	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	15.92/15.91/15.91	303/303/303	TOTAL DEPTH = 24 FEET
8	18	3:30	4:03	N	N/A	N	N/A	Y	5:35	0.18/0.18/0.18	15.77/15.78/15.78	300/302/302	TOTAL DEPTH = 20 FEET
9	21	6:30	7:05	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.72/15.72/15.72	299/300/301	TOTAL DEPTH = 24 FEET
10	24	9:30	10:05	N	N/A	N	N/A	Y	10:45	0.17/0.17/0.17	15.80/15.80/15.80	288/291/293	TOTAL DEPTH = 25 FEET
DELAWARE RIVER STATION: DR-07													
1	0	9:30	9:15	N	N/A	N	N/A	Y	10:38	0.18/0.18/0.18	15.77/15.77/15.77	300/300/300	TOTAL DEPTH = 5.5 FEET
2	2	11:30	11:10	N	N/A	N	N/A	Y	12:28	0.17/0.17/0.17	15.78/15.78/15.78	297/297/298	TOTAL DEPTH = 5 FEET
3	4	13:30	13:20	N	N/A	N	N/A	Y	15:35	0.17/0.17/0.17	15.77/15.77/15.77	299/299/299	TOTAL DEPTH = 4.1 FEET
4	6	15:30	15:00	N	N/A	N	N/A	Y	17:40	0.18/0.18/0.18	16.01/16.01/15.99	304/304/304	TOTAL DEPTH = 2.7 FEET
5	9	18:30	18:00	N	N/A	N	N/A	Y	19:30	0.18/0.18/0.18	15.89/15.89/15.89	300/300/300	TOTAL DEPTH = 1.5 FEET
6	12	21:30	21:00	N	N/A	N	N/A	Y	22:15	0.18/0.18/0.18	15.89/15.89/15.91	303/303/303	TOTAL DEPTH = 5 FEET
7	15	0:30	1:33	N	N/A	N	N/A	Y	3:52	0.18/0.18/0.18	15.94/15.93/15.93	303/303/303	TOTAL DEPTH = 6 FEET
8	18	3:30	4:16	N	N/A	N	N/A	Y	5:35	0.18/0.18/0.18	15.92/15.92/15.91	306/306/307	TOTAL DEPTH = 5 FEET
9	21	6:30	7:20	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.68/15.67/15.67	301/301/302	TOTAL DEPTH = 5 FEET
10	24	9:30	10:17	N	N/A	N	N/A	Y	10:45	0.18/0.18/0.18	15.76/15.76/15.76	295/297/297	TOTAL DEPTH = 8 FEET

WET WEATHER EVENT: 3
CSO STATION: CSO-02

DATE: *5/22/2017* **Note Temperature of Receiving Stream if below 10 °C threshhold**

START OF RAINFALL TIME: *10:30*

Sampling Round	Sample Interval from Start of Rainfall (Hours)	Target Sample Collection Time (hh:mm)	Actual Sample Collection Time (hh:mm)	Duplicate Sample Collected? (Y/N)	Duplicate Collection Time (hh:mm)	Field Blank Sample Collected? (Y/N)	Field Blank Collection Time (hh:mm)	Chain of Custody Provided & Completed (Y/N)	Time Sample Transferred to Lab Courier (hh:mm)	Filed Observations (see notes, below)
1	T=0 (First Flush)	10:25	10:30	N	N/A	Y	10:31	Y	12:28	
2	30 Min	10:55	11:00	N	N/A	N	N/A	Y	12:28	
3	60 Min	11:25	11:30	N	N/A	N	N/A	Y	12:28	
4	2 Hours	0:25	0:40	N	N/A	N	N/A	Y	15:35	
5	4 Hours	14:25	-	-	-	-	-	-		NO OVERFLOW
6	8 Hours	18:25	-	-	-	-	-	-		NO OVERFLOW
7	12 Hours	22:25	-	-	-	-	-	-		NO OVERFLOW
8	24 Hours	10:25	-	-	-	-	-	-		NO OVERFLOW
CSO STATION: CSO-05										
1	T=0 (First Flush)	10:25	10:25	N	N/A	N	N/A	Y	12:28	
2	30 Min	10:55	11:05	N	N/A	N	N/A	Y	12:28	
3	60 Min	11:25	11:35	N	N/A	N	N/A	Y	12:28	
4	2 Hours	0:25	0:35	N	N/A	N	N/A	Y	15:35	
5	4 Hours	14:25	14:35	N	N/A	N	N/A	Y	15:35	
6	8 Hours	18:25	-	-	-	-	-	-		NO OVERFLOW
7	12 Hours	22:25	-	-	-	-	-	-		NO OVERFLOW
8	24 Hours	10:25	-	-	-	-	-	-		NO OVERFLOW
CSO STATION: CSO-18										
1	T=0 (First Flush)	10:45	10:45	N	N/A	N	N/A	Y	12:28	
2	30 Min	11:15	11:15	N	N/A	N	N/A	Y	12:28	
3	60 Min	11:45	0:05	N	N/A	Y	0:00	Y	12:28	
4	2 Hours	0:45	0:45	N	N/A	N	N/A	Y	15:35	
5	4 Hours	14:45	-	-	-	-	-	-		NO OVERFLOW at 14:45
6	8 Hours	18:45	-	-	-	-	-	-		NO OVERFLOW at 18:45
7	12 Hours	22:45	-	-	-	-	-	-		NO OVERFLOW at 22:45
8	24 Hours	10:45	-	-	-	-	-	-		NO OVERFLOW at 10:45
CSO STATION: CSO-19										
1	T=0 (First Flush)	10:45	11:00	N	N/A	N	N/A	Y	12:28	
2	30 Min	11:15	-	-	-	-	-	-		NO OVERFLOW at 11:25
3	60 Min	11:45	-	-	-	-	-	-		NO OVERFLOW at 12:15
4	2 Hours	0:45	0:55	Y	0:55	N	N/A	Y	15:35	
5	4 Hours	14:45	-	-	-	-	-	-		NO OVERFLOW at 14:45
6	8 Hours	18:45	-	-	-	-	-	-		NO OVERFLOW at 18:45
7	12 Hours	22:45	-	-	-	-	-	-		NO OVERFLOW at 22:45
8	24 Hours	10:45	-	-	-	-	-	-		NO OVERFLOW at 10:45

WET WEATHER EVENT: 3 **STORM WATER STATION: SW-05A**										
DATE: *5/22/2017*			**Note Temperature of Receiving Stream if below 10 °C threshhold**							
START OF RAINFALL TIME: *10:30*										
Sampling Round	**Sample Interval from Start of Rainfall (Hours)**	**Target Sample Collection Time (hh:mm)**	**Actual Sample Collection Time (hh:mm)**	**Duplicate Sample Collected? (Y/N)**	**Duplicate Collection Time (hh:mm)**	**Field Blank Sample Collected? (Y/N)**	**Field Blank Collection Time (hh:mm)**	**Chain of Custody Provided & Completed (Y/N)**	**Time Sample Transferred to Lab Courier (hh:mm)**	**Filed Observations (see notes, below)**
1	T=0 (First Flush)	10:30	10:40					Y	12:28	
2	30 Min	11:00	11:10					Y	12:28	
3	60 Min	11:30	11:40					Y	12:28	
4	2 Hours	0:30	0:40					Y	15:35	
5	4 Hours	14:30	14:40					Y	15:35	
6	8 Hours	18:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE
7	12 Hours	22:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE
8	24 Hours	10:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE
STORM WATER STATION: SW-SS2										
1	T=0 (First Flush)	10:30	10:30					Y	12:28	
2	30 Min	11:00	11:00					Y	12:28	
3	60 Min	11:30	11:30					Y	12:28	
4	2 Hours	0:30	0:30					Y	15:35	
5	4 Hours	14:30	14:30					Y	15:35	
6	8 Hours	18:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE
7	12 Hours	22:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE
8	24 Hours	10:30	-					-	-	NO FLOW OR VERY LESS FLOW TO SAMPLE

Login Number	Sample ID	Sample Date/Time	Parameter Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	Tech Initials
L6810904-1	DR-01-1	05/22/17 09:20am	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/22/17 05:05PM	
L6810904-1	DR-01-1	05/22/17 09:20am	E. COLI-MF (1603)	EPA 1603	12E	05/22/17 05:04PM	
L6810904-1	DR-01-1	05/22/17 09:20am	FECAL COLIFORM-MF	SM 9222D	24E	05/22/17 05:04PM	
L6810904-2	DR-02-1	05/22/17 09:35am	ENTEROCOCCUS-MF 24	EPA 1600	14E	05/22/17 05:05PM	
L6810904-2	DR-02-1	05/22/17 09:35am	E. COLI-MF (1603)	EPA 1603	8E	05/22/17 05:04PM	
L6810904-2	DR-02-1	05/22/17 09:35am	FECAL COLIFORM-MF	SM 9222D	40	05/22/17 05:04PM	
L6810904-3	DR-03-1	05/22/17 09:50am	ENTEROCOCCUS-MF 24	EPA 1600	20E	05/22/17 05:05PM	
L6810904-3	DR-03-1	05/22/17 09:50am	E. COLI-MF (1603)	EPA 1603	12E	05/22/17 05:04PM	
L6810904-3	DR-03-1	05/22/17 09:50am	FECAL COLIFORM-MF	SM 9222D	32E	05/22/17 05:04PM	
L6810904-4	DR-04-1	05/22/17 09:05am	ENTEROCOCCUS-MF 24	EPA 1600	6E	05/22/17 05:05PM	
L6810904-4	DR-04-1	05/22/17 09:05am	E. COLI-MF (1603)	EPA 1603	3 E	05/22/17 05:04PM	
L6810904-4	DR-04-1	05/22/17 09:05am	FECAL COLIFORM-MF	SM 9222D	22	05/22/17 05:04PM	
L6810904-5	DR-05-1	05/22/17 09:30am	ENTEROCOCCUS-MF 24	EPA 1600	12E	05/22/17 05:05PM	
L6810904-5	DR-05-1	05/22/17 09:30am	E. COLI-MF (1603)	EPA 1603	6E	05/22/17 05:04PM	
L6810904-5	DR-05-1	05/22/17 09:30am	FECAL COLIFORM-MF	SM 9222D	12E	05/22/17 05:04PM	
L6810904-6	DR-06-1	05/22/17 09:10am	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/22/17 05:05PM	
L6810904-6	DR-06-1	05/22/17 09:10am	E. COLI-MF (1603)	EPA 1603	6E	05/22/17 05:04PM	
L6810904-6	DR-06-1	05/22/17 09:10am	FECAL COLIFORM-MF	SM 9222D	6E	05/22/17 05:04PM	
L6810904-7	DR-07-1	05/22/17 09:15am	ENTEROCOCCUS-MF 24	EPA 1600	6E	05/22/17 05:05PM	
L6810904-7	DR-07-1	05/22/17 09:15am	E. COLI-MF (1603)	EPA 1603	10E	05/22/17 05:04PM	
L6810904-7	DR-07-1	05/22/17 09:15am	FECAL COLIFORM-MF	SM 9222D	12E	05/22/17 05:04PM	
L6810904-8	BLANK 03	05/22/17 09:05am	ENTEROCOCCUS-MF 24	EPA 1600	<2	05/22/17 05:05PM	
L6810904-8	BLANK 03	05/22/17 09:05am	E. COLI-MF (1603)	EPA 1603	<2	05/22/17 05:04PM	
L6810904-8	BLANK 03	05/22/17 09:05am	FECAL COLIFORM-MF	SM 9222D	<2	05/22/17 05:04PM	
L6810904-9	CSO-05-1	05/22/17 10:25am	ENTEROCOCCUS-MF 24	EPA 1600	476000E	05/22/17 06:24PM	
L6810904-9	CSO-05-1	05/22/17 10:25am	E. COLI-MF (1603)	EPA 1603	920000E	05/22/17 06:21PM	
L6810904-9	CSO-05-1	05/22/17 10:25am	FECAL COLIFORM-MF	SM 9222D	1080000E	05/22/17 06:23PM	
L6810904-10	CSO-02-1	05/22/17 10:30am	ENTEROCOCCUS-MF 24	EPA 1600	558000E	05/22/17 06:24PM	
L6810904-10	CSO-02-1	05/22/17 10:30am	E. COLI-MF (1603)	EPA 1603	730000E	05/22/17 06:21PM	
L6810904-10	CSO-02-1	05/22/17 10:30am	FECAL COLIFORM-MF	SM 9222D	170000E	05/22/17 06:23PM	
L6810904-11	BLANK 04	05/22/17 10:31am	ENTEROCOCCUS-MF 24	EPA 1600	<10	05/22/17 06:24PM	
L6810904-11	BLANK 04	05/22/17 10:31am	E. COLI-MF (1603)	EPA 1603	<10	05/22/17 06:21PM	
L6810904-11	BLANK 04	05/22/17 10:31am	FECAL COLIFORM-MF	SM 9222D	<10	05/22/17 06:23PM	
L6810904-12	SW-SS2-1	05/22/17 10:31am	ENTEROCOCCUS-MF 24	EPA 1600	505000E	05/22/17 06:24PM	
L6810904-12	SW-SS2-1	05/22/17 10:31am	E. COLI-MF (1603)	EPA 1603	49000	05/22/17 06:21PM	
L6810904-12	SW-SS2-1	05/22/17 10:31am	FECAL COLIFORM-MF	SM 9222D	21000	05/22/17 06:23PM	
L6810904-13	SW-05A-1	05/22/17 10:40am	ENTEROCOCCUS-MF 24	EPA 1600	82000E	05/22/17 06:24PM	
L6810904-13	SW-05A-1	05/22/17 10:40am	E. COLI-MF (1603)	EPA 1603	20000	05/22/17 06:21PM	
L6810904-13	SW-05A-1	05/22/17 10:40am	FECAL COLIFORM-MF	SM 9222D	35000	05/22/17 06:23PM	
L6810904-14	SW-SS2-2	05/22/17 11:00am	ENTEROCOCCUS-MF 24	EPA 1600	177000E	05/22/17 06:24PM	
L6810904-14	SW-SS2-2	05/22/17 11:00am	E. COLI-MF (1603)	EPA 1603	21000	05/22/17 06:21PM	
L6810904-14	SW-SS2-2	05/22/17 11:00am	FECAL COLIFORM-MF	SM 9222D	19000E	05/22/17 06:23PM	
L6810904-15	SW-05A-2	05/22/17 11:10am	ENTEROCOCCUS-MF 24	EPA 1600	148000E	05/22/17 06:24PM	
L6810904-15	SW-05A-2	05/22/17 11:10am	E. COLI-MF (1603)	EPA 1603	20000	05/22/17 06:21PM	
L6810904-15	SW-05A-2	05/22/17 11:10am	FECAL COLIFORM-MF	SM 9222D	18000E	05/22/17 06:23PM	
L6810904-16	SW-05A-3	05/22/17 11:40am	ENTEROCOCCUS-MF 24	EPA 1600	129000E	05/22/17 06:24PM	
L6810904-16	SW-05A-3	05/22/17 11:40am	E. COLI-MF (1603)	EPA 1603	9000E	05/22/17 06:21PM	
L6810904-16	SW-05A-3	05/22/17 11:40am	FECAL COLIFORM-MF	SM 9222D	21000	05/22/17 06:23PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-17	SW-SS2-3	05/22/17 11:30am	ENTEROCOCCUS-MF 24	EPA 1600	185000E	05/22/17 06:24PM	
L6810904-17	SW-SS2-3	05/22/17 11:30am	E. COLI-MF (1603)	EPA 1603	32000	05/22/17 06:21PM	
L6810904-17	SW-SS2-3	05/22/17 11:30am	FECAL COLIFORM-MF	SM 9222D	23000	05/22/17 06:23PM	
L6810904-18	CC-03	05/22/17 10:42am	ENTEROCOCCUS-MF 24	EPA 1600	270	05/22/17 06:24PM	
L6810904-18	CC-03	05/22/17 10:42am	E. COLI-MF (1603)	EPA 1603	60E	05/22/17 06:21PM	
L6810904-18	CC-03	05/22/17 10:42am	FECAL COLIFORM-MF	SM 9222D	60E	05/22/17 06:23PM	
L6810904-19	RC-03	05/22/17 10:56am	ENTEROCOCCUS-MF 24	EPA 1600	20E	05/22/17 06:24PM	
L6810904-19	RC-03	05/22/17 10:56am	E. COLI-MF (1603)	EPA 1603	160E	05/22/17 06:21PM	
L6810904-19	RC-03	05/22/17 10:56am	FECAL COLIFORM-MF	SM 9222D	210	05/22/17 06:23PM	
L6810904-20	RC-02	05/22/17 11:07am	ENTEROCOCCUS-MF 24	EPA 1600	10000E	05/22/17 06:24PM	
L6810904-20	RC-02	05/22/17 11:07am	E. COLI-MF (1603)	EPA 1603	87000 E	05/22/17 06:54PM	
L6810904-20	RC-02	05/22/17 11:07am	FECAL COLIFORM-MF	SM 9222D	103000E	05/22/17 06:23PM	
L6810904-21	RC-01	05/22/17 11:23am	ENTEROCOCCUS-MF 24	EPA 1600	14000E	05/22/17 06:24PM	
L6810904-21	RC-01	05/22/17 11:23am	E. COLI-MF (1603)	EPA 1603	5300	05/22/17 06:21PM	
L6810904-21	RC-01	05/22/17 11:23am	FECAL COLIFORM-MF	SM 9222D	4200	05/22/17 06:23PM	
L6810904-22	CC-01	05/22/17 11:42am	ENTEROCOCCUS-MF 24	EPA 1600	14000E	05/22/17 06:24PM	
L6810904-22	CC-01	05/22/17 11:42am	E. COLI-MF (1603)	EPA 1603	1600E	05/22/17 06:21PM	
L6810904-22	CC-01	05/22/17 11:42am	FECAL COLIFORM-MF	SM 9222D	2600	05/22/17 06:23PM	
L6810904-23	CC-02	05/22/17 11:54am	ENTEROCOCCUS-MF 24	EPA 1600	660E	05/22/17 06:24PM	
L6810904-23	CC-02	05/22/17 11:54am	E. COLI-MF (1603)	EPA 1603	700E	05/22/17 06:21PM	
L6810904-23	CC-02	05/22/17 11:54am	FECAL COLIFORM-MF	SM 9222D	1600E	05/22/17 06:23PM	
L6810904-24	BLANK 01	05/22/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	05/22/17 06:24PM	
L6810904-24	BLANK 01	05/22/17 12:00pm	E. COLI-MF (1603)	EPA 1603	<10	05/22/17 06:21PM	
L6810904-24	BLANK 01	05/22/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	<10	05/22/17 06:23PM	
L6810904-25	CSO-18-1	05/22/17 10:45am	ENTEROCOCCUS-MF 24	EPA 1600	116000E	05/22/17 06:24PM	
L6810904-25	CSO-18-1	05/22/17 10:45am	E. COLI-MF (1603)	EPA 1603	441000E	05/22/17 06:21PM	
L6810904-25	CSO-18-1	05/22/17 10:45am	FECAL COLIFORM-MF	SM 9222D	42000	05/22/17 06:23PM	
L6810904-26	CSO-19-1	05/22/17 11:00am	ENTEROCOCCUS-MF 24	EPA 1600	267000E	05/22/17 06:24PM	
L6810904-26	CSO-19-1	05/22/17 11:00am	E. COLI-MF (1603)	EPA 1603	730000E	05/22/17 06:21PM	
L6810904-26	CSO-19-1	05/22/17 11:00am	FECAL COLIFORM-MF	SM 9222D	122000E	05/22/17 06:23PM	
L6810904-27	CSO-02-2	05/22/17 11:00am	ENTEROCOCCUS-MF 24	EPA 1600	238000E	05/22/17 06:24PM	
L6810904-27	CSO-02-2	05/22/17 11:00am	E. COLI-MF (1603)	EPA 1603	209000 E	05/22/17 06:54PM	
L6810904-27	CSO-02-2	05/22/17 11:00am	FECAL COLIFORM-MF	SM 9222D	126000E	05/22/17 06:23PM	
L6810904-28	CSO-05-2	05/22/17 11:05am	ENTEROCOCCUS-MF 24	EPA 1600	147000E	05/22/17 06:24PM	
L6810904-28	CSO-05-2	05/22/17 11:05am	E. COLI-MF (1603)	EPA 1603	135000 E	05/22/17 06:54PM	
L6810904-28	CSO-05-2	05/22/17 11:05am	FECAL COLIFORM-MF	SM 9222D	92000E	05/22/17 06:23PM	
L6810904-29	DR-01-2	05/22/17 11:10am	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/22/17 06:24PM	
L6810904-29	DR-01-2	05/22/17 11:10am	E. COLI-MF (1603)	EPA 1603	10 E	05/22/17 06:54PM	
L6810904-29	DR-01-2	05/22/17 11:10am	FECAL COLIFORM-MF	SM 9222D	30E	05/22/17 06:23PM	
L6810904-30	DR-02-2	05/22/17 11:15am	ENTEROCOCCUS-MF 24	EPA 1600	4 Q, E	05/22/17 08:18PM	
L6810904-30	DR-02-2	05/22/17 11:15am	E. COLI-MF (1603)	EPA 1603	<2	05/22/17 06:54PM	
L6810904-30	DR-02-2	05/22/17 11:15am	FECAL COLIFORM-MF	SM 9222D	26E	05/22/17 06:23PM	
L6810904-31	DR-03-2	05/22/17 11:25am	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/22/17 06:24PM	
L6810904-31	DR-03-2	05/22/17 11:25am	E. COLI-MF (1603)	EPA 1603	2 E, Q	05/22/17 07:40PM	
L6810904-31	DR-03-2	05/22/17 11:25am	FECAL COLIFORM-MF	SM 9222D	6E	05/22/17 06:23PM	
L6810904-32	DR-04-2	05/22/17 11:00am	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/22/17 06:24PM	
L6810904-32	DR-04-2	05/22/17 11:00am	E. COLI-MF (1603)	EPA 1603	12 E, Q	05/22/17 07:40PM	
L6810904-32	DR-04-2	05/22/17 11:00am	FECAL COLIFORM-MF	SM 9222D	24E	05/22/17 06:23PM	
L6810904-33	DR-05-2	05/22/17 11:20am	ENTEROCOCCUS-MF 24	EPA 1600	32E	05/22/17 06:24PM	
L6810904-33	DR-05-2	05/22/17 11:20am	E. COLI-MF (1603)	EPA 1603	4E	05/22/17 06:54PM	
L6810904-33	DR-05-2	05/22/17 11:20am	FECAL COLIFORM-MF	SM 9222D	34E	05/22/17 06:23PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-34	DR-06-2	05/22/17 11:05am	ENTEROCOCCUS-MF 24	EPA 1600	2 E, Q	05/22/17 08:18PM	
L6810904-34	DR-06-2	05/22/17 11:05am	E. COLI-MF (1603)	EPA 1603	6 E, Q	05/22/17 07:40PM	
L6810904-34	DR-06-2	05/22/17 11:05am	FECAL COLIFORM-MF	SM 9222D	4E	05/22/17 06:23PM	
L6810904-35	DR-07-2	05/22/17 11:10am	ENTEROCOCCUS-MF 24	EPA 1600	10E	05/22/17 06:24PM	
L6810904-35	DR-07-2	05/22/17 11:10am	E. COLI-MF (1603)	EPA 1603	10E	05/22/17 06:21PM	
L6810904-35	DR-07-2	05/22/17 11:10am	FECAL COLIFORM-MF	SM 9222D	4E	05/22/17 06:23PM	
L6810904-36	BLANK 02	05/22/17 11:05am	ENTEROCOCCUS-MF 24	EPA 1600	650E	05/22/17 06:24PM	
L6810904-36	BLANK 02	05/22/17 11:05am	E. COLI-MF (1603)	EPA 1603	<2 Q	05/22/17 07:40PM	
L6810904-36	BLANK 02	05/22/17 11:05am	FECAL COLIFORM-MF	SM 9222D	<2	05/22/17 06:23PM	
L6810904-37	CSO-18-1	05/22/17 11:15am	ENTEROCOCCUS-MF 24	EPA 1600	72000E	05/22/17 06:24PM	
L6810904-37	CSO-18-1	05/22/17 11:15am	E. COLI-MF (1603)	EPA 1603	101000 E, Q	05/22/17 07:40PM	
L6810904-37	CSO-18-1	05/22/17 11:15am	FECAL COLIFORM-MF	SM 9222D	71000E	05/22/17 06:23PM	
L6810904-38	CSO-02-3	05/22/17 11:30am	ENTEROCOCCUS-MF 24	EPA 1600	920000E	05/22/17 06:24PM	
L6810904-38	CSO-02-3	05/22/17 11:30am	E. COLI-MF (1603)	EPA 1603	1030000 E, Q	05/22/17 07:40PM	
L6810904-38	CSO-02-3	05/22/17 11:30am	FECAL COLIFORM-MF	SM 9222D	>60000	05/22/17 07:28PM	
L6810904-39	CSO-05-3	05/22/17 11:35am	ENTEROCOCCUS-MF 24	EPA 1600	141000 E, Q	05/22/17 08:18PM	
L6810904-39	CSO-05-3	05/22/17 11:35am	E. COLI-MF (1603)	EPA 1603	401000 Q,E	05/22/17 07:40PM	
L6810904-39	CSO-05-3	05/22/17 11:35am	FECAL COLIFORM-MF	SM 9222D	110000 E	05/22/17 07:28PM	
L6810904-40	BLANK-05	05/22/17 12:00pm	ENTEROCOCCUS-MF 24	EPA 1600	<10	05/22/17 06:24PM	
L6810904-40	BLANK-05	05/22/17 12:00pm	E. COLI-MF (1603)	EPA 1603	10 E, Q	05/22/17 07:40PM	
L6810904-40	BLANK-05	05/22/17 12:00pm	FECAL COLIFORM-MF	SM 9222D	<10	05/22/17 07:28PM	
L6810904-41	CSO-18-3	05/22/17 12:05pm	ENTEROCOCCUS-MF 24	EPA 1600	33000	05/22/17 06:24PM	
L6810904-41	CSO-18-3	05/22/17 12:05pm	E. COLI-MF (1603)	EPA 1603	76000 E, Q	05/22/17 07:40PM	
L6810904-41	CSO-18-3	05/22/17 12:05pm	FECAL COLIFORM-MF	SM 9222D	88000E	05/22/17 06:23PM	
L6810904-42	SW-SS2-4	05/22/17 12:30pm	ENTEROCOCCUS-MF 24	EPA 1600	137000E	05/22/17 08:18PM	
L6810904-42	SW-SS2-4	05/22/17 12:30pm	E. COLI-MF (1603)	EPA 1603	21000 Q	05/22/17 08:16PM	
L6810904-42	SW-SS2-4	05/22/17 12:30pm	FECAL COLIFORM-MF	SM 9222D	21000	05/22/17 07:28PM	
L6810904-43	SW-05A-4	05/22/17 12:40pm	ENTEROCOCCUS-MF 24	EPA 1600	172000E	05/22/17 08:18PM	
L6810904-43	SW-05A-4	05/22/17 12:40pm	E. COLI-MF (1603)	EPA 1603	156000 E, Q	05/22/17 08:16PM	
L6810904-43	SW-05A-4	05/22/17 12:40pm	FECAL COLIFORM-MF	SM 9222D	81000 E	05/22/17 07:28PM	
L6810904-44	CSO-05-4	05/22/17 12:35pm	ENTEROCOCCUS-MF 24	EPA 1600	98000E	05/22/17 08:18PM	
L6810904-44	CSO-05-4	05/22/17 12:35pm	E. COLI-MF (1603)	EPA 1603	205000 E, Q	05/22/17 08:16PM	
L6810904-44	CSO-05-4	05/22/17 12:35pm	FECAL COLIFORM-MF	SM 9222D	114000 E	05/22/17 07:28PM	
L6810904-45	CSO-02-4	05/22/17 12:40pm	ENTEROCOCCUS-MF 24	EPA 1600	304000E	05/22/17 08:18PM	
L6810904-45	CSO-02-4	05/22/17 12:40pm	E. COLI-MF (1603)	EPA 1603	290000 E, Q	05/22/17 08:16PM	
L6810904-45	CSO-02-4	05/22/17 12:40pm	FECAL COLIFORM-MF	SM 9222D	117000 E	05/22/17 07:28PM	
L6810904-46	CSO-18-4	05/22/17 12:45pm	ENTEROCOCCUS-MF 24	EPA 1600	40000	05/22/17 08:18PM	
L6810904-46	CSO-18-4	05/22/17 12:45pm	E. COLI-MF (1603)	EPA 1603	255000 E, Q	05/22/17 08:16PM	
L6810904-46	CSO-18-4	05/22/17 12:45pm	FECAL COLIFORM-MF	SM 9222D	79000 E	05/22/17 07:28PM	
L6810904-47	CSO-19-2	05/22/17 12:55pm	ENTEROCOCCUS-MF 24	EPA 1600	130000E	05/22/17 08:18PM	
L6810904-47	CSO-19-2	05/22/17 12:55pm	E. COLI-MF (1603)	EPA 1603	300000 E, Q	05/22/17 08:16PM	
L6810904-47	CSO-19-2	05/22/17 12:55pm	FECAL COLIFORM-MF	SM 9222D	156000 E	05/22/17 07:28PM	
L6810904-48	DUP-CSO	05/22/17 12:55pm	ENTEROCOCCUS-MF 24	EPA 1600	188000E	05/22/17 08:18PM	
L6810904-48	DUP-CSO	05/22/17 12:55pm	E. COLI-MF (1603)	EPA 1603	241000 Q, E	05/22/17 08:16PM	
L6810904-48	DUP-CSO	05/22/17 12:55pm	FECAL COLIFORM-MF	SM 9222D	155000 E	05/22/17 07:28PM	
L6810904-49	DR-01-3	05/22/17 01:15pm	ENTEROCOCCUS-MF 24	EPA 1600	5 E	05/22/17 08:18PM	
L6810904-49	DR-01-3	05/22/17 01:15pm	E. COLI-MF (1603)	EPA 1603	12 E, Q	05/22/17 08:16PM	
L6810904-49	DR-01-3	05/22/17 01:15pm	FECAL COLIFORM-MF	SM 9222D	32 E	05/22/17 07:28PM	
L6810904-50	DR-02-3	05/22/17 01:20pm	ENTEROCOCCUS-MF 24	EPA 1600	26E	05/22/17 08:18PM	
L6810904-50	DR-02-3	05/22/17 01:20pm	E. COLI-MF (1603)	EPA 1603	30 E, Q	05/22/17 08:16PM	
L6810904-50	DR-02-3	05/22/17 01:20pm	FECAL COLIFORM-MF	SM 9222D	50 E	05/22/17 07:28PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-51	DR-03-3	05/22/17 01:30pm	ENTEROCOCCUS-MF 24	EPA 1600	20E	05/22/17 08:18PM	
L6810904-51	DR-03-3	05/22/17 01:30pm	E. COLI-MF (1603)	EPA 1603	32 E, Q	05/22/17 08:16PM	
L6810904-51	DR-03-3	05/22/17 01:30pm	FECAL COLIFORM-MF	SM 9222D	38 E	05/22/17 07:28PM	
L6810904-52	DUP-DR1	05/22/17 01:15pm	ENTEROCOCCUS-MF 24	EPA 1600	10E	05/22/17 08:18PM	
L6810904-52	DUP-DR1	05/22/17 01:15pm	E. COLI-MF (1603)	EPA 1603	20 E, Q	05/22/17 08:16PM	
L6810904-52	DUP-DR1	05/22/17 01:15pm	FECAL COLIFORM-MF	SM 9222D	58	05/22/17 07:28PM	
L6810904-53	DR-04-3	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	4 E, Q	05/22/17 08:18PM	
L6810904-53	DR-04-3	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	8 E, Q	05/22/17 08:16PM	
L6810904-53	DR-04-3	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	46 Q	05/22/17 07:28PM	
L6810904-54	DR-05-3	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	58 Q	05/22/17 08:18PM	
L6810904-54	DR-05-3	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	86 Q	05/22/17 08:16PM	
L6810904-54	DR-05-3	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	250 Q	05/22/17 07:28PM	
L6810904-55	DR-06-3	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/22/17 08:18PM	
L6810904-55	DR-06-3	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	8 Q, E	05/22/17 08:16PM	
L6810904-55	DR-06-3	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	6 Q, E	05/22/17 07:28PM	
L6810904-56	DR-07-3	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	410 Q	05/22/17 08:18PM	
L6810904-56	DR-07-3	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	490 Q	05/22/17 08:16PM	
L6810904-56	DR-07-3	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	480 Q	05/22/17 07:28PM	
L6810904-57	CSO-05-5	05/22/17 02:35pm	ENTEROCOCCUS-MF 24	EPA 1600	191000E	05/22/17 08:18PM	
L6810904-57	CSO-05-5	05/22/17 02:35pm	E. COLI-MF (1603)	EPA 1603	1780000 E, Q	05/22/17 08:16PM	
L6810904-57	CSO-05-5	05/22/17 02:35pm	FECAL COLIFORM-MF	SM 9222D	266000 E	05/22/17 07:28PM	
L6810904-58	SW-SS2-5	05/22/17 02:30pm	ENTEROCOCCUS-MF 24	EPA 1600	121000E	05/22/17 08:18PM	
L6810904-58	SW-SS2-5	05/22/17 02:30pm	E. COLI-MF (1603)	EPA 1603	8546 Q	05/22/17 08:16PM	
L6810904-58	SW-SS2-5	05/22/17 02:30pm	FECAL COLIFORM-MF	SM 9222D	21000	05/22/17 07:28PM	
L6810904-59	SW-05A-5	05/22/17 02:40pm	ENTEROCOCCUS-MF 24	EPA 1600	19000E	05/22/17 08:18PM	
L6810904-59	SW-05A-5	05/22/17 02:40pm	E. COLI-MF (1603)	EPA 1603	8000 Q	05/22/17 08:16PM	
L6810904-59	SW-05A-5	05/22/17 02:40pm	FECAL COLIFORM-MF	SM 9222D	32000	05/22/17 07:28PM	
L6810904-60	CC-03	05/22/17 02:40pm	ENTEROCOCCUS-MF 24	EPA 1600	11000E	05/22/17 10:17PM	
L6810904-60	CC-03	05/22/17 02:40pm	E. COLI-MF (1603)	EPA 1603	22000	05/22/17 10:26PM	
L6810904-60	CC-03	05/22/17 02:40pm	FECAL COLIFORM-MF	SM 9222D	10000E	05/22/17 10:39PM	
L6810904-61	RC-03	05/22/17 02:50pm	ENTEROCOCCUS-MF 24	EPA 1600	1700E	05/22/17 10:17PM	
L6810904-61	RC-03	05/22/17 02:50pm	E. COLI-MF (1603)	EPA 1603	2900	05/22/17 10:26PM	
L6810904-61	RC-03	05/22/17 02:50pm	FECAL COLIFORM-MF	SM 9222D	2100	05/22/17 10:39PM	
L6810904-62	RC-02	05/22/17 03:05pm	ENTEROCOCCUS-MF 24	EPA 1600	1000E	05/22/17 10:17PM	
L6810904-62	RC-02	05/22/17 03:05pm	E. COLI-MF (1603)	EPA 1603	2800	05/22/17 10:26PM	
L6810904-62	RC-02	05/22/17 03:05pm	FECAL COLIFORM-MF	SM 9222D	2400	05/22/17 10:39PM	
L6810904-63	RC-01	05/22/17 03:18pm	ENTEROCOCCUS-MF 24	EPA 1600	2000	05/22/17 10:17PM	
L6810904-63	RC-01	05/22/17 03:18pm	E. COLI-MF (1603)	EPA 1603	870E	05/22/17 10:26PM	
L6810904-63	RC-01	05/22/17 03:18pm	FECAL COLIFORM-MF	SM 9222D	480	05/22/17 10:39PM	
L6810904-64	CC-07	05/22/17 03:40pm	ENTEROCOCCUS-MF 24	EPA 1600	3000	05/22/17 10:17PM	
L6810904-64	CC-07	05/22/17 03:40pm	E. COLI-MF (1603)	EPA 1603	1000E	05/22/17 10:26PM	
L6810904-64	CC-07	05/22/17 03:40pm	FECAL COLIFORM-MF	SM 9222D	1700E	05/22/17 10:39PM	
L6810904-65	CC-02	05/22/17 03:50pm	ENTEROCOCCUS-MF 24	EPA 1600	5000	05/22/17 10:17PM	
L6810904-65	CC-02	05/22/17 03:50pm	E. COLI-MF (1603)	EPA 1603	4900	05/22/17 10:26PM	
L6810904-65	CC-02	05/22/17 03:50pm	FECAL COLIFORM-MF	SM 9222D	2400	05/22/17 10:39PM	
L6810904-66	DUPLICATE-CC	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	6000 Q	05/22/17 10:17PM	
L6810904-66	DUPLICATE-CC	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	4800 Q	05/22/17 10:26PM	
L6810904-66	DUPLICATE-CC	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	4000 Q	05/22/17 10:39PM	
L6810904-67	DUPLICATE-RC	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	2200 Q	05/22/17 10:17PM	
L6810904-67	DUPLICATE-RC	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	4400 Q	05/22/17 10:26PM	
L6810904-67	DUPLICATE-RC	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	2600 Q	05/22/17 10:39PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-68	DR-01-4	05/22/17 03:15pm	ENTEROCOCCUS-MF 24	EPA 1600	46	05/22/17 10:17PM	
L6810904-68	DR-01-4	05/22/17 03:15pm	E. COLI-MF (1603)	EPA 1603	64	05/22/17 10:26PM	
L6810904-68	DR-01-4	05/22/17 03:15pm	FECAL COLIFORM-MF	SM 9222D	26E	05/22/17 10:39PM	
L6810904-69	DR-02-4	05/22/17 03:20pm	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/22/17 10:17PM	
L6810904-69	DR-02-4	05/22/17 03:20pm	E. COLI-MF (1603)	EPA 1603	24E	05/22/17 10:26PM	
L6810904-69	DR-02-4	05/22/17 03:20pm	FECAL COLIFORM-MF	SM 9222D	18E	05/22/17 10:39PM	
L6810904-70	DR-03-4	05/22/17 03:25pm	ENTEROCOCCUS-MF 24	EPA 1600	58	05/22/17 10:17PM	
L6810904-70	DR-03-4	05/22/17 03:25pm	E. COLI-MF (1603)	EPA 1603	142	05/22/17 10:26PM	
L6810904-70	DR-03-4	05/22/17 03:25pm	FECAL COLIFORM-MF	SM 9222D	72	05/22/17 10:39PM	
L6810904-71	DR-04-4	05/22/17 03:30pm	ENTEROCOCCUS-MF 24	EPA 1600	100E	05/22/17 10:17PM	
L6810904-71	DR-04-4	05/22/17 03:30pm	E. COLI-MF (1603)	EPA 1603	270	05/22/17 10:26PM	
L6810904-71	DR-04-4	05/22/17 03:30pm	FECAL COLIFORM-MF	SM 9222D	180E	05/22/17 10:39PM	
L6810904-72	DR-05-4	05/22/17 03:35pm	ENTEROCOCCUS-MF 24	EPA 1600	1600E	05/22/17 10:17PM	
L6810904-72	DR-05-4	05/22/17 03:35pm	E. COLI-MF (1603)	EPA 1603	16E	05/22/17 10:26PM	
L6810904-72	DR-05-4	05/22/17 03:35pm	FECAL COLIFORM-MF	SM 9222D	42	05/22/17 10:39PM	
L6810904-73	DR-06-4	05/22/17 02:55pm	ENTEROCOCCUS-MF 24	EPA 1600	2 E	05/22/17 10:17PM	
L6810904-73	DR-06-4	05/22/17 02:55pm	E. COLI-MF (1603)	EPA 1603	10 E	05/22/17 10:26PM	
L6810904-73	DR-06-4	05/22/17 02:55pm	FECAL COLIFORM-MF	SM 9222D	<2	05/22/17 10:39PM	
L6810904-74	DR-07-4	05/22/17 03:00pm	ENTEROCOCCUS-MF 24	EPA 1600	130E	05/22/17 10:17PM	
L6810904-74	DR-07-4	05/22/17 03:00pm	E. COLI-MF (1603)	EPA 1603	260	05/22/17 10:26PM	
L6810904-74	DR-07-4	05/22/17 03:00pm	FECAL COLIFORM-MF	SM 9222D	290	05/22/17 10:39PM	
L6810904-75	DR-06-5	05/22/17 05:55pm	ENTEROCOCCUS-MF 24	EPA 1600	2E	05/22/17 11:55PM	
L6810904-75	DR-06-5	05/22/17 05:55pm	E. COLI-MF (1603)	EPA 1603	4E	05/22/17 10:26PM	
L6810904-75	DR-06-5	05/22/17 05:55pm	FECAL COLIFORM-MF	SM 9222D	2E	05/22/17 10:39PM	
L6810904-76	DR-07-5	05/22/17 06:00pm	ENTEROCOCCUS-MF 24	EPA 1600	14E	05/22/17 11:55PM	
L6810904-76	DR-07-5	05/22/17 06:00pm	E. COLI-MF (1603)	EPA 1603	24E	05/22/17 10:26PM	
L6810904-76	DR-07-5	05/22/17 06:00pm	FECAL COLIFORM-MF	SM 9222D	32E	05/22/17 10:39PM	
L6810904-77	DR-01-5	05/22/17 06:15pm	ENTEROCOCCUS-MF 24	EPA 1600	66	05/22/17 11:55PM	
L6810904-77	DR-01-5	05/22/17 06:15pm	E. COLI-MF (1603)	EPA 1603	50	05/22/17 10:26PM	
L6810904-77	DR-01-5	05/22/17 06:15pm	FECAL COLIFORM-MF	SM 9222D	36E	05/22/17 10:39PM	
L6810904-78	DR-02-5	05/22/17 06:20pm	ENTEROCOCCUS-MF 24	EPA 1600	30 E	05/22/17 11:55PM	
L6810904-78	DR-02-5	05/22/17 06:20pm	E. COLI-MF (1603)	EPA 1603	24E	05/22/17 10:26PM	
L6810904-78	DR-02-5	05/22/17 06:20pm	FECAL COLIFORM-MF	SM 9222D	20E	05/22/17 10:39PM	
L6810904-79	DR-03-5	05/22/17 06:25pm	ENTEROCOCCUS-MF 24	EPA 1600	124E	05/22/17 11:55PM	
L6810904-79	DR-03-5	05/22/17 06:25pm	E. COLI-MF (1603)	EPA 1603	300	05/22/17 10:26PM	
L6810904-79	DR-03-5	05/22/17 06:25pm	FECAL COLIFORM-MF	SM 9222D	190E	05/22/17 10:39PM	
L6810904-80	DR-04-5	05/22/17 06:30pm	ENTEROCOCCUS-MF 24	EPA 1600	112	05/22/17 11:55PM	
L6810904-80	DR-04-5	05/22/17 06:30pm	E. COLI-MF (1603)	EPA 1603	340	05/22/17 10:26PM	
L6810904-80	DR-04-5	05/22/17 06:30pm	FECAL COLIFORM-MF	SM 9222D	310	05/22/17 10:39PM	
L6810904-81	DR-05-5	05/22/17 06:35pm	ENTEROCOCCUS-MF 24	EPA 1600	280E	05/22/17 11:55PM	
L6810904-81	DR-05-5	05/22/17 06:35pm	E. COLI-MF (1603)	EPA 1603	280	05/22/17 10:26PM	
L6810904-81	DR-05-5	05/22/17 06:35pm	FECAL COLIFORM-MF	SM 9222D	340	05/22/17 10:39PM	
L6810904-82	RC-01-03	05/22/17 06:40pm	ENTEROCOCCUS-MF 24	EPA 1600	600	05/22/17 10:17PM	
L6810904-82	RC-01-03	05/22/17 06:40pm	E. COLI-MF (1603)	EPA 1603	300	05/22/17 10:26PM	
L6810904-82	RC-01-03	05/22/17 06:40pm	FECAL COLIFORM-MF	SM 9222D	370	05/22/17 10:39PM	
L6810904-83	RC-02-03	05/22/17 06:18pm	ENTEROCOCCUS-MF 24	EPA 1600	2600	05/22/17 11:55PM	
L6810904-83	RC-02-03	05/22/17 06:18pm	E. COLI-MF (1603)	EPA 1603	840E	05/22/17 10:26PM	
L6810904-83	RC-02-03	05/22/17 06:18pm	FECAL COLIFORM-MF	SM 9222D	800E	05/22/17 10:39PM	
L6810904-84	RC-03-03	05/22/17 06:12pm	ENTEROCOCCUS-MF 24	EPA 1600	4200	05/22/17 10:17PM	
L6810904-84	RC-03-03	05/22/17 06:12pm	E. COLI-MF (1603)	EPA 1603	1900E	05/22/17 10:26PM	
L6810904-84	RC-03-03	05/22/17 06:12pm	FECAL COLIFORM-MF	SM 9222D	1000E	05/22/17 10:39PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-85	CC-01-03	05/22/17 06:46pm	ENTEROCOCCUS-MF 24	EPA 1600	1500E	05/22/17 11:55PM	
L6810904-85	CC-01-03	05/22/17 06:46pm	E. COLI-MF (1603)	EPA 1603	610	05/22/17 10:26PM	
L6810904-85	CC-01-03	05/22/17 06:46pm	FECAL COLIFORM-MF	SM 9222D	550	05/22/17 10:39PM	
L6810904-86	CC-02-03	05/22/17 07:00pm	ENTEROCOCCUS-MF 24	EPA 1600	2000	05/22/17 10:17PM	
L6810904-86	CC-02-03	05/22/17 07:00pm	E. COLI-MF (1603)	EPA 1603	2500	05/22/17 10:26PM	
L6810904-86	CC-02-03	05/22/17 07:00pm	FECAL COLIFORM-MF	SM 9222D	2000	05/22/17 10:39PM	
L6810904-87	CC-03-03	05/22/17 06:00pm	ENTEROCOCCUS-MF 24	EPA 1600	4800	05/22/17 11:55PM	
L6810904-87	CC-03-03	05/22/17 06:00pm	E. COLI-MF (1603)	EPA 1603	8500E	05/22/17 10:26PM	
L6810904-87	CC-03-03	05/22/17 06:00pm	FECAL COLIFORM-MF	SM 9222D	18000E	05/22/17 10:39PM	
L6810904-88	DR-01-06	05/22/17 09:15pm	ENTEROCOCCUS-MF 24	EPA 1600	76	05/22/17 11:55PM	
L6810904-88	DR-01-06	05/22/17 09:15pm	E. COLI-MF (1603)	EPA 1603	353	05/22/17 11:44PM	
L6810904-88	DR-01-06	05/22/17 09:15pm	FECAL COLIFORM-MF	SM 9222D	70	05/22/17 11:47PM	
L6810904-89	DR-02-06	05/22/17 09:25pm	ENTEROCOCCUS-MF 24	EPA 1600	72	05/22/17 11:55PM	
L6810904-89	DR-02-06	05/22/17 09:25pm	E. COLI-MF (1603)	EPA 1603	162E	05/22/17 11:44PM	
L6810904-89	DR-02-06	05/22/17 09:25pm	FECAL COLIFORM-MF	SM 9222D	210	05/22/17 11:47PM	
L6810904-90	DR-03-06	05/22/17 09:30pm	ENTEROCOCCUS-MF 24	EPA 1600	116	05/22/17 11:55PM	
L6810904-90	DR-03-06	05/22/17 09:30pm	E. COLI-MF (1603)	EPA 1603	200	05/22/17 11:44PM	
L6810904-90	DR-03-06	05/22/17 09:30pm	FECAL COLIFORM-MF	SM 9222D	160E	05/22/17 11:47PM	
L6810904-91	DR-04-06	05/22/17 09:40pm	ENTEROCOCCUS-MF 24	EPA 1600	260	05/22/17 11:55PM	
L6810904-91	DR-04-06	05/22/17 09:40pm	E. COLI-MF (1603)	EPA 1603	132	05/22/17 11:44PM	
L6810904-91	DR-04-06	05/22/17 09:40pm	FECAL COLIFORM-MF	SM 9222D	180E	05/22/17 11:47PM	
L6810904-92	DR-05-06	05/22/17 09:45pm	ENTEROCOCCUS-MF 24	EPA 1600	100	05/22/17 11:55PM	
L6810904-92	DR-05-06	05/22/17 09:45pm	E. COLI-MF (1603)	EPA 1603	124	05/22/17 11:44PM	
L6810904-92	DR-05-06	05/22/17 09:45pm	FECAL COLIFORM-MF	SM 9222D	280	05/22/17 11:47PM	
L6810904-93	DR-06-06	05/22/17 08:55pm	ENTEROCOCCUS-MF 24	EPA 1600	2E	05/22/17 11:55PM	
L6810904-93	DR-06-06	05/22/17 08:55pm	E. COLI-MF (1603)	EPA 1603	4E	05/22/17 11:44PM	
L6810904-93	DR-06-06	05/22/17 08:55pm	FECAL COLIFORM-MF	SM 9222D	6E	05/22/17 11:47PM	
L6810904-94	DR-07-06	05/22/17 09:00pm	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/22/17 11:55PM	
L6810904-94	DR-07-06	05/22/17 09:00pm	E. COLI-MF (1603)	EPA 1603	8E	05/22/17 11:44PM	
L6810904-94	DR-07-06	05/22/17 09:00pm	FECAL COLIFORM-MF	SM 9222D	2E	05/22/17 11:47PM	
L6810904-95	DUP-DR	05/22/17 00:00pm	ENTEROCOCCUS-MF 24	EPA 1600	102 Q	05/22/17 11:55PM	
L6810904-95	DUP-DR	05/22/17 00:00pm	E. COLI-MF (1603)	EPA 1603	152 Q	05/22/17 11:44PM	
L6810904-95	DUP-DR	05/22/17 00:00pm	FECAL COLIFORM-MF	SM 9222D	140 E, Q	05/22/17 11:47PM	
L6810904-96	DR-01-07	05/23/17 12:05am	ENTEROCOCCUS-MF 24	EPA 1600	24E	05/23/17 07:33AM	
L6810904-96	DR-01-07	05/23/17 12:05am	E. COLI-MF (1603)	EPA 1603	18E	05/23/17 07:08AM	
L6810904-96	DR-01-07	05/23/17 12:05am	FECAL COLIFORM-MF	SM 9222D	18E	05/23/17 07:53AM	
L6810904-97	DR-02-07	05/23/17 12:20am	ENTEROCOCCUS-MF 24	EPA 1600	10E	05/23/17 07:33AM	
L6810904-97	DR-02-07	05/23/17 12:20am	E. COLI-MF (1603)	EPA 1603	6E	05/23/17 07:08AM	
L6810904-97	DR-02-07	05/23/17 12:20am	FECAL COLIFORM-MF	SM 9222D	22E	05/23/17 07:53AM	
L6810904-98	DR-03-07	05/23/17 12:34am	ENTEROCOCCUS-MF 24	EPA 1600	38E	05/23/17 07:33AM	
L6810904-98	DR-03-07	05/23/17 12:34am	E. COLI-MF (1603)	EPA 1603	34E	05/23/17 07:08AM	
L6810904-98	DR-03-07	05/23/17 12:34am	FECAL COLIFORM-MF	SM 9222D	42	05/23/17 07:53AM	
L6810904-99	DR-04-07	05/23/17 12:48am	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/23/17 07:33AM	
L6810904-99	DR-04-07	05/23/17 12:48am	E. COLI-MF (1603)	EPA 1603	5 E	05/23/17 07:08AM	
L6810904-99	DR-04-07	05/23/17 12:48am	FECAL COLIFORM-MF	SM 9222D	16E	05/23/17 07:53AM	
L6810904-100	DR-05-07	05/23/17 01:02am	ENTEROCOCCUS-MF 24	EPA 1600	56	05/23/17 07:33AM	
L6810904-100	DR-05-07	05/23/17 01:02am	E. COLI-MF (1603)	EPA 1603	12E	05/23/17 07:08AM	
L6810904-100	DR-05-07	05/23/17 01:02am	FECAL COLIFORM-MF	SM 9222D	22E	05/23/17 07:53AM	
L6810904-101	DR-06-07	05/23/17 01:15am	ENTEROCOCCUS-MF 24	EPA 1600	8E	05/23/17 07:33AM	
L6810904-101	DR-06-07	05/23/17 01:15am	E. COLI-MF (1603)	EPA 1603	6E	05/23/17 07:08AM	
L6810904-101	DR-06-07	05/23/17 01:15am	FECAL COLIFORM-MF	SM 9222D	10E	05/23/17 07:53AM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-102	DR-07-07	05/23/17 01:33am	ENTEROCOCCUS-MF 24	EPA 1600	2E	05/23/17 07:33AM	
L6810904-102	DR-07-07	05/23/17 01:33am	E. COLI-MF (1603)	EPA 1603	6E	05/23/17 07:08AM	
L6810904-102	DR-07-07	05/23/17 01:33am	FECAL COLIFORM-MF	SM 9222D	80	05/23/17 07:53AM	
L6810904-103	RC-01-04	05/23/17 01:50am	ENTEROCOCCUS-MF 24	EPA 1600	170E	05/23/17 07:33AM	
L6810904-103	RC-01-04	05/23/17 01:50am	E. COLI-MF (1603)	EPA 1603	76	05/23/17 07:08AM	
L6810904-103	RC-01-04	05/23/17 01:50am	FECAL COLIFORM-MF	SM 9222D	108	05/23/17 07:53AM	
L6810904-104	RC-02-04	05/23/17 01:35am	ENTEROCOCCUS-MF 24	EPA 1600	580	05/23/17 07:33AM	
L6810904-104	RC-02-04	05/23/17 01:35am	E. COLI-MF (1603)	EPA 1603	300	05/23/17 07:08AM	
L6810904-104	RC-02-04	05/23/17 01:35am	FECAL COLIFORM-MF	SM 9222D	440	05/23/17 07:53AM	
L6810904-105	RC-03-04	05/23/17 01:20am	ENTEROCOCCUS-MF 24	EPA 1600	1200E	05/23/17 07:33AM	
L6810904-105	RC-03-04	05/23/17 01:20am	E. COLI-MF (1603)	EPA 1603	1900E	05/23/17 07:08AM	
L6810904-105	RC-03-04	05/23/17 01:20am	FECAL COLIFORM-MF	SM 9222D	1800E	05/23/17 07:53AM	
L6810904-106	CC-01-04	05/23/17 02:17am	ENTEROCOCCUS-MF 24	EPA 1600	520	05/23/17 07:33AM	
L6810904-106	CC-01-04	05/23/17 02:17am	E. COLI-MF (1603)	EPA 1603	170E	05/23/17 07:08AM	
L6810904-106	CC-01-04	05/23/17 02:17am	FECAL COLIFORM-MF	SM 9222D	380	05/23/17 07:53AM	
L6810904-107	CC-02-04	05/23/17 02:05am	ENTEROCOCCUS-MF 24	EPA 1600	600	05/23/17 07:33AM	
L6810904-107	CC-02-04	05/23/17 02:05am	E. COLI-MF (1603)	EPA 1603	470	05/23/17 07:08AM	
L6810904-107	CC-02-04	05/23/17 02:05am	FECAL COLIFORM-MF	SM 9222D	350	05/23/17 07:53AM	
L6810904-108	CC-03-04	05/23/17 01:05am	ENTEROCOCCUS-MF 24	EPA 1600	1700E	05/23/17 07:33AM	
L6810904-108	CC-03-04	05/23/17 01:05am	E. COLI-MF (1603)	EPA 1603	2700E	05/23/17 07:08AM	
L6810904-108	CC-03-04	05/23/17 01:05am	FECAL COLIFORM-MF	SM 9222D	3800	05/23/17 07:53AM	
L6810904-109	DR-02-08	05/23/17 03:15am	ENTEROCOCCUS-MF 24	EPA 1600	70E	05/23/17 10:18AM	
L6810904-109	DR-02-08	05/23/17 03:15am	E. COLI-MF (1603)	EPA 1603	50E	05/23/17 10:32AM	
L6810904-109	DR-02-08	05/23/17 03:15am	FECAL COLIFORM-MF	SM 9222D	9 E	05/23/17 10:54AM	
L6810904-110	DR-03-08	05/23/17 03:25am	ENTEROCOCCUS-MF 24	EPA 1600	68	05/23/17 10:18AM	
L6810904-110	DR-03-08	05/23/17 03:25am	E. COLI-MF (1603)	EPA 1603	116	05/23/17 10:32AM	
L6810904-110	DR-03-08	05/23/17 03:25am	FECAL COLIFORM-MF	SM 9222D	1000 E	05/23/17 10:54AM	
L6810904-111	DR-04-08	05/23/17 03:37am	ENTEROCOCCUS-MF 24	EPA 1600	70	05/23/17 10:18AM	
L6810904-111	DR-04-08	05/23/17 03:37am	E. COLI-MF (1603)	EPA 1603	118	05/23/17 10:32AM	
L6810904-111	DR-04-08	05/23/17 03:37am	FECAL COLIFORM-MF	SM 9222D	250	05/23/17 10:54AM	
L6810904-112	DR-05-08	05/23/17 03:50am	ENTEROCOCCUS-MF 24	EPA 1600	110	05/23/17 10:18AM	
L6810904-112	DR-05-08	05/23/17 03:50am	E. COLI-MF (1603)	EPA 1603	260	05/23/17 10:32AM	
L6810904-112	DR-05-08	05/23/17 03:50am	FECAL COLIFORM-MF	SM 9222D	310	05/23/17 10:54AM	
L6810904-113	DR-06-08	05/23/17 04:03am	ENTEROCOCCUS-MF 24	EPA 1600	6E	05/23/17 10:18AM	
L6810904-113	DR-06-08	05/23/17 04:03am	E. COLI-MF (1603)	EPA 1603	4E	05/23/17 10:32AM	
L6810904-113	DR-06-08	05/23/17 04:03am	FECAL COLIFORM-MF	SM 9222D	5 E	05/23/17 10:54AM	
L6810904-114	DR-07-08	05/23/17 04:16am	ENTEROCOCCUS-MF 24	EPA 1600	14E	05/23/17 10:18AM	
L6810904-114	DR-07-08	05/23/17 04:16am	E. COLI-MF (1603)	EPA 1603	28E	05/23/17 10:32AM	
L6810904-114	DR-07-08	05/23/17 04:16am	FECAL COLIFORM-MF	SM 9222D	24E	05/23/17 10:54AM	
L6810904-115	DR-01-09	05/23/17 06:00am	ENTEROCOCCUS-MF 24	EPA 1600	10E	05/23/17 01:29PM	
L6810904-115	DR-01-09	05/23/17 06:00am	E. COLI-MF (1603)	EPA 1603	8E	05/23/17 01:26PM	
L6810904-115	DR-01-09	05/23/17 06:00am	FECAL COLIFORM-MF	SM 9222D	32 Q, E	05/23/17 02:22PM	
L6810904-116	DR-02-09	05/23/17 06:13am	ENTEROCOCCUS-MF 24	EPA 1600	40	05/23/17 01:29PM	
L6810904-116	DR-02-09	05/23/17 06:13am	E. COLI-MF (1603)	EPA 1603	68	05/23/17 01:26PM	
L6810904-116	DR-02-09	05/23/17 06:13am	FECAL COLIFORM-MF	SM 9222D	46	05/23/17 02:22PM	
L6810904-117	DR-03-09	05/23/17 06:26am	ENTEROCOCCUS-MF 24	EPA 1600	92	05/23/17 01:29PM	
L6810904-117	DR-03-09	05/23/17 06:26am	E. COLI-MF (1603)	EPA 1603	62	05/23/17 01:26PM	
L6810904-117	DR-03-09	05/23/17 06:26am	FECAL COLIFORM-MF	SM 9222D	88	05/23/17 02:22PM	
L6810904-118	DR-04-09	05/23/17 06:38am	ENTEROCOCCUS-MF 24	EPA 1600	86	05/23/17 01:29PM	
L6810904-118	DR-04-09	05/23/17 06:38am	E. COLI-MF (1603)	EPA 1603	122	05/23/17 01:26PM	
L6810904-118	DR-04-09	05/23/17 06:38am	FECAL COLIFORM-MF	SM 9222D	78	05/23/17 02:22PM	

Login Number	Sample ID	Sample Date/Time	Parm Stored	Method	Result (cfu/100 mL)	Analysis Date/Time	
L6810904-119	DR-05-09	05/23/17 06:52am	ENTEROCOCCUS-MF 24	EPA 1600	90	05/23/17 01:29PM	
L6810904-119	DR-05-09	05/23/17 06:52am	E. COLI-MF (1603)	EPA 1603	128	05/23/17 01:26PM	
L6810904-119	DR-05-09	05/23/17 06:52am	FECAL COLIFORM-MF	SM 9222D	180E	05/23/17 02:22PM	
L6810904-120	DR-06-09	05/23/17 07:05am	ENTEROCOCCUS-MF 24	EPA 1600	8E	05/23/17 01:29PM	
L6810904-120	DR-06-09	05/23/17 07:05am	E. COLI-MF (1603)	EPA 1603	16E	05/23/17 01:26PM	
L6810904-120	DR-06-09	05/23/17 07:05am	FECAL COLIFORM-MF	SM 9222D	26E	05/23/17 02:22PM	
L6810904-121	DR-07-09	05/23/17 07:20am	ENTEROCOCCUS-MF 24	EPA 1600	6E	05/23/17 01:29PM	
L6810904-121	DR-07-09	05/23/17 07:20am	E. COLI-MF (1603)	EPA 1603	16E	05/23/17 01:26PM	
L6810904-121	DR-07-09	05/23/17 07:20am	FECAL COLIFORM-MF	SM 9222D	16E	05/23/17 02:22PM	
L6810904-122	DR-01-10	05/23/17 09:00am	ENTEROCOCCUS-MF 24	EPA 1600	16E	05/23/17 01:29PM	
L6810904-122	DR-01-10	05/23/17 09:00am	E. COLI-MF (1603)	EPA 1603	24E	05/23/17 01:26PM	
L6810904-122	DR-01-10	05/23/17 09:00am	FECAL COLIFORM-MF	SM 9222D	44	05/23/17 02:22PM	
L6810904-123	DR-02-10	05/23/17 09:12am	ENTEROCOCCUS-MF 24	EPA 1600	42	05/23/17 01:29PM	
L6810904-123	DR-02-10	05/23/17 09:12am	E. COLI-MF (1603)	EPA 1603	68	05/23/17 01:26PM	
L6810904-123	DR-02-10	05/23/17 09:12am	FECAL COLIFORM-MF	SM 9222D	42	05/23/17 02:22PM	
L6810904-124	DR-03-10	05/23/17 09:24am	ENTEROCOCCUS-MF 24	EPA 1600	50	05/23/17 01:29PM	
L6810904-124	DR-03-10	05/23/17 09:24am	E. COLI-MF (1603)	EPA 1603	90	05/23/17 01:26PM	
L6810904-124	DR-03-10	05/23/17 09:24am	FECAL COLIFORM-MF	SM 9222D	92	05/23/17 02:22PM	
L6810904-125	DR-04-10	05/23/17 09:40am	ENTEROCOCCUS-MF 24	EPA 1600	22E	05/23/17 01:29PM	
L6810904-125	DR-04-10	05/23/17 09:40am	E. COLI-MF (1603)	EPA 1603	32E	05/23/17 01:26PM	
L6810904-125	DR-04-10	05/23/17 09:40am	FECAL COLIFORM-MF	SM 9222D	26E	05/23/17 02:22PM	
L6810904-126	DR-05-10	05/23/17 09:53am	ENTEROCOCCUS-MF 24	EPA 1600	16E	05/23/17 01:29PM	
L6810904-126	DR-05-10	05/23/17 09:53am	E. COLI-MF (1603)	EPA 1603	38E	05/23/17 01:26PM	
L6810904-126	DR-05-10	05/23/17 09:53am	FECAL COLIFORM-MF	SM 9222D	112	05/23/17 02:22PM	
L6810904-127	DR-06-10	05/23/17 10:05am	ENTEROCOCCUS-MF 24	EPA 1600	2E	05/23/17 01:29PM	
L6810904-127	DR-06-10	05/23/17 10:05am	E. COLI-MF (1603)	EPA 1603	2E	05/23/17 01:26PM	
L6810904-127	DR-06-10	05/23/17 10:05am	FECAL COLIFORM-MF	SM 9222D	6E	05/23/17 02:22PM	
L6810904-128	DR-07-10	05/23/17 10:17am	ENTEROCOCCUS-MF 24	EPA 1600	4E	05/23/17 01:29PM	
L6810904-128	DR-07-10	05/23/17 10:17am	E. COLI-MF (1603)	EPA 1603	12E	05/23/17 01:26PM	
L6810904-128	DR-07-10	05/23/17 10:17am	FECAL COLIFORM-MF	SM 9222D	6E	05/23/17 02:22PM	
L6810904-129	CC-01-05	05/23/17 10:20am	ENTEROCOCCUS-MF 24	EPA 1600	170E	05/23/17 01:29PM	
L6810904-129	CC-01-05	05/23/17 10:20am	E. COLI-MF (1603)	EPA 1603	240	05/23/17 01:26PM	
L6810904-129	CC-01-05	05/23/17 10:20am	FECAL COLIFORM-MF	SM 9222D	220	05/23/17 02:22PM	
L6810904-130	CC-02-05	05/23/17 10:05am	ENTEROCOCCUS-MF 24	EPA 1600	400	05/23/17 01:29PM	
L6810904-130	CC-02-05	05/23/17 10:05am	E. COLI-MF (1603)	EPA 1603	610	05/23/17 01:26PM	
L6810904-130	CC-02-05	05/23/17 10:05am	FECAL COLIFORM-MF	SM 9222D	1200E	05/23/17 02:22PM	
L6810904-131	CC-03-05	05/23/17 09:05am	ENTEROCOCCUS-MF 24	EPA 1600	50	05/23/17 01:29PM	
L6810904-131	CC-03-05	05/23/17 09:05am	E. COLI-MF (1603)	EPA 1603	112	05/23/17 01:26PM	
L6810904-131	CC-03-05	05/23/17 09:05am	FECAL COLIFORM-MF	SM 9222D	190E	05/23/17 02:22PM	
L6810904-132	RC-01-05	05/23/17 09:50am	ENTEROCOCCUS-MF 24	EPA 1600	40	05/23/17 01:29PM	
L6810904-132	RC-01-05	05/23/17 09:50am	E. COLI-MF (1603)	EPA 1603	56	05/23/17 01:26PM	
L6810904-132	RC-01-05	05/23/17 09:50am	FECAL COLIFORM-MF	SM 9222D	44	05/23/17 02:22PM	
L6810904-133	RC-02-05	05/23/17 09:35am	ENTEROCOCCUS-MF 24	EPA 1600	280	05/23/17 01:29PM	
L6810904-133	RC-02-05	05/23/17 09:35am	E. COLI-MF (1603)	EPA 1603	200	05/23/17 01:26PM	
L6810904-133	RC-02-05	05/23/17 09:35am	FECAL COLIFORM-MF	SM 9222D	230	05/23/17 02:22PM	
L6810904-134	RC-03-05	05/23/17 09:22am	ENTEROCOCCUS-MF 24	EPA 1600	64	05/23/17 01:29PM	
L6810904-134	RC-03-05	05/23/17 09:22am	E. COLI-MF (1603)	EPA 1603	84	05/23/17 01:26PM	
L6810904-134	RC-03-05	05/23/17 09:22am	FECAL COLIFORM-MF	SM 9222D	136E	05/23/17 02:22PM	

APPENDIX G

SAMPLE COLLECTION MATRIX

Dry Weather Event									Field Measurement Water Depth				Field Duplicate Locations			
Water Body	**Location**	**# Rounds**	**Round Notes**	**No. Samples/ Event**	**No. of Field Duplicates/ Event**	**No. of Field Blanks/ Event**	**Lab Analytes**	**Field Measurements**	**Surface**	**Mid-depth**	**Bottom**	**# Lab Samples/Event**	**Dry 1 Field Duplicate Locations**	**Dry 2 Field Duplicate Locations**	**Dry 3 Field Duplicate Locations**	**Notes**
Chester Creek	CC-01	2	Incoming & outgoing tide	2	1	1 See notes column	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X			8	CC-01 outgoing tide			Prepare field blank at first sampling location for each event, regardless of tide condition.
Chester Creek	CC-02	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X					CC-02 outgoing tide		
Chester Creek	CC-03	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X						CC-03 incoming tide	
Ridley Creek	RC-01	2	Incoming & outgoing tide	2	1	none	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X			7			RC-01 outgoing tide	
Ridley Creek	RC-02	2	Incoming & outgoing tide	2		none	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X					RC-02 incoming tide		
Ridley Creek	RC-03	2	Incoming & outgoing tide	2		none	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	X				RC-03 incoming tide			
Delaware River	DR-01	2	Incoming & outgoing tide	2	1	1 See notes column	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	X	X	X	12				
Delaware River	DR-02	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	X	X	X		DR-02 outgoing tide			
Delaware River	DR-03	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	X	X	X				DR-03 outgoing tide	
Delaware River	DR-04	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	X	X	X			DR-04 incoming tide		
Delaware River	DR-05	2	Incoming & outgoing tide	2			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	X	X	X					
Delaware River	DR-06	not sampled					none	none				none				
Delaware River	DR-07	not sampled					none	none				none				
Outfall (combined sewer)	CSO-02	not sampled					none	none				none				
Outfall (combined sewer)	CSO-05	not sampled					none	none				none				
Outfall (combined sewer)	CSO-18	not sampled					none	none				none				
Outfall (combined sewer)	CSO-19	not sampled					none	none				none				
Outfall (storm water)	SW-05A	not sampled					none	none				none				
Outfall (storm water)	SW-SS2	not sampled					none	none				none				

Wet Weather Event									Field Measurement Water Depth			Field Duplicate Locations				
Water Body	**Location**	**# Rounds**	**Sample Collection Times/Intervals from T=0 (hours)**	**No. Samples/ Event**	**No. of Field Duplicates/ Event**	**No. of Field Blanks/ Event**	**Lab Analytes**	**Field Measurements**	**Surface**	**Mid-depth**	**Bottom**	**per event**	**Wet 1 Field Duplicate Locations**	**Wet 2 Field Duplicate Locations**	**Wet 3 Field Duplicate Locations**	**Notes**
Chester Creek	CC-01	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5	1	1 See notes column	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x			17		CC-01 HR 8.5-10.5		Prepare field blank at first sampling location for each event, regardless of tide condition.
Chester Creek	CC-02	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x						CC-02 HR 4.5-6.5	
Chester Creek	CC-03	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x				CC-03 HR0.5-2.5			
Ridley Creek	RC-01	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5	1	1 See notes column	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x			17	RC-01 HR 14.5-16.5			
Ridley Creek	RC-02	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x					RC-02 HR0.5-2.5		
Ridley Creek	RC-03	5	0.5-2.5, 4.5-6.5, 8.5-10.5, 14.5-16.5, 22-24	5			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (surface water depth)	x						RC-03 HR4.5-6.5	
Delaware River	DR-01	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10	2	1 See notes column	E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x	73		DR-01 HR 9		
Delaware River	DR-02	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x		DR-02 HR 2			
Delaware River	DR-03	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x			DR-03 HR 21	DR-03 HR 4	
Delaware River	DR-04	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x		DR-04 HR 15			
Delaware River	DR-05	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x				DR-05 HR 12	
Delaware River	DR-06	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x					
Delaware River	DR-07	10	0, 2, 4, 6, 9, 12, 15, 18, 21, 24	10			E. coli, Enterococcus, Fecal coliform	Salinity, Temperature, Conductivity (at surface water, mid, near bottom depths)	x	x	x					
Outfall (combined sewer)	CSO-02	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max	1	1 Same location as field duplicate, See notes column	E. coli, Enterococcus, Fecal coliform	none				34	CSO-02 HR 1			Prepare field blank at same location as field duplicate. Prepare field blank once crew arrives at sampling location.
Outfall (combined sewer)	CSO-05	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max			E. coli, Enterococcus, Fecal coliform	none								
Outfall (combined sewer)	CSO-18	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max			E. coli, Enterococcus, Fecal coliform	none						CSO-18 HR 1		
Outfall (combined sewer)	CSO-19	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max			E. coli, Enterococcus, Fecal coliform	none							CSO-19 HR 1	
Outfall (storm water)	SW-05A	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max	0	0	E. coli, Enterococcus, Fecal coliform	none				16				
Outfall (storm water)	SW-SS2	8	0, 0.5, 1, 2, 4, 8, 12, 24	8 max	0	0	E. coli, Enterococcus, Fecal coliform	none								

APPENDIX H

WATER QUALITY SAMPLING PLOTS

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1.4 DR-01 Dry 8
1.4 DR-01 Wet 9
1.5 DR-02 Dry 10
1.5 DR-02 Wet 11
1.6 DR-03 Dry 12
1.6 DR-03 Wet 13
1.7 DR-04 Dry 14
1.7 DR-04 Wet 15
1.8 DR-05 Dry 16
1.8 DR-05 Wet 17
1.9 RC-01 Dry 18
1.9 RC-01 Wet 19
1.10 RC-02 Dry 20
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1.11 RC-03 Dry 22
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2.3 CSO-018 33
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4.2 CSO-05 51
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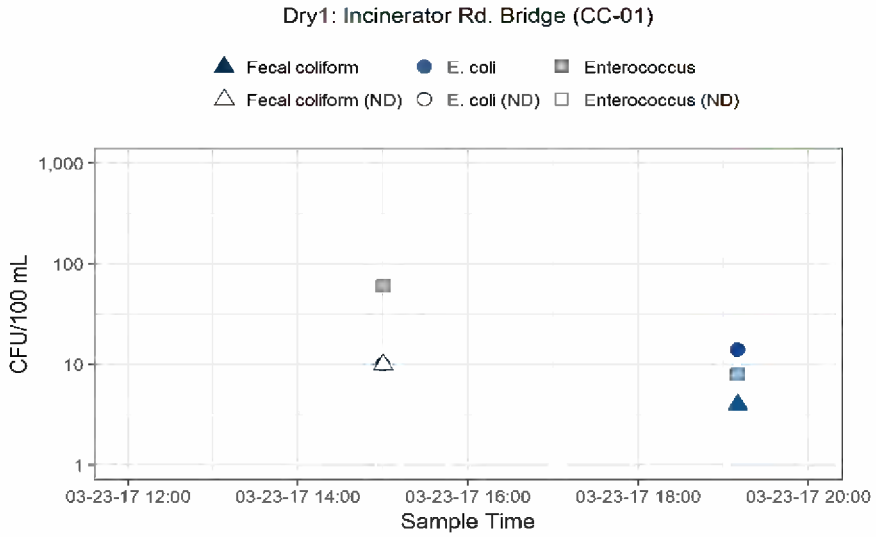
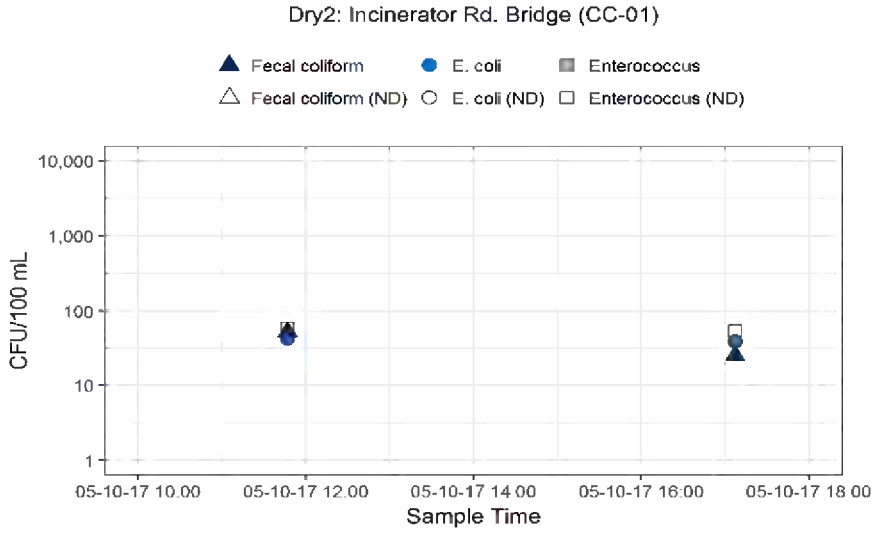
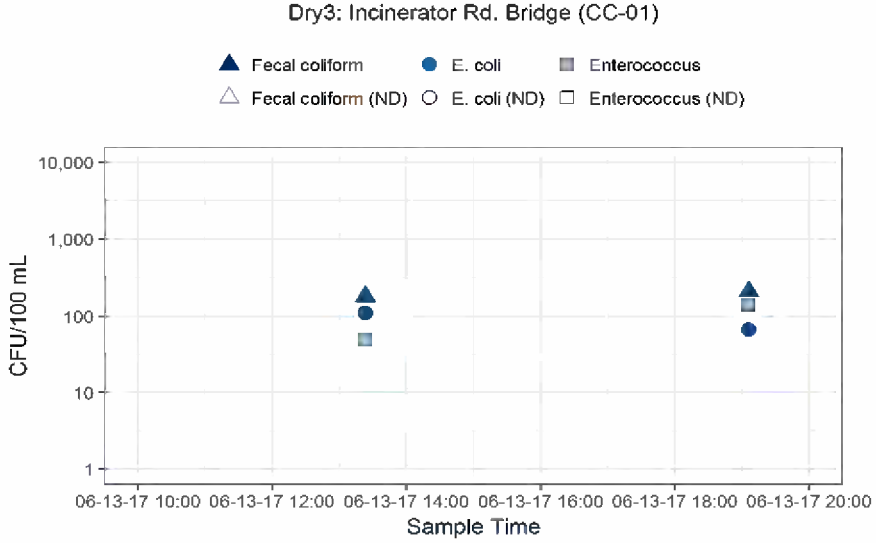
Section 1 Sampling Results by Station

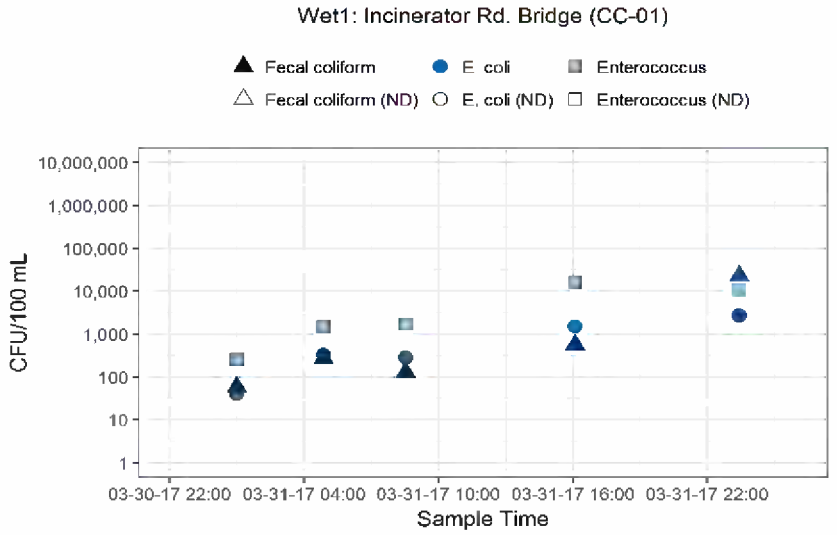
1.1 CC-01 Dry

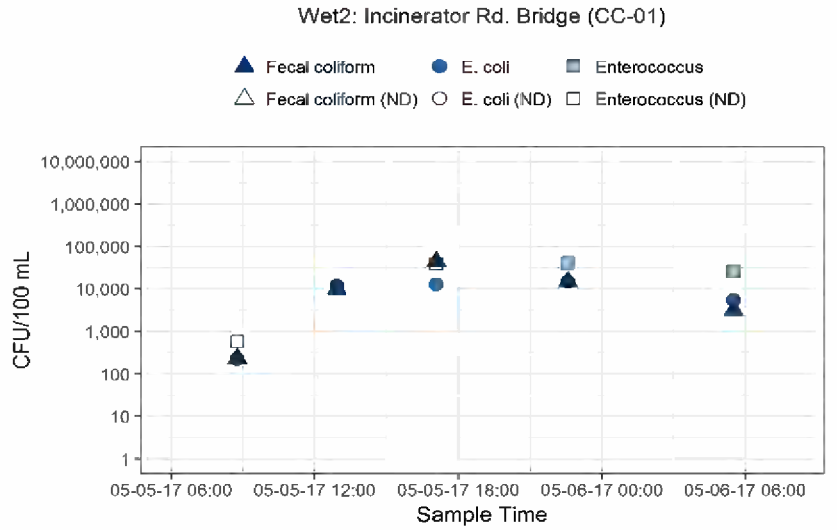

Dry1: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

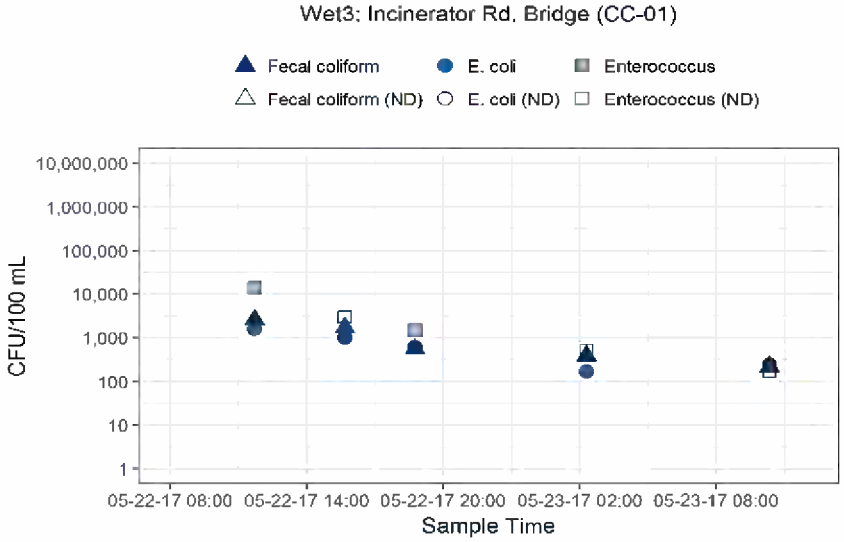

Dry2: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

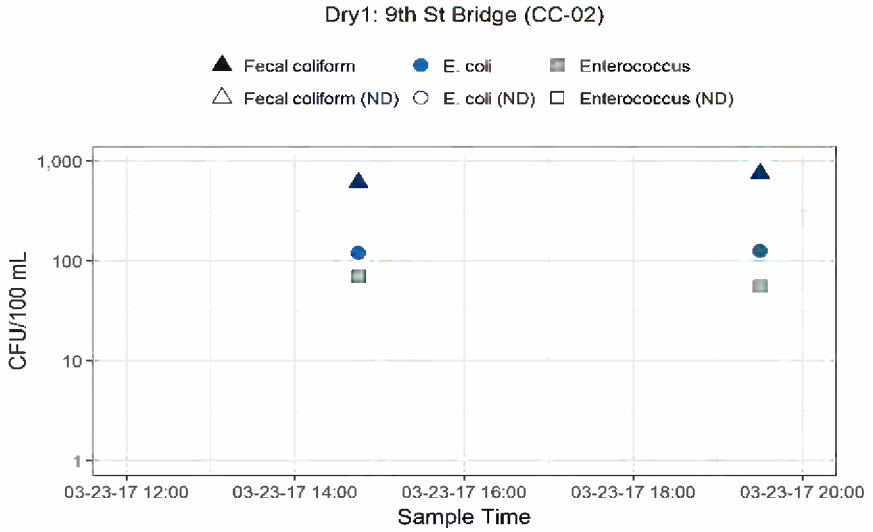
1.1 CC-01 Wet

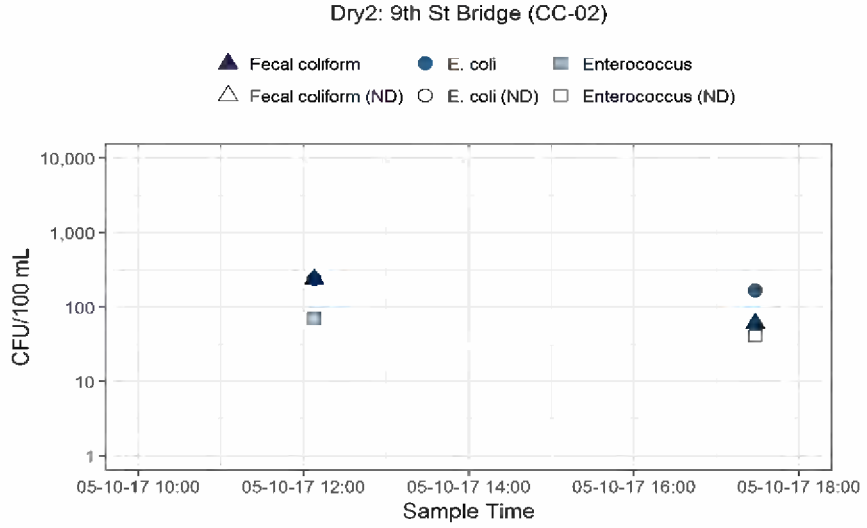

Wet1: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

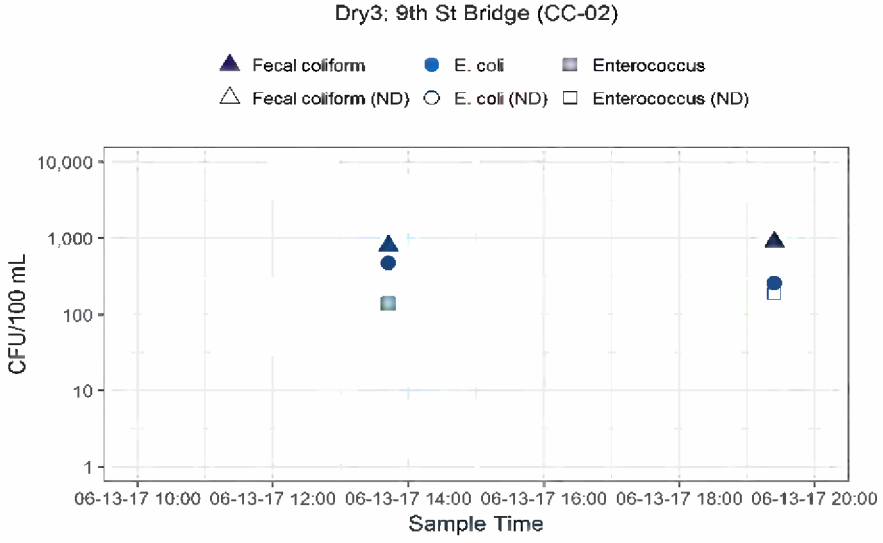

Wet2: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: Incinerator Rd. Bridge (CC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

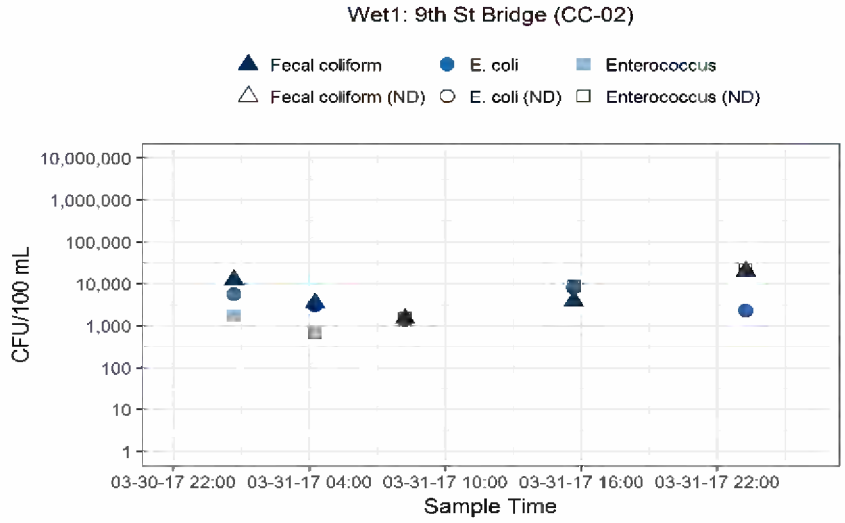
1.2 CC-02 Dry

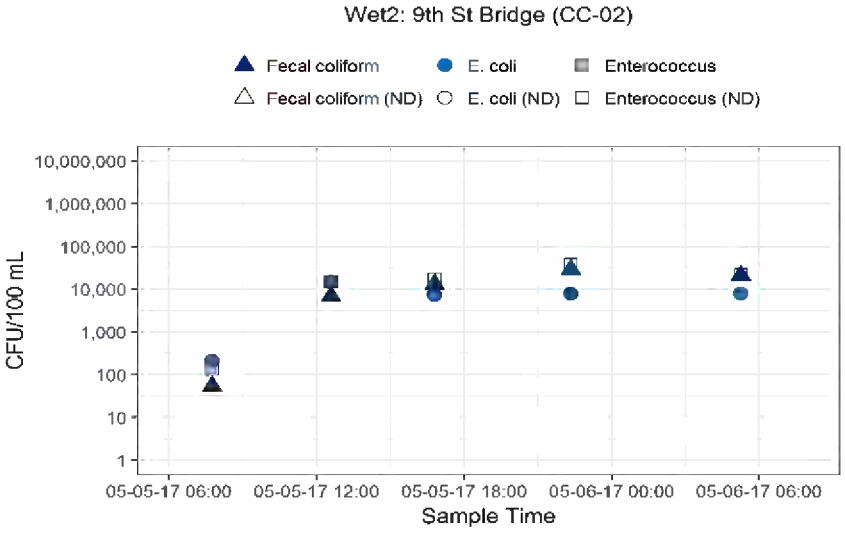

Dry1: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

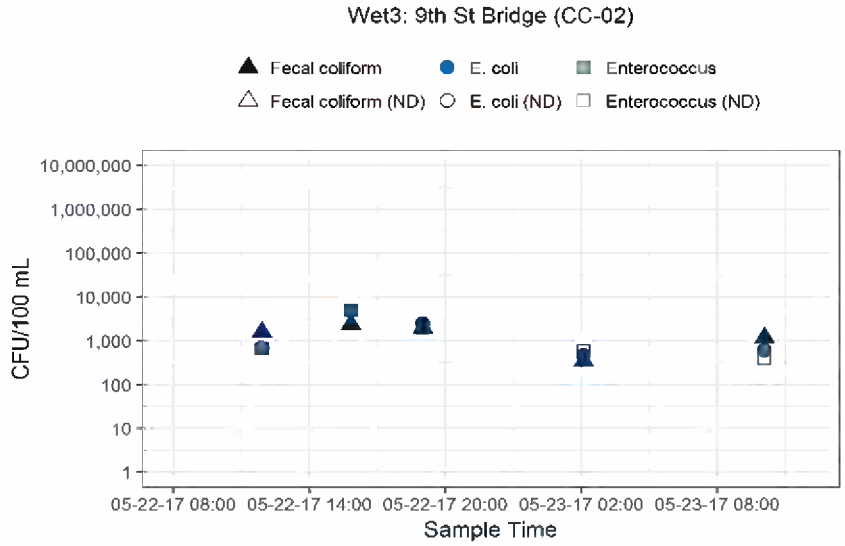

Dry2: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

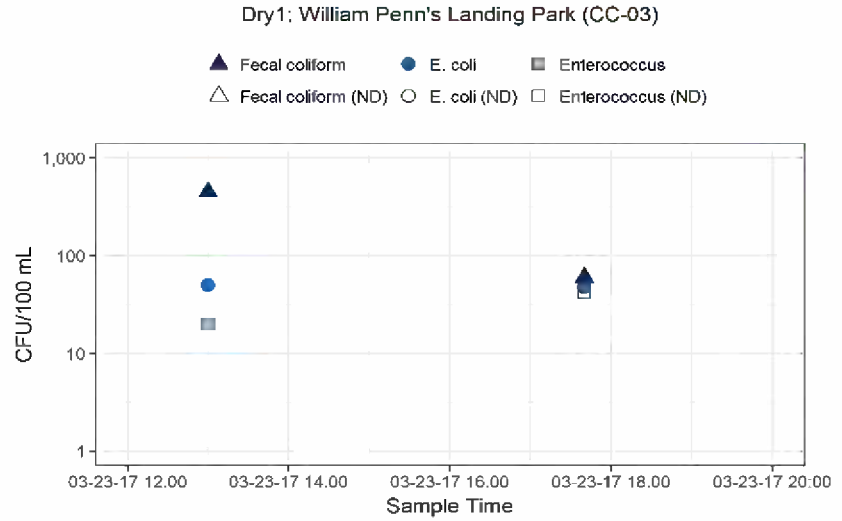
1.2 CC-02 Wet

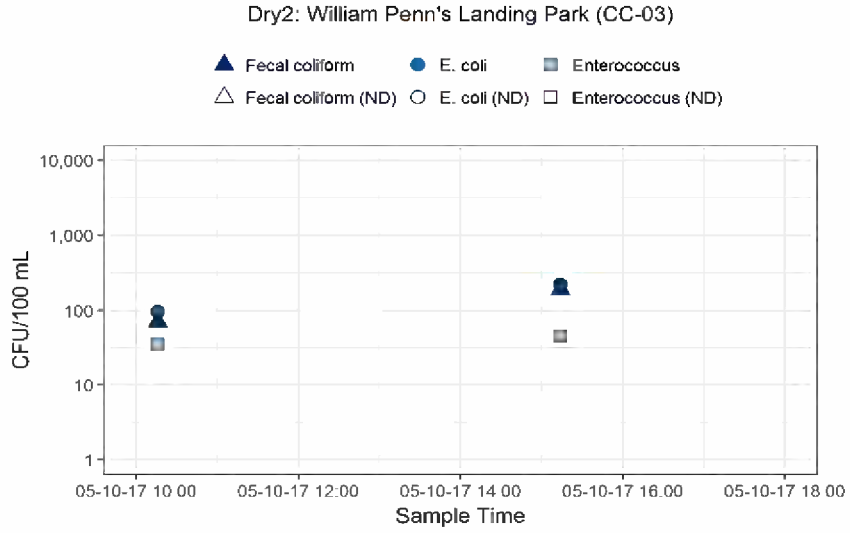

Wet1: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

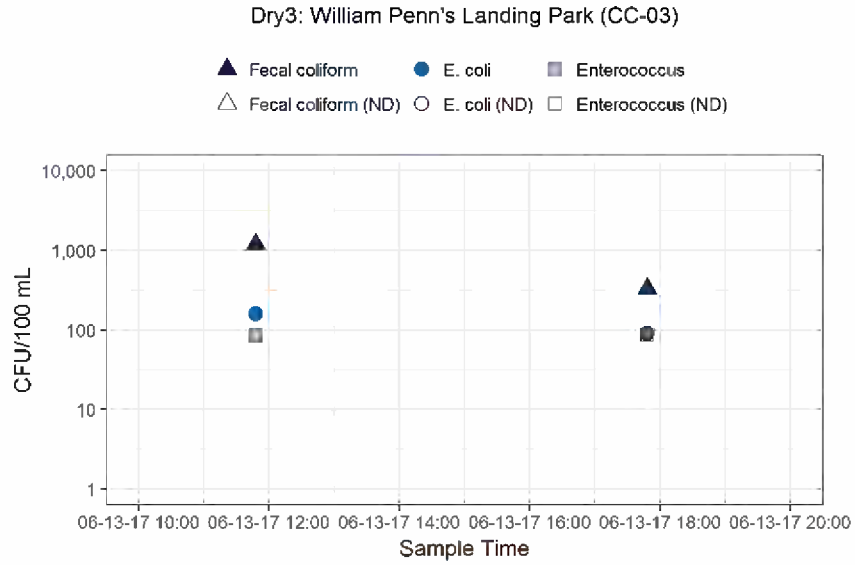

Wet2: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: 9th St Bridge (CC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

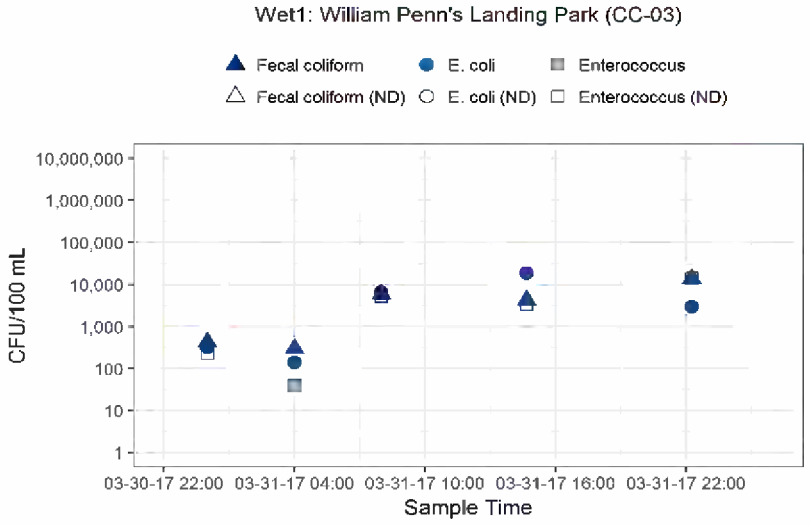
1.3 CC-03 Dry

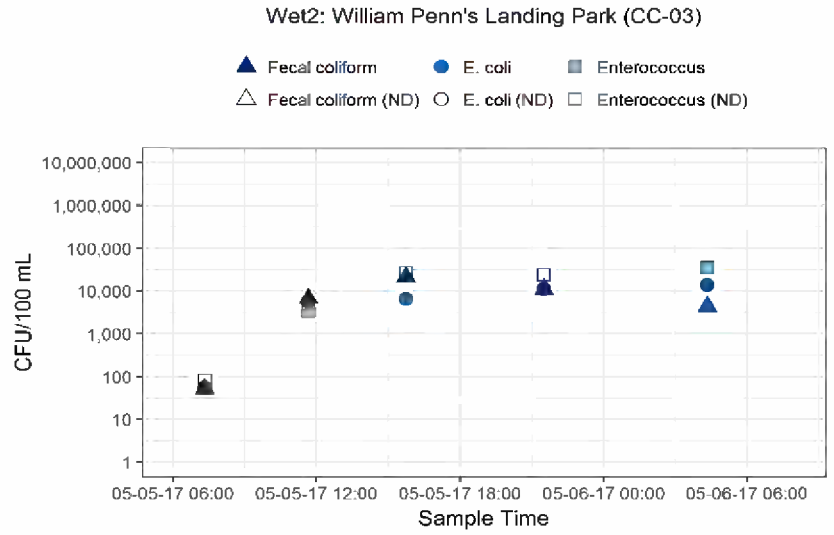

Dry1: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

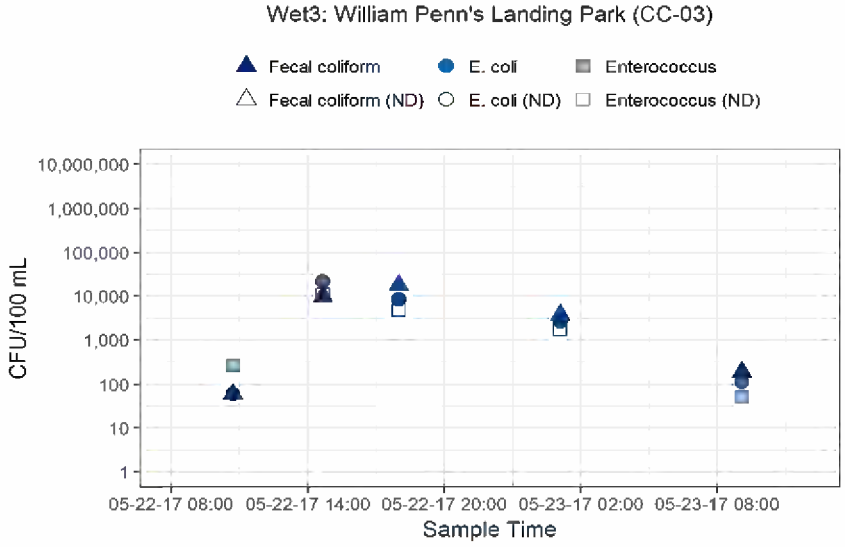

Dry2: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

1.3 CC-03 Wet

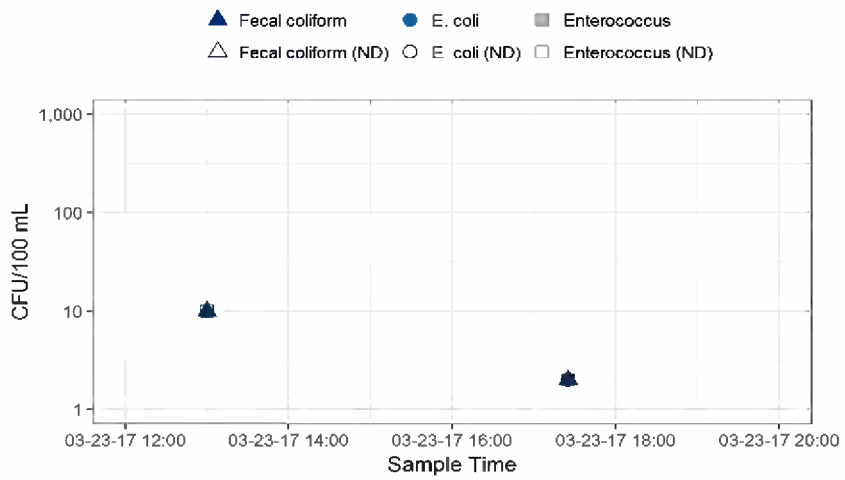

Wet1: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time


Wet2: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time

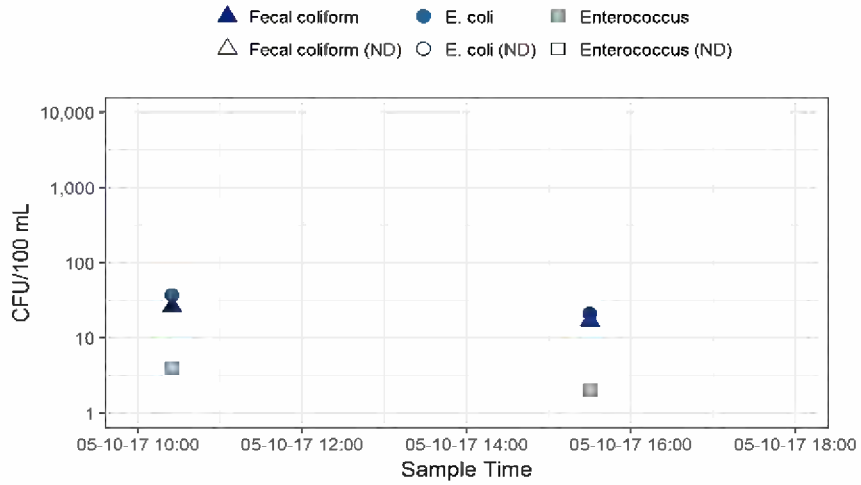

Wet3: William Penn's Landing Park (CC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

1.4 DR-01 Dry

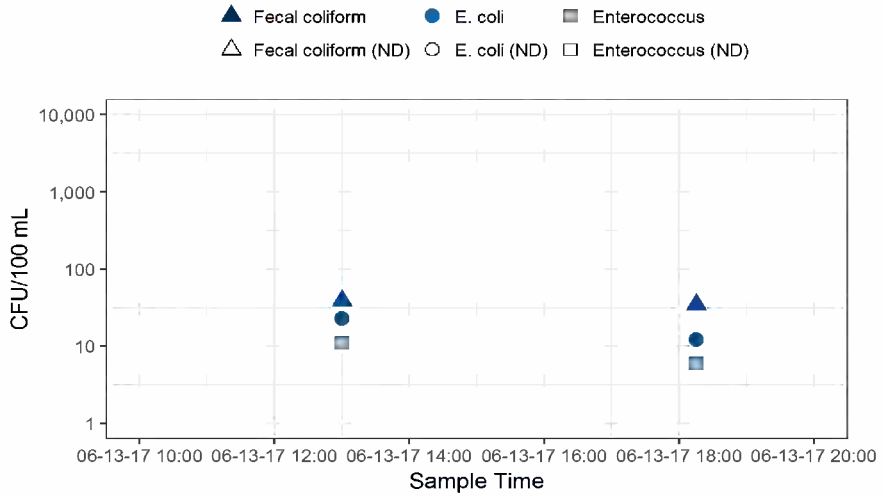
Dry1: Delaware River between Ridley Crk and Crum Crk (DR-01)



Dry2: Delaware River between Ridley Crk and Crum Crk (DR-01)

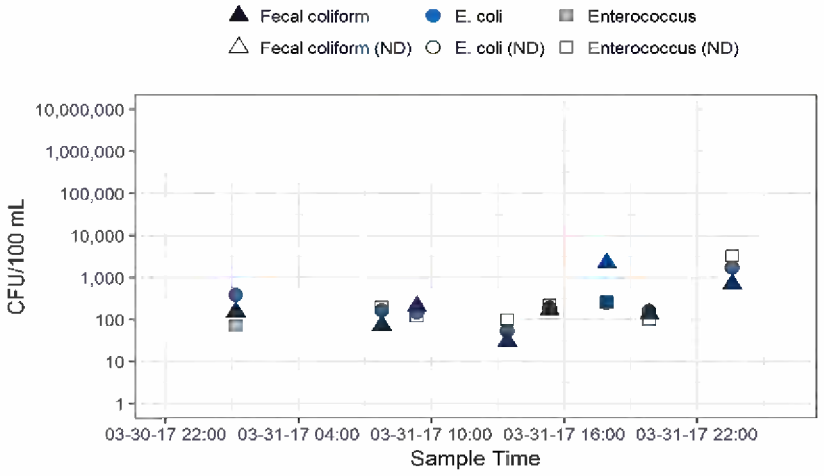


Dry3: Delaware River between Ridley Crk and Crum Crk (DR-01)

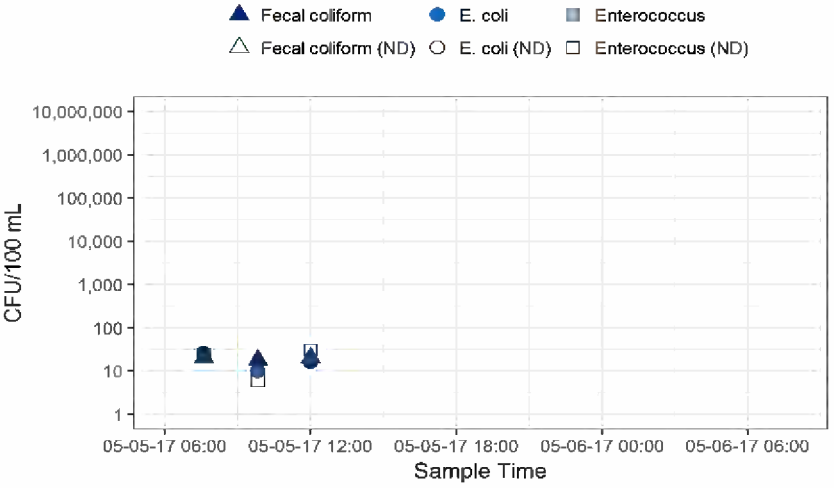


1.4 DR-01 Wet

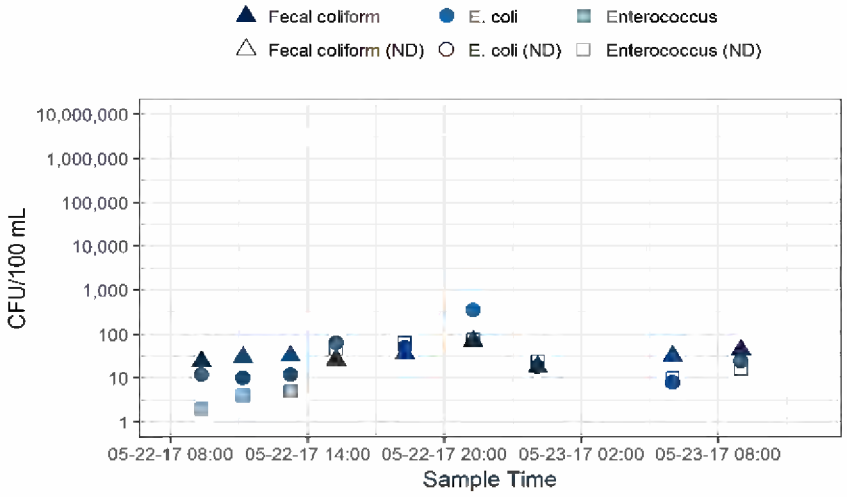
Wet1: Delaware River between Ridley Crk and Crum Crk (DR-01)



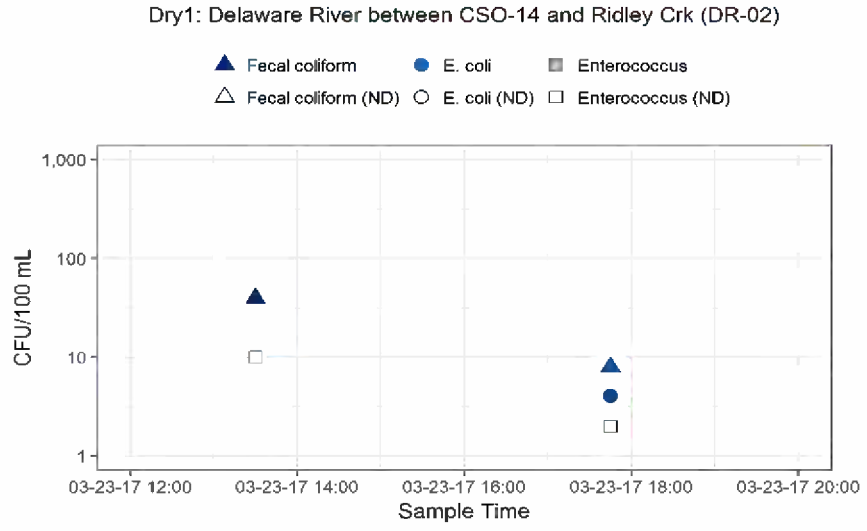
Wet2: Delaware River between Ridley Crk and Crum Crk (DR-01)

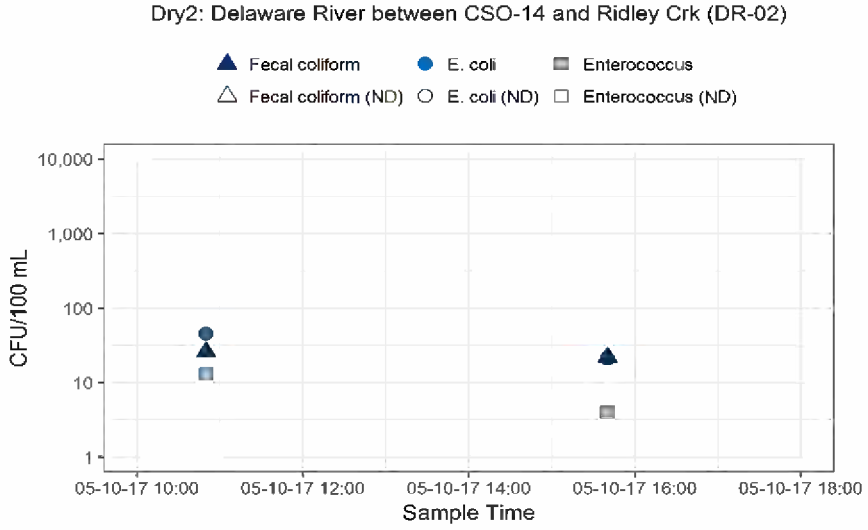


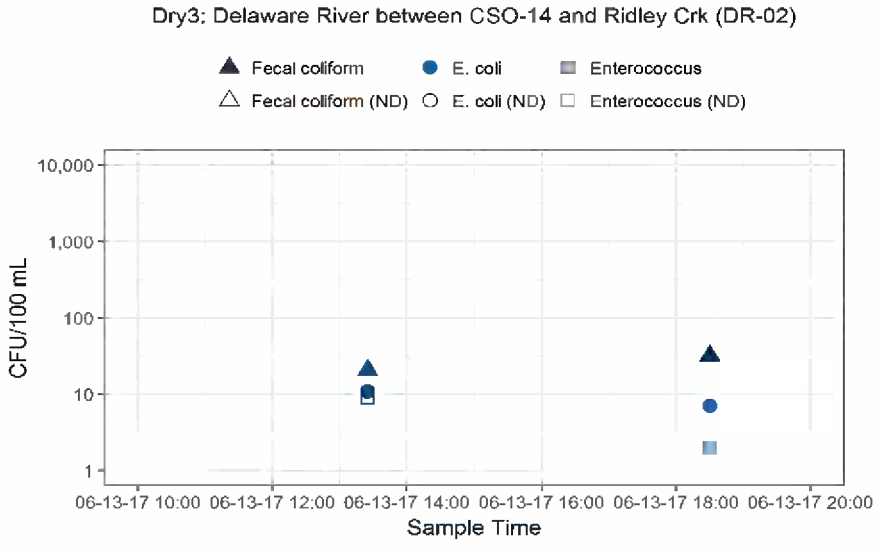
Wet3: Delaware River between Ridley Crk and Crum Crk (DR-01)



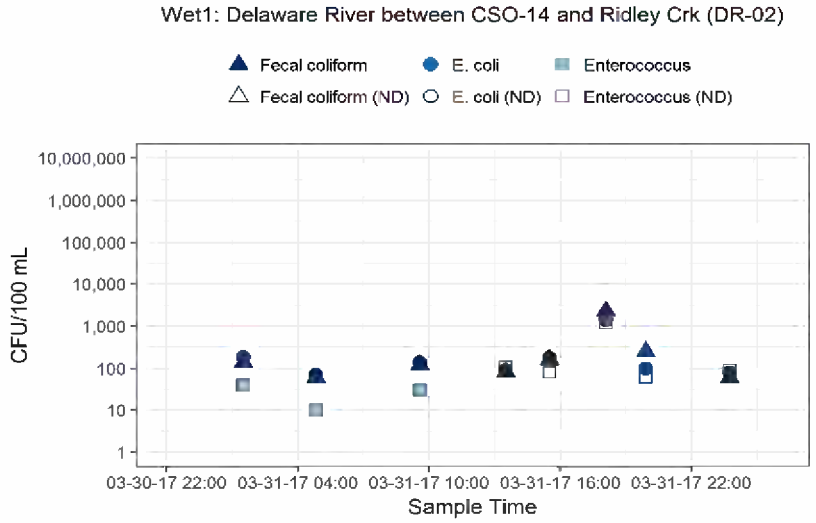
1.5 DR-02 Dry

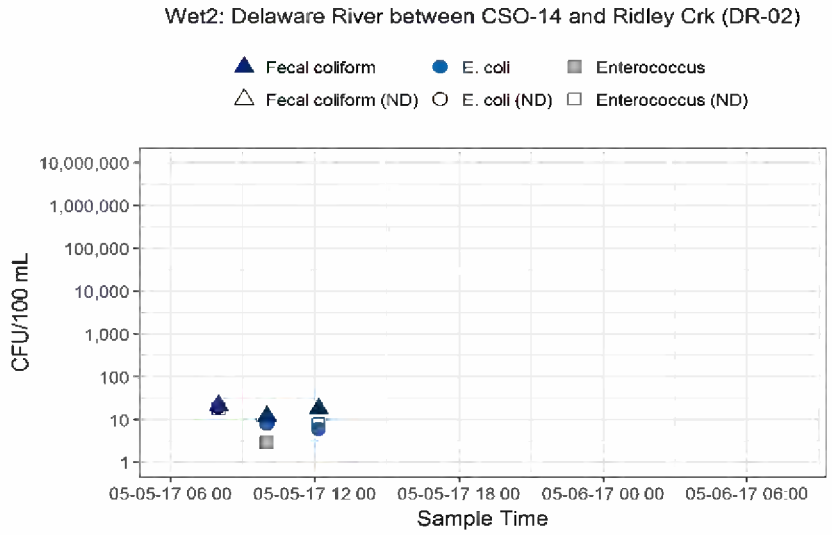

Dry1: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

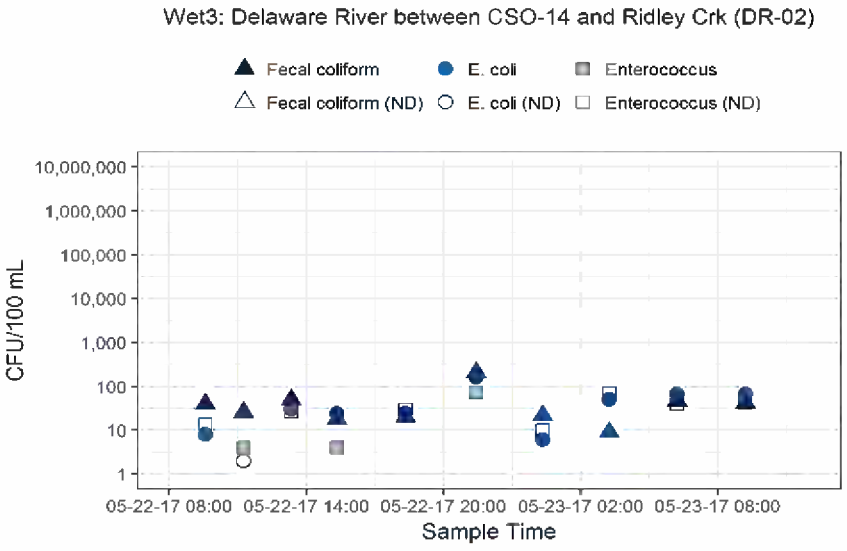

Dry2: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

1.5 DR-02 Wet

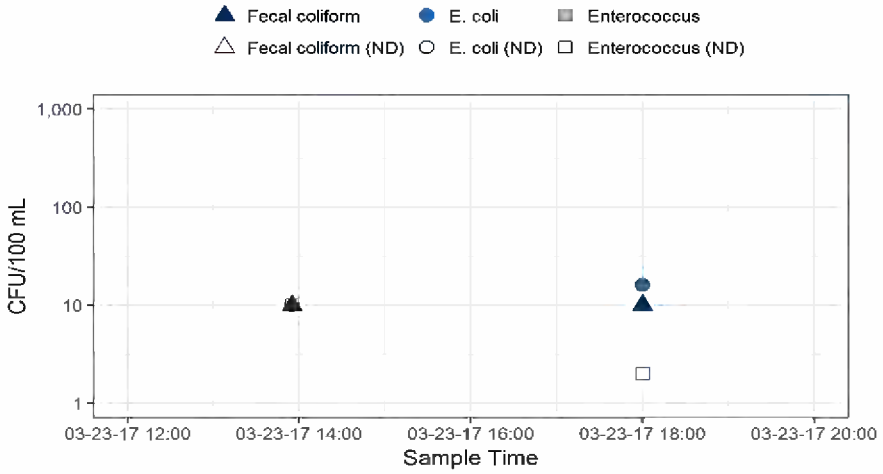

Wet1: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time


Wet2: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time

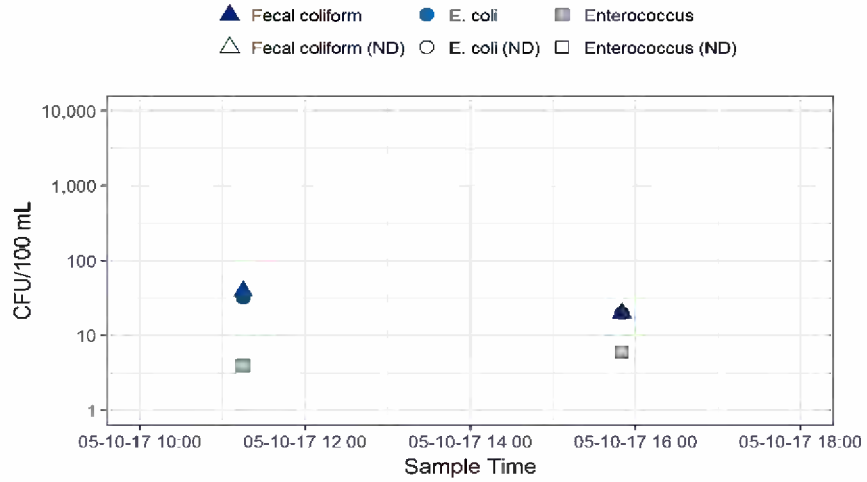

Wet3: Delaware River between CSO-14 and Ridley Crk (DR-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

1.6 DR-03 Dry

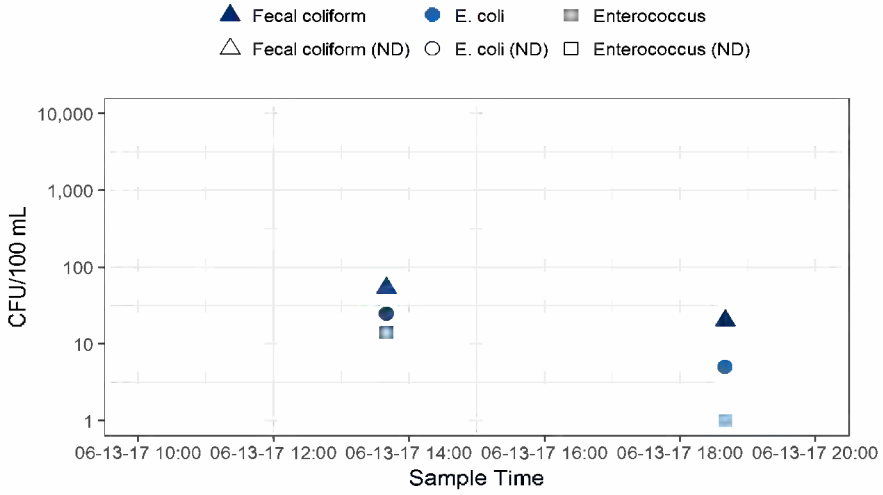
Dry1: Delaware River between CSO-11 and Chester Crk (DR-03)



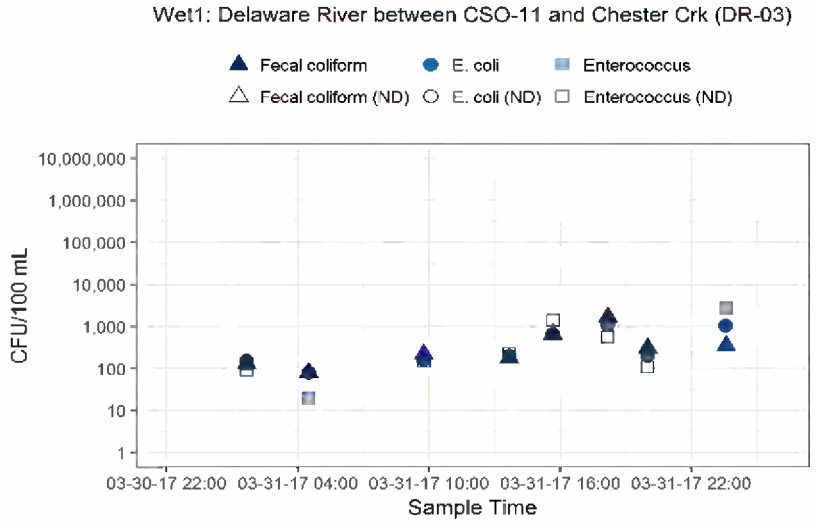
Dry2: Delaware River between CSO-11 and Chester Crk (DR-03)

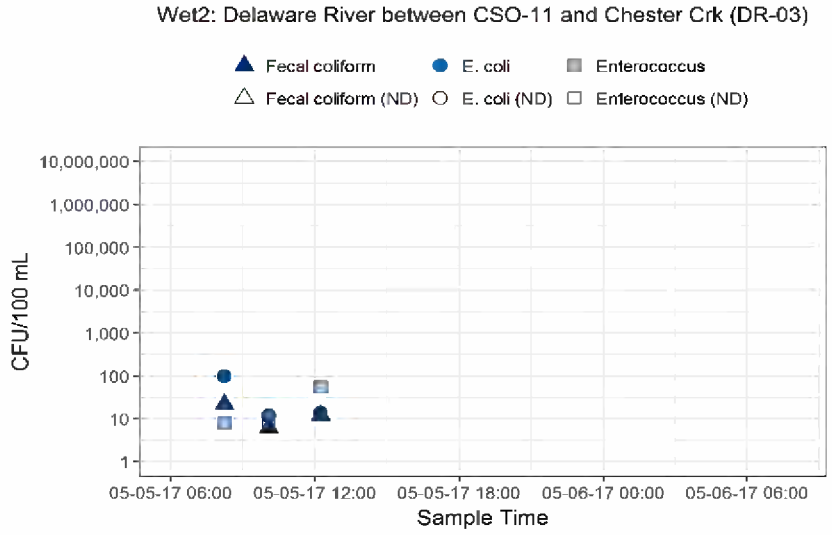


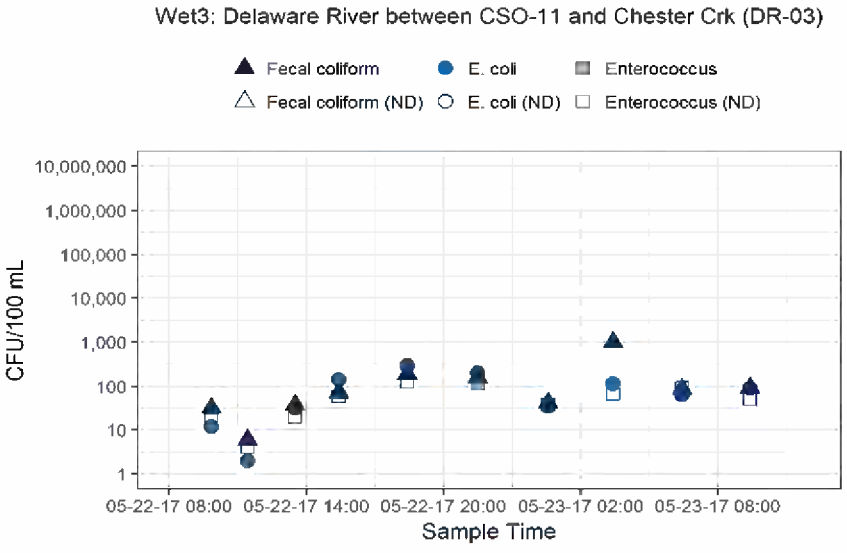
Dry3: Delaware River between CSO-11 and Chester Crk (DR-03)



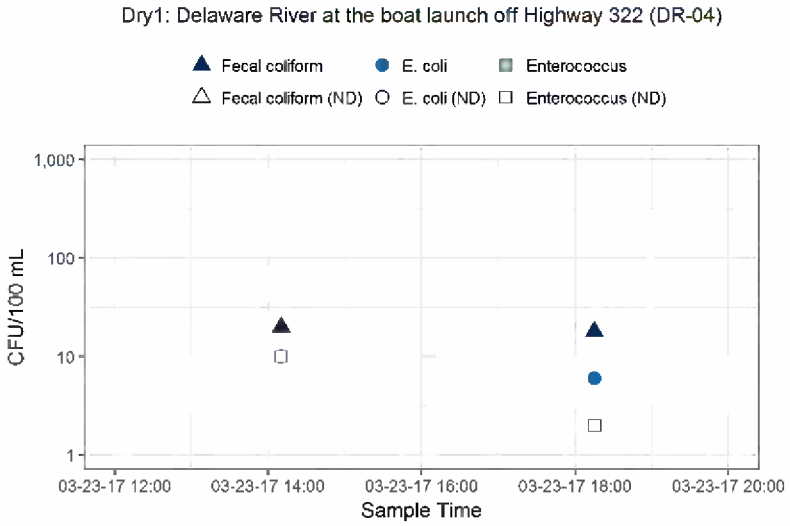
1.6 DR-03 Wet

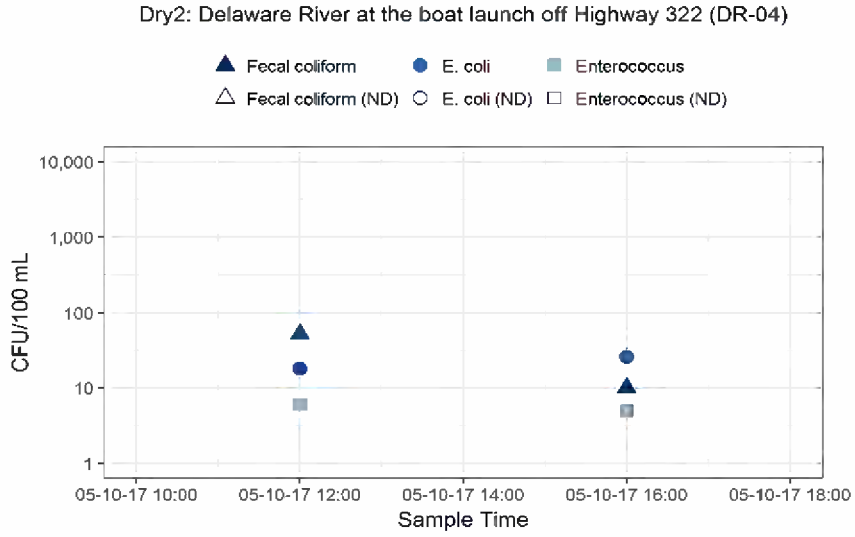

Wet1: Delaware River between CSO-11 and Chester Crk (DR-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

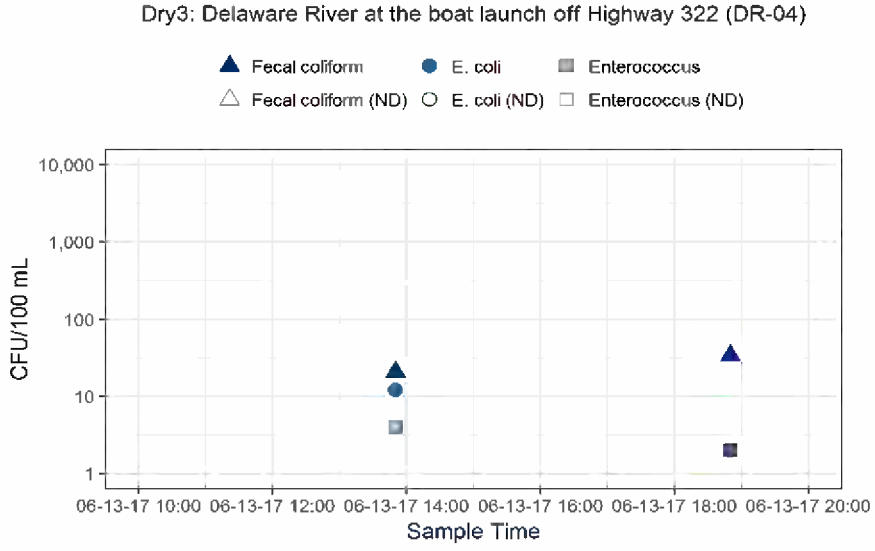

Wet2: Delaware River between CSO-11 and Chester Crk (DR-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: Delaware River between CSO-11 and Chester Crk (DR-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

1.7 DR-04 Dry

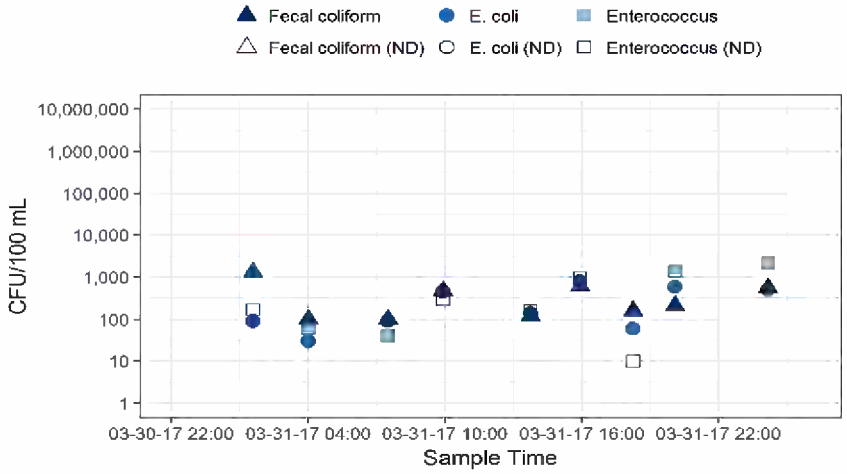

Dry1: Delaware River at the boat launch off Highway 322 (DR-04)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time


Dry2: Delaware River at the boat launch off Highway 322 (DR-04)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time

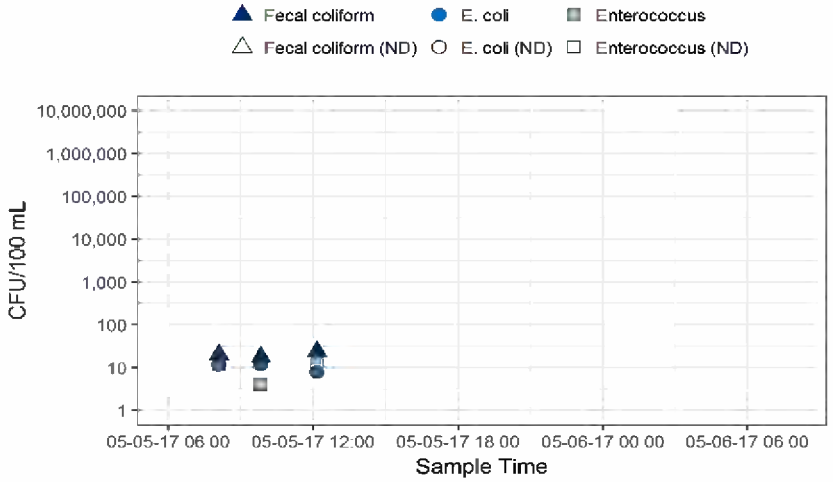

Dry3: Delaware River at the boat launch off Highway 322 (DR-04)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

1.7 DR-04 Wet

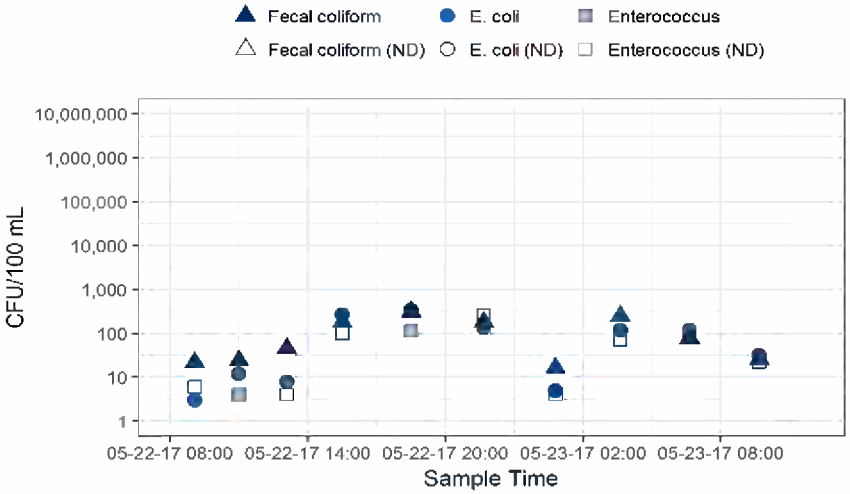
Wet1: Delaware River at the boat launch off Highway 322 (DR-04)



Wet2: Delaware River at the boat launch off Highway 322 (DR-04)

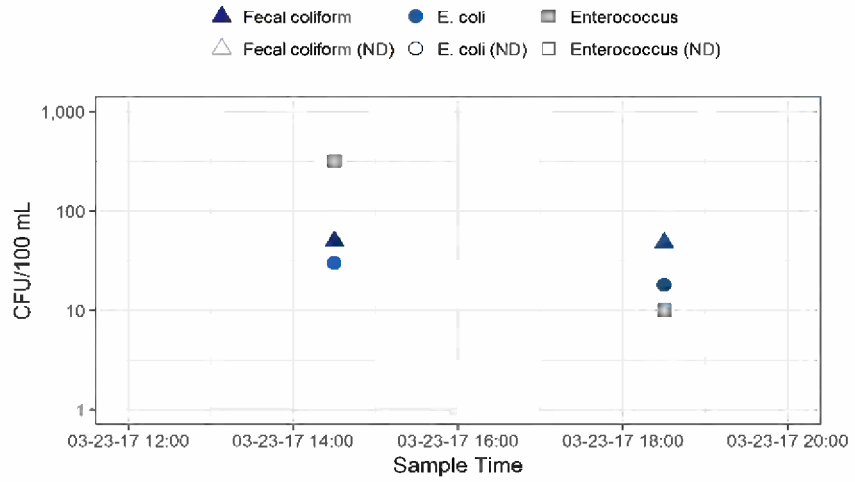


Wet3: Delaware River at the boat launch off Highway 322 (DR-04)

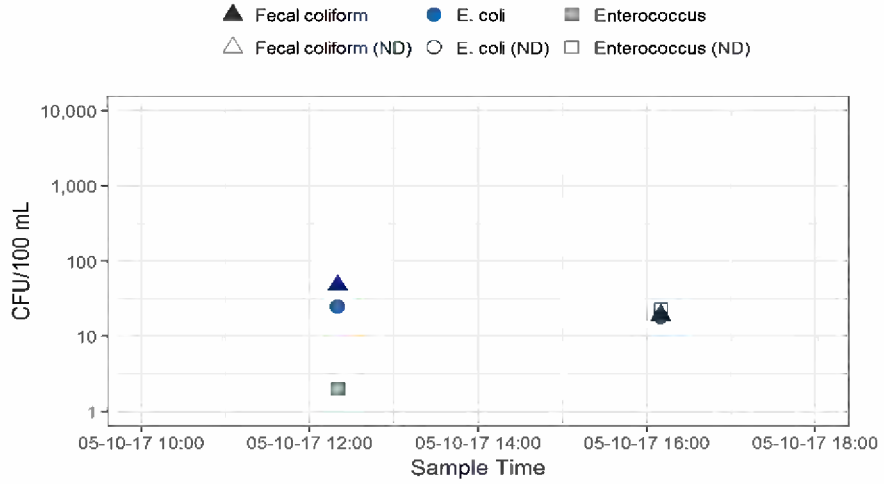


1.8 DR-05 Dry

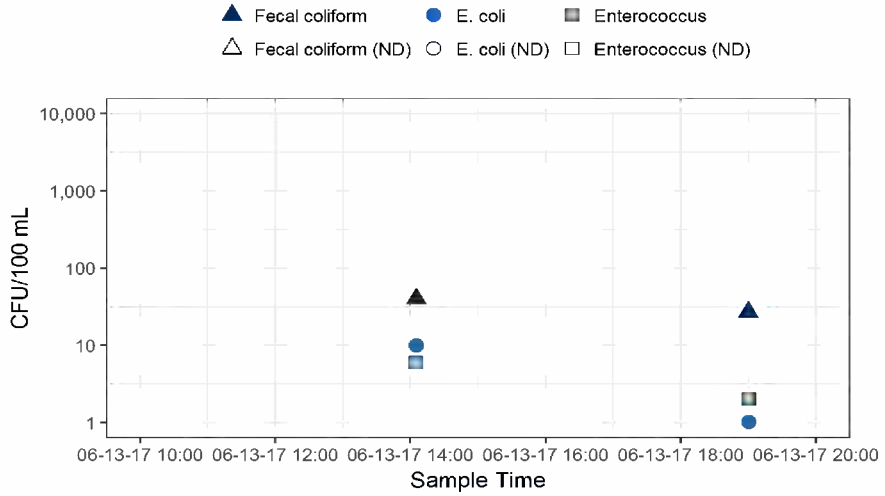
Dry1: Delaware River between CSO- 002 and Stoney Crk (DR-05)



Dry2: Delaware River between CSO- 002 and Stoney Crk (DR-05)

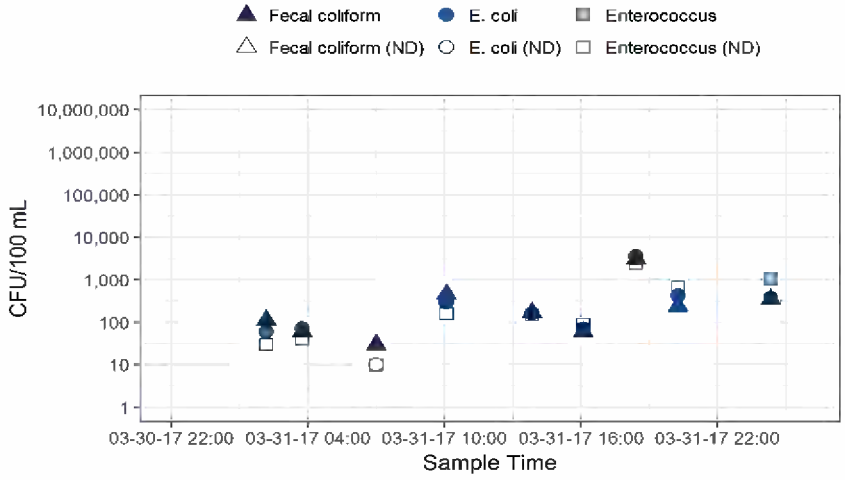


Dry3: Delaware River between CSO- 002 and Stoney Crk (DR-05)

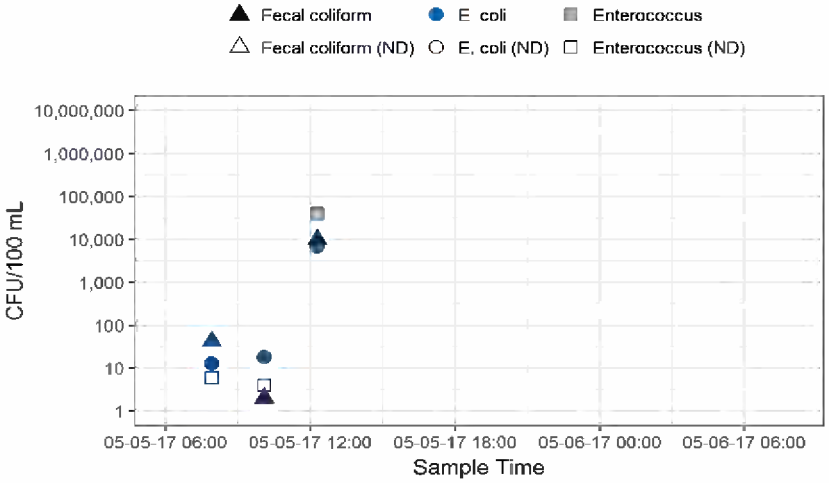


1.8 DR-05 Wet

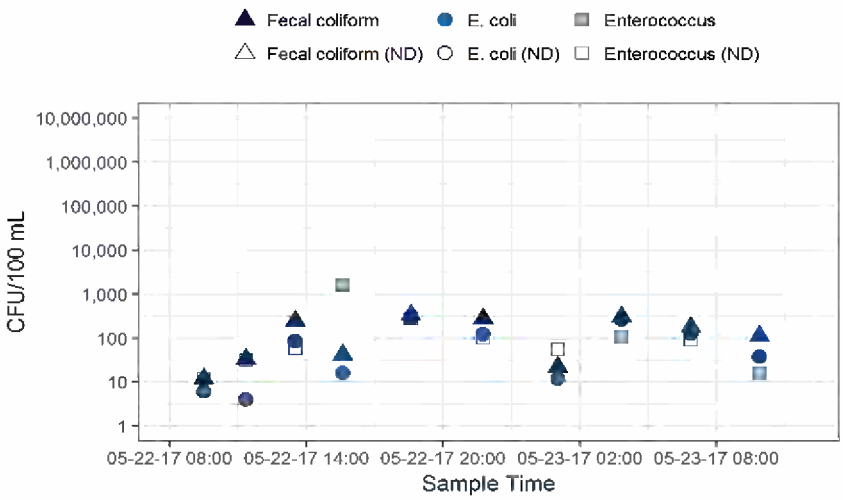
Wet1: Delaware River between CSO- 002 and Stoney Crk (DR-05)



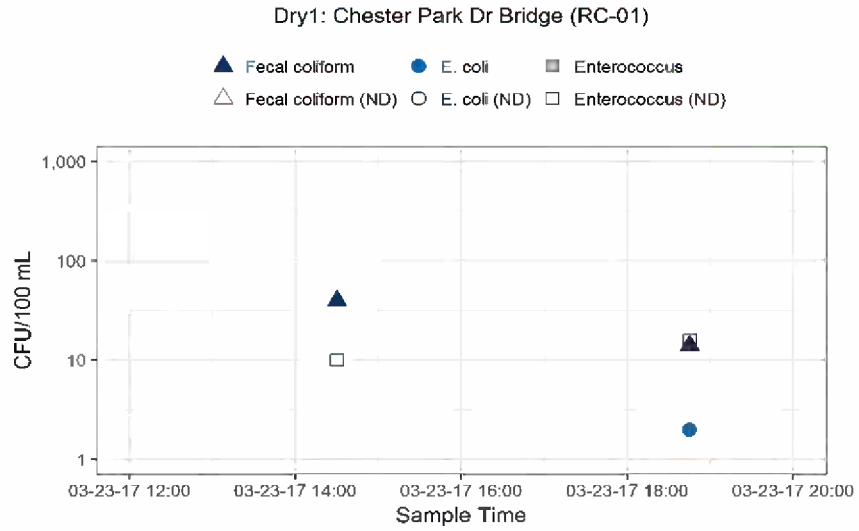
Wet2: Delaware River between CSO- 002 and Stoney Crk (DR-05)

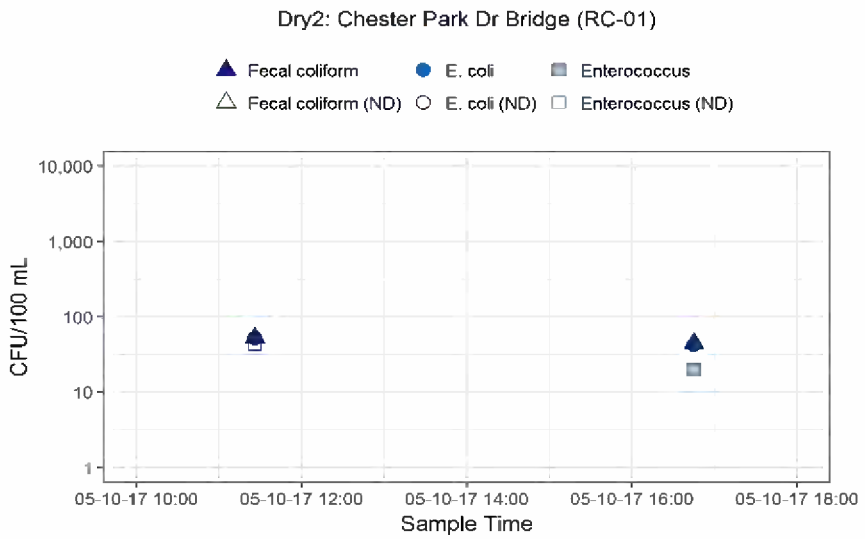


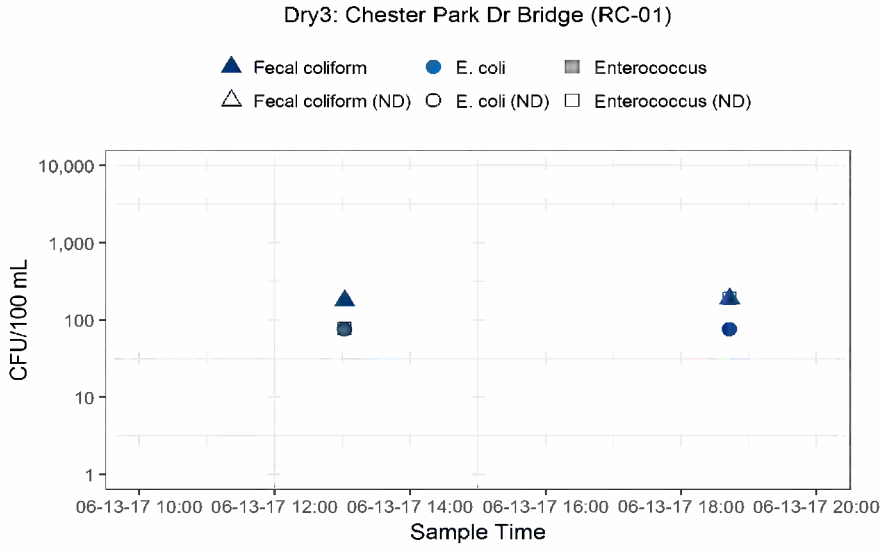
Wet3: Delaware River between CSO- 002 and Stoney Crk (DR-05)



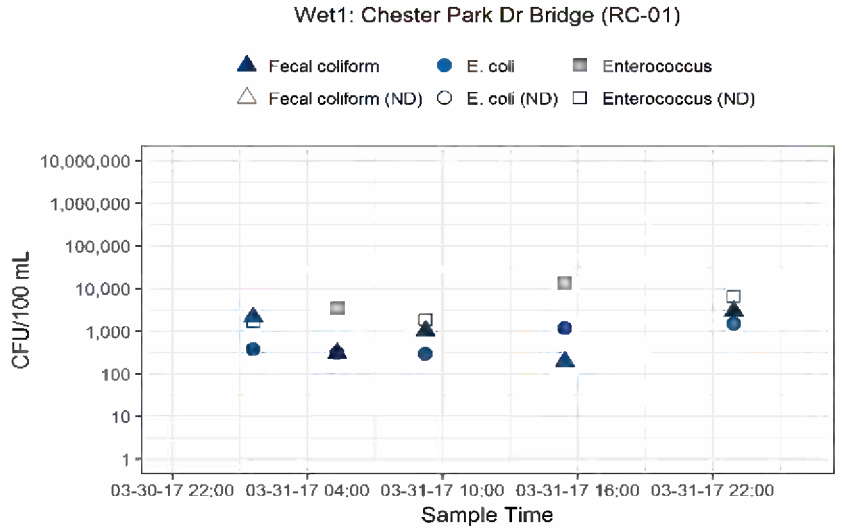
1.9 RC-01 Dry

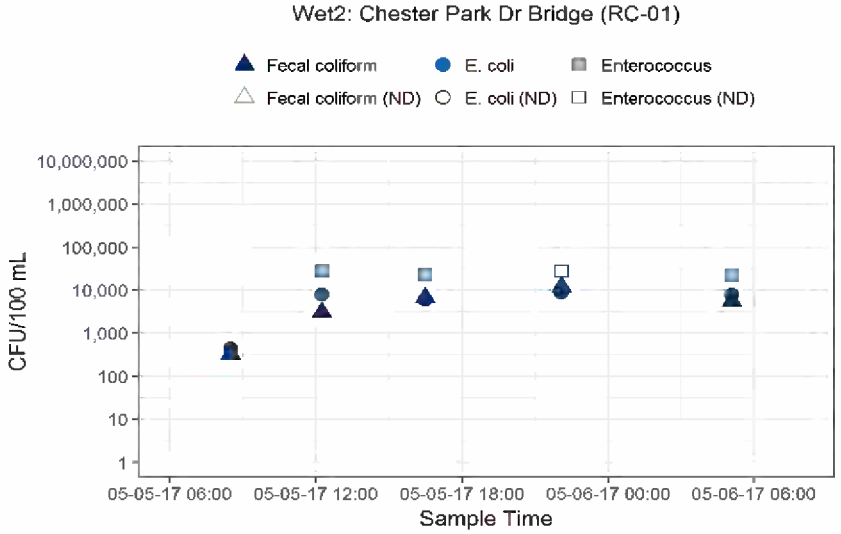

Dry1: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

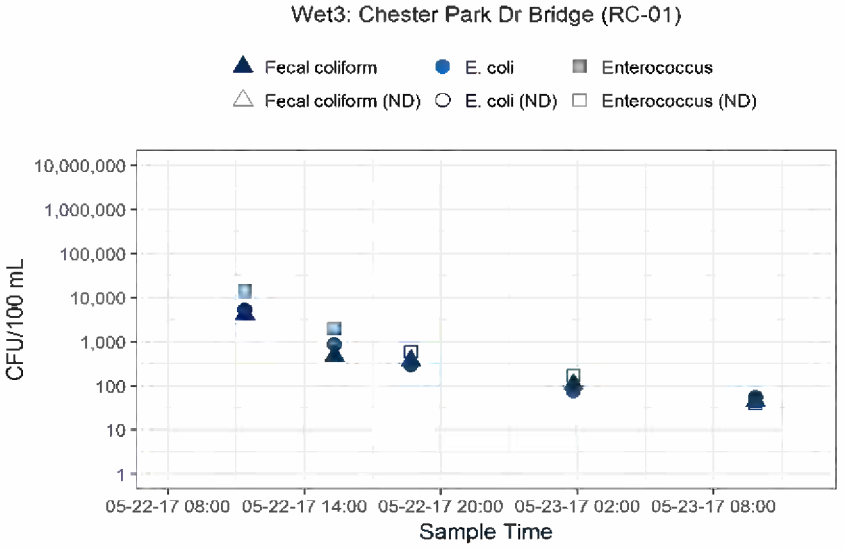

Dry2: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

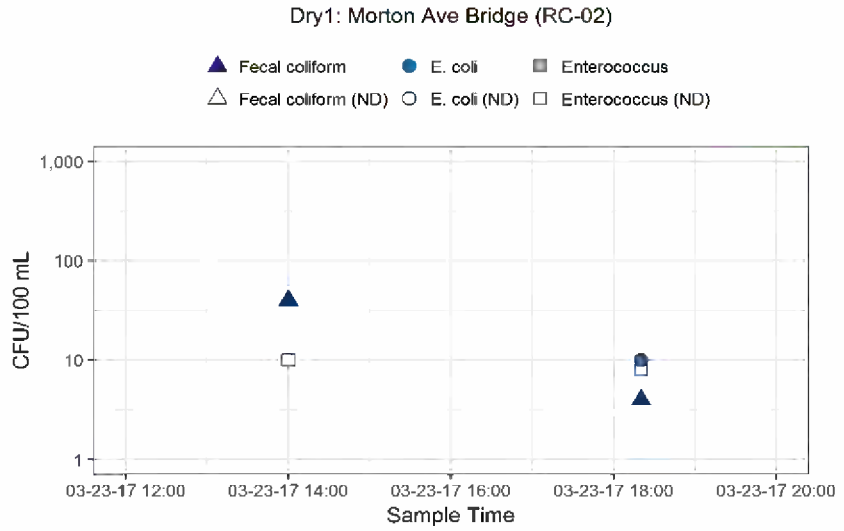
1.9 RC-01 Wet

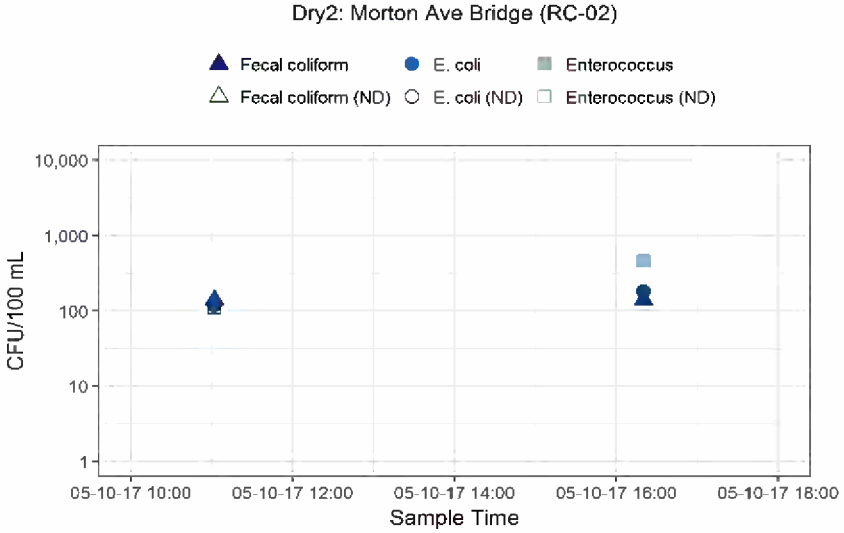

Wet1: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

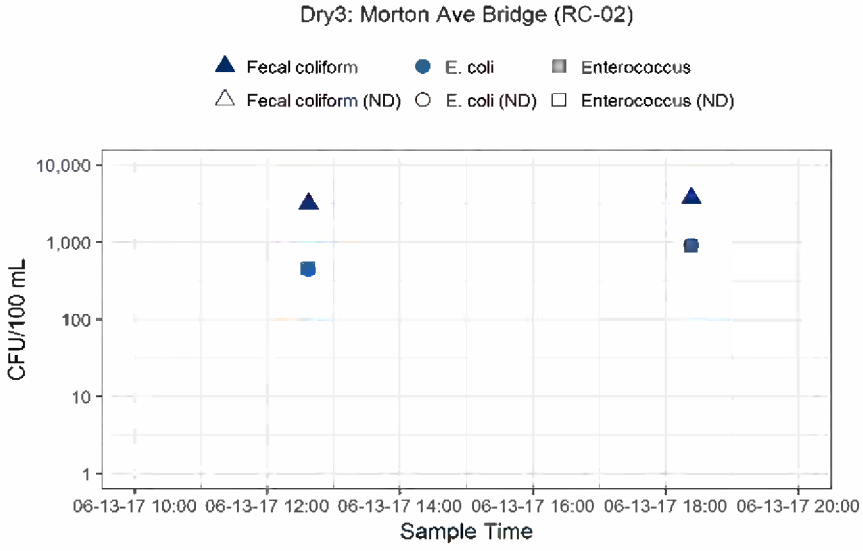

Wet2: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: Chester Park Dr Bridge (RC-01)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

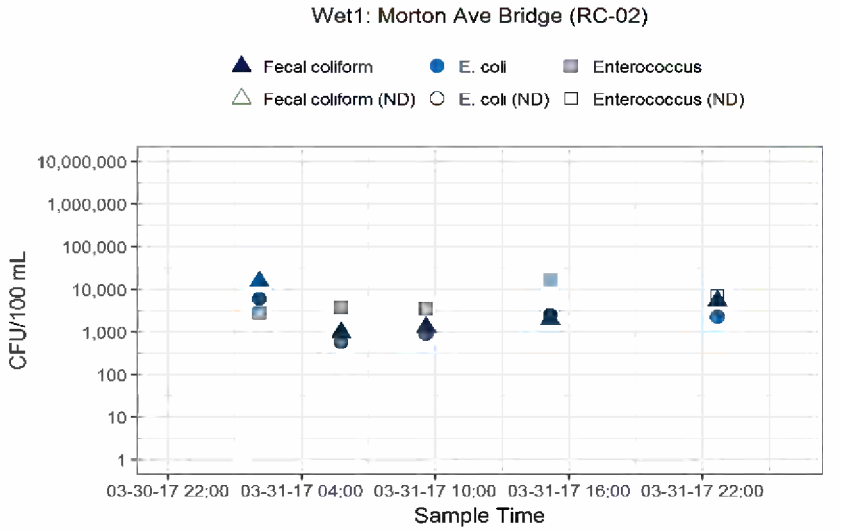
1.10 RC-02 Dry

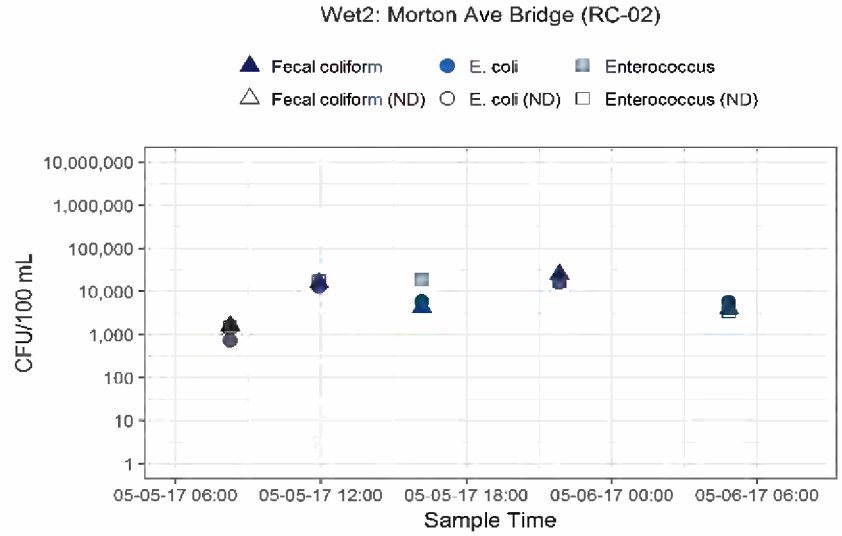

Dry1: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

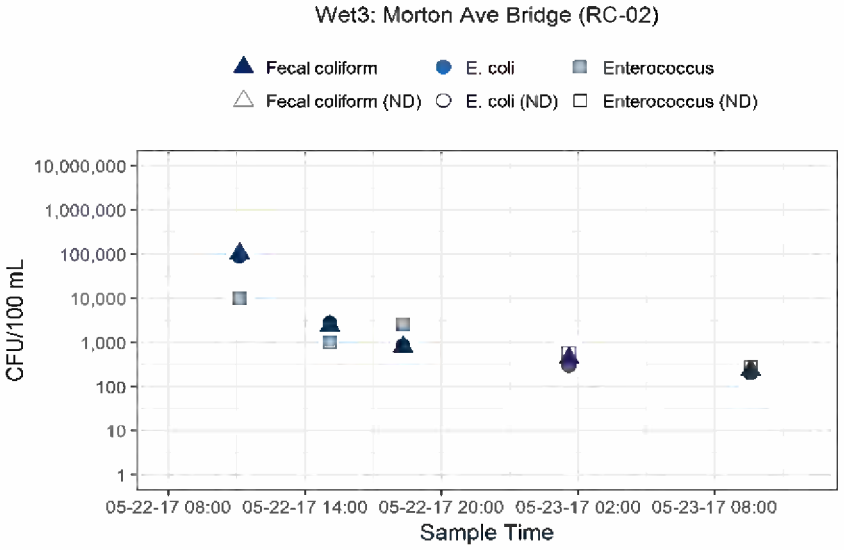

Dry2: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

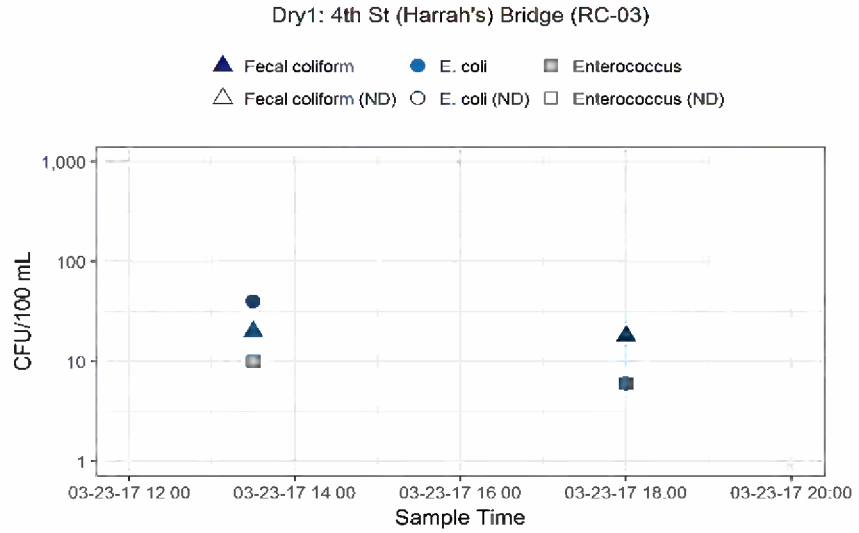
1.10 RC-02 Wet

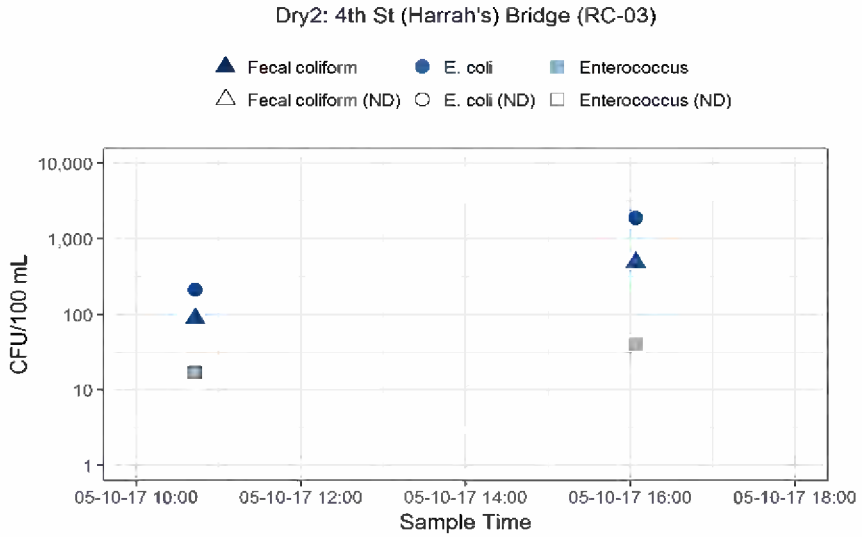

Wet1: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

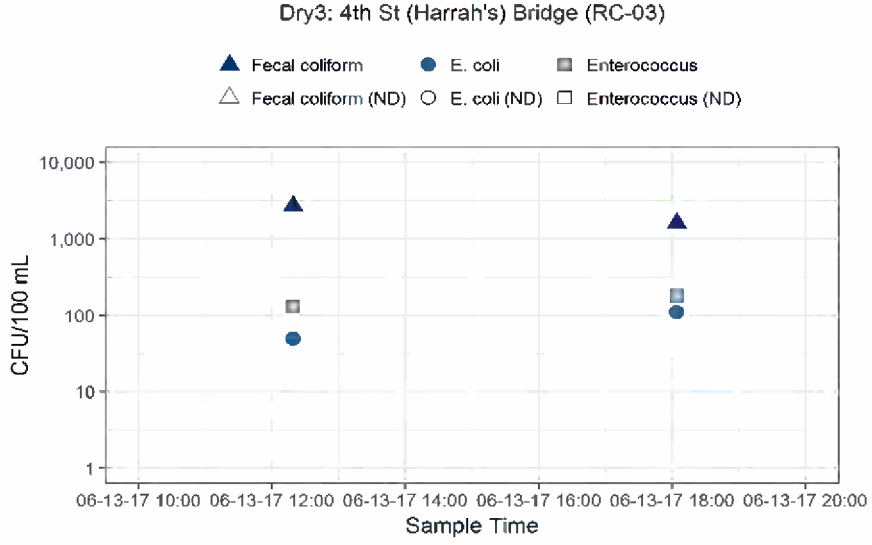

Wet2: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: Morton Ave Bridge (RC-02)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

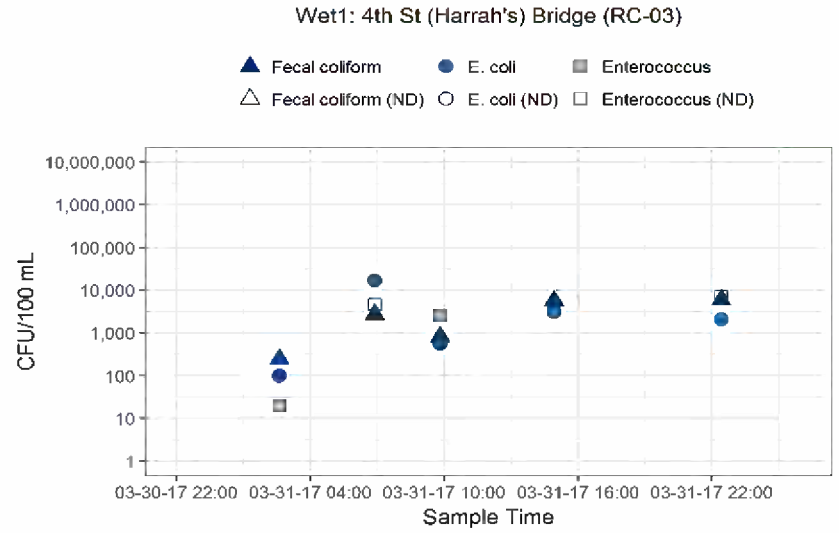
1.11 RC-03 Dry

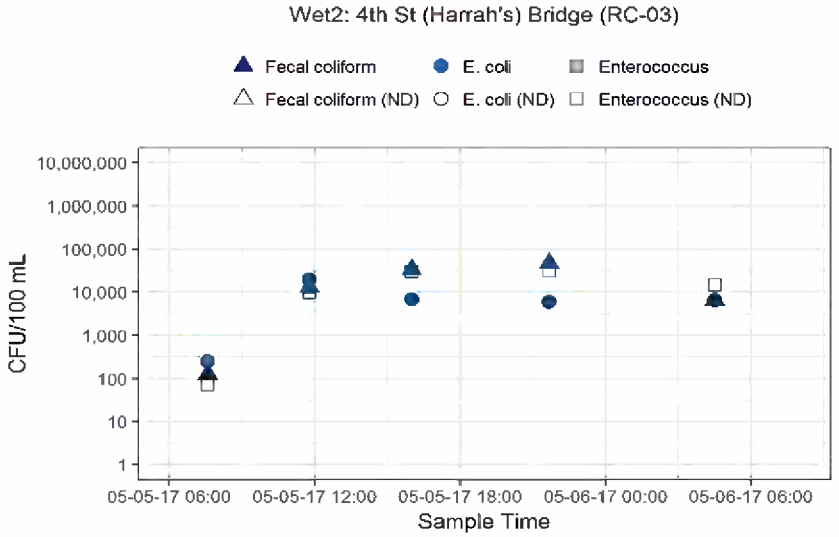

Dry1: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
1,000
100
10
1
03-23-17 12:00
03-23-17 14:00
03-23-17 16:00
03-23-17 18:00
03-23-17 20:00
Sample Time

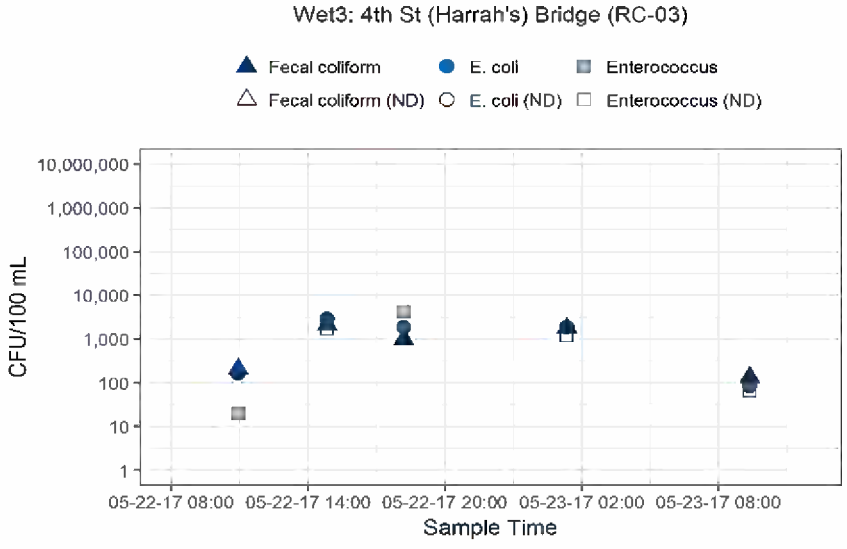

Dry2: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
05-10-17 10:00
05-10-17 12:00
05-10-17 14:00
05-10-17 16:00
05-10-17 18:00
Sample Time


Dry3: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000
1,000
100
10
1
06-13-17 10:00
06-13-17 12:00
06-13-17 14:00
06-13-17 16:00
06-13-17 18:00
06-13-17 20:00
Sample Time

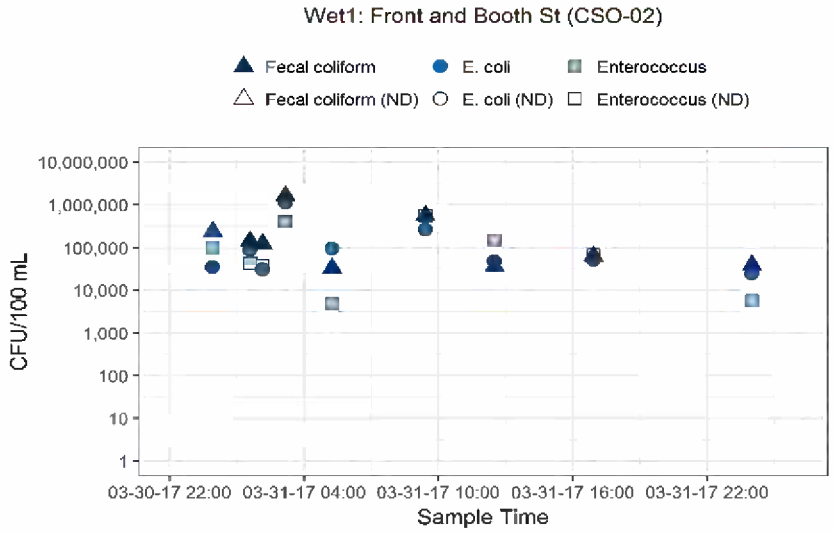
1.11 RC-03 Wet

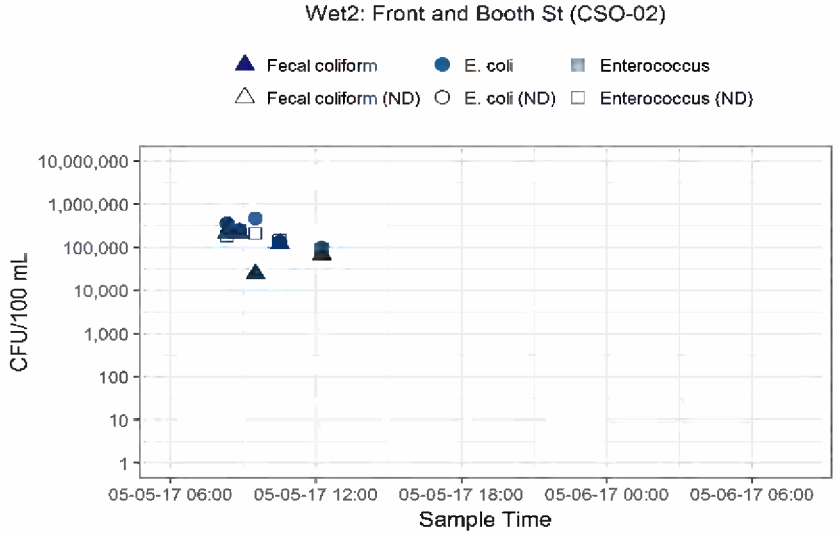

Wet1: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
03-30-17 22:00
03-31-17 04:00
03-31-17 10:00
03-31-17 16:00
03-31-17 22:00
Sample Time

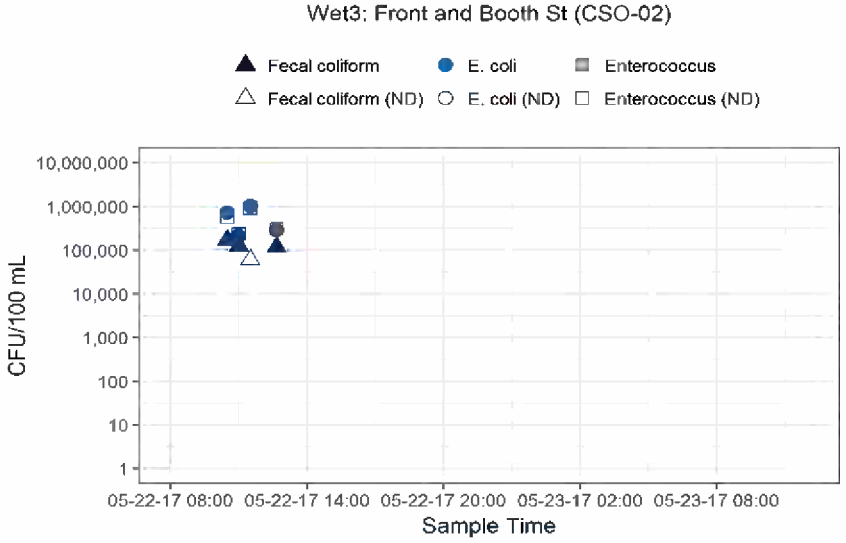

Wet2: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-05-17 06:00
05-05-17 12:00
05-05-17 18:00
05-06-17 00:00
05-06-17 06:00
Sample Time


Wet3: 4th St (Harrah's) Bridge (RC-03)
Fecal coliform
E. coli
Enterococcus
Fecal coliform (ND)
E. coli (ND)
Enterococcus (ND)
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
05-22-17 08:00
05-22-17 14:00
05-22-17 20:00
05-23-17 02:00
05-23-17 08:00
Sample Time

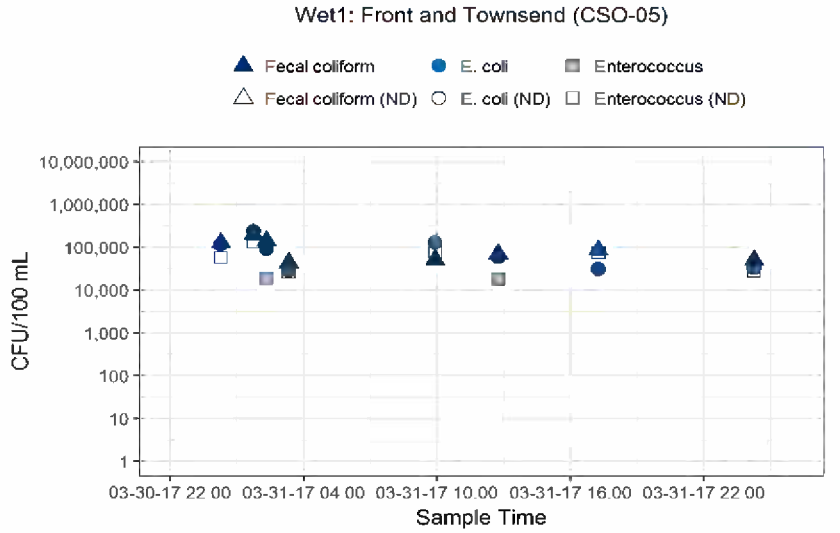
1.12 CSO-02 Wet

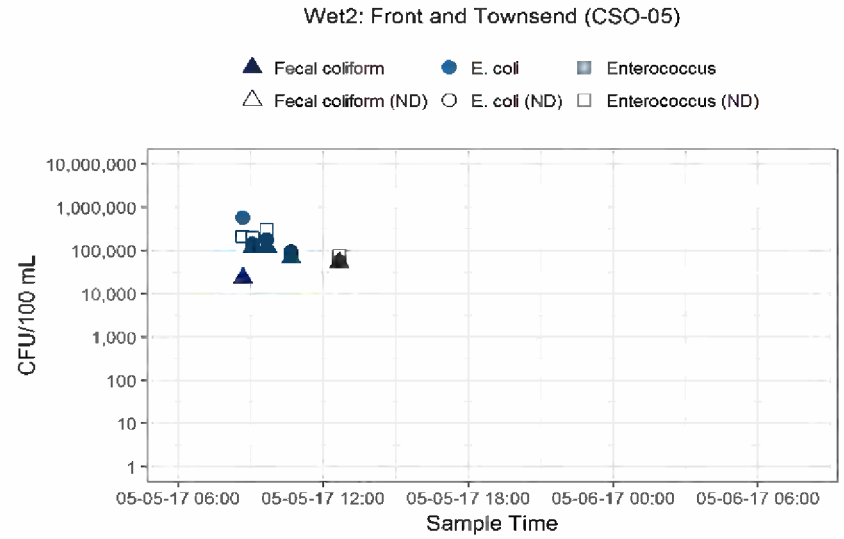


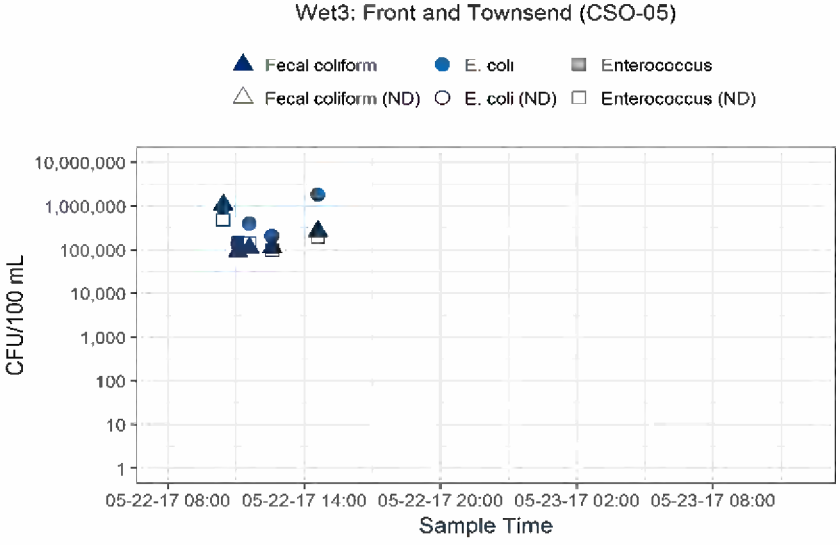




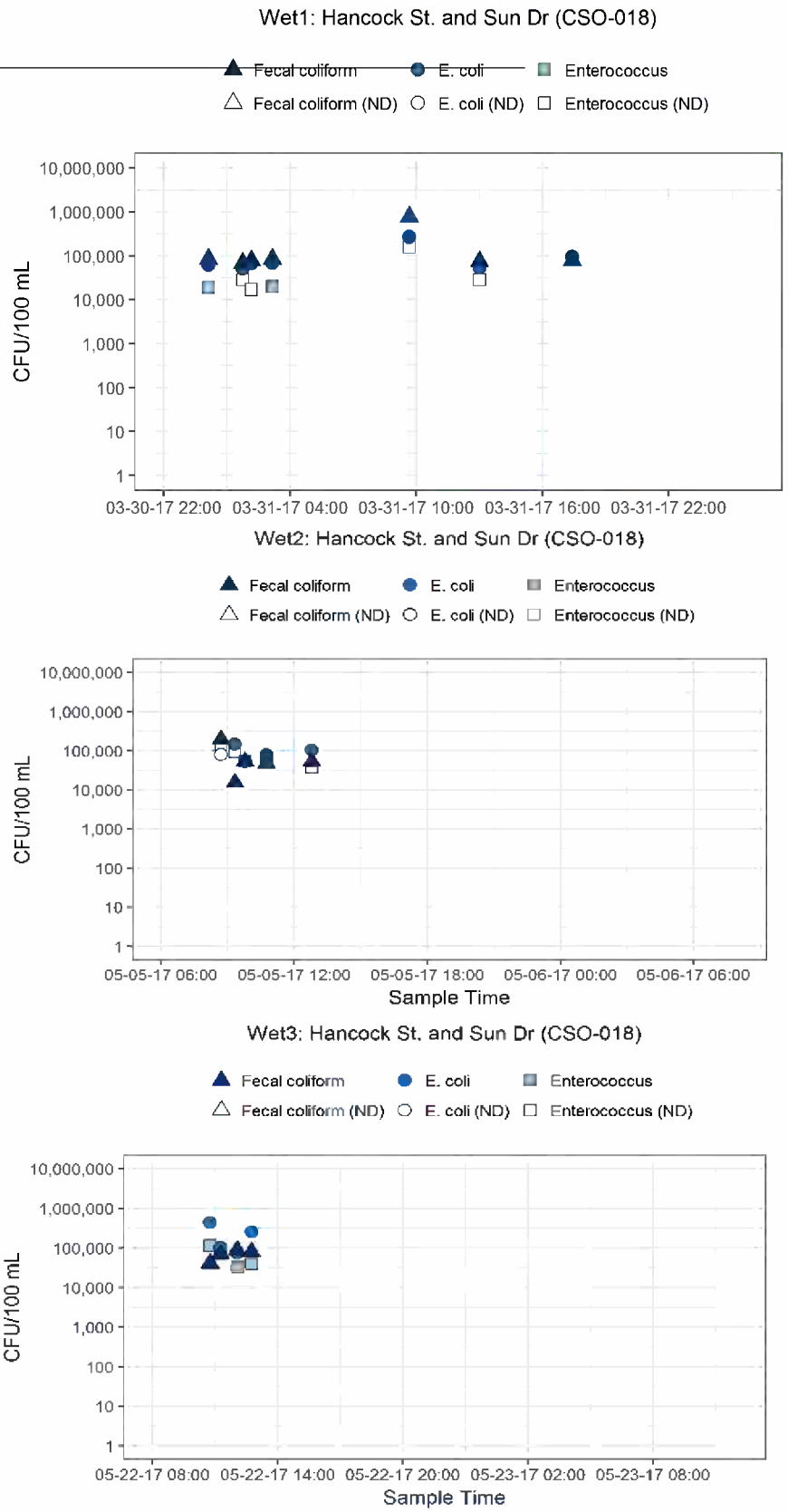
1.12 CSO-05 Wet



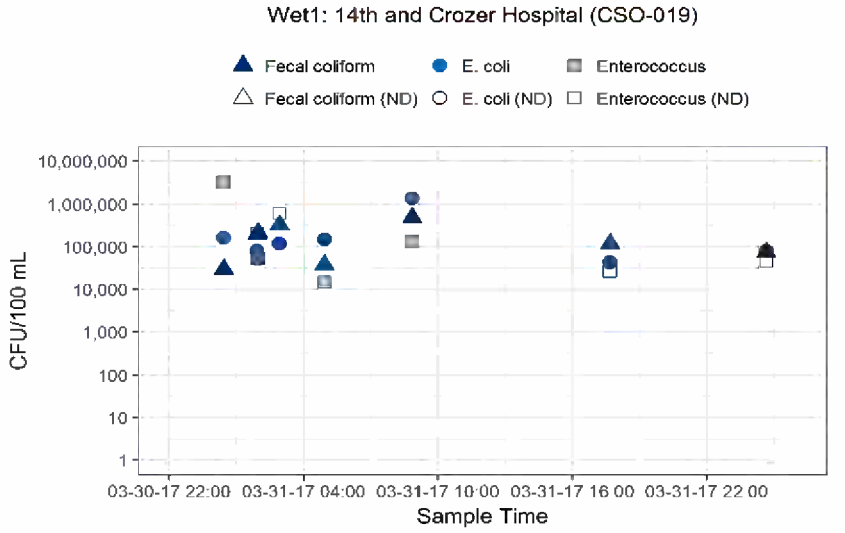


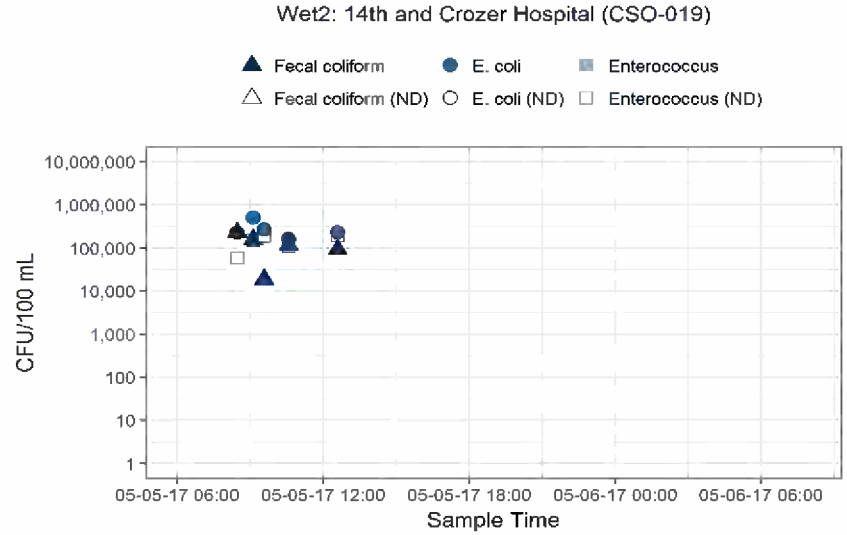


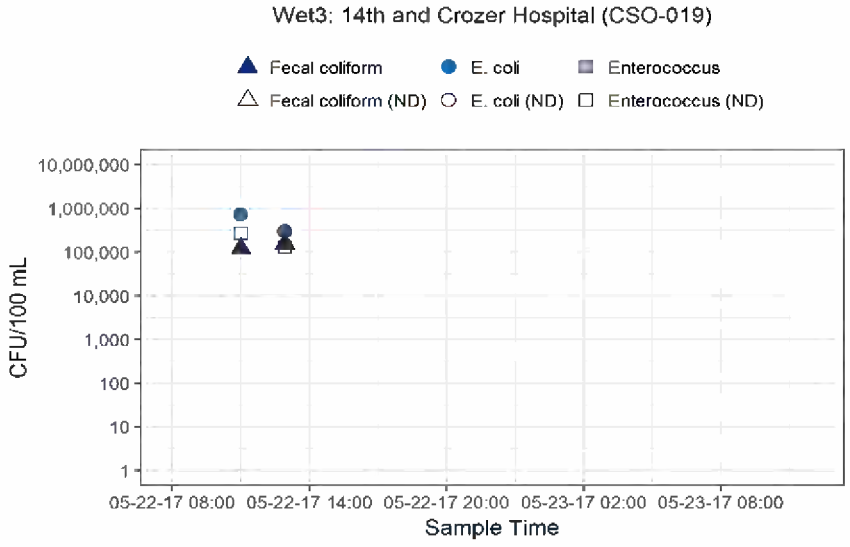
1.13 CSO-18 Wet



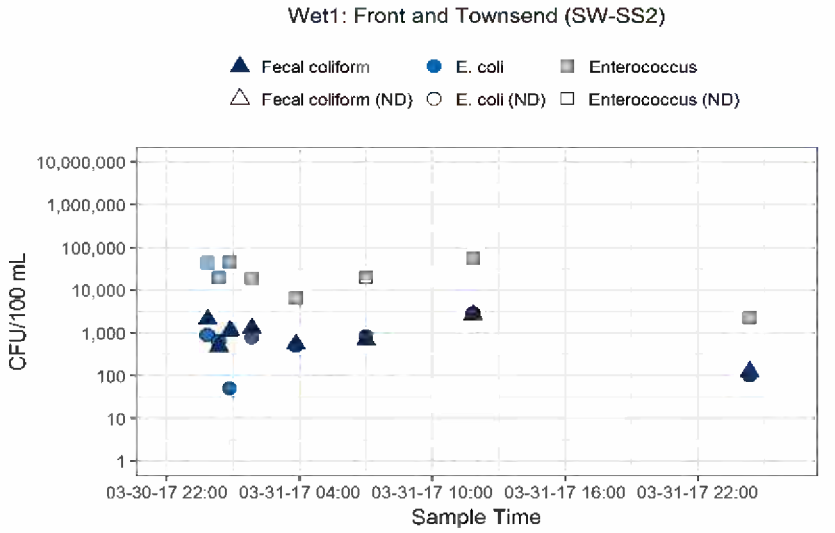
1.14 CSO-19 Wet

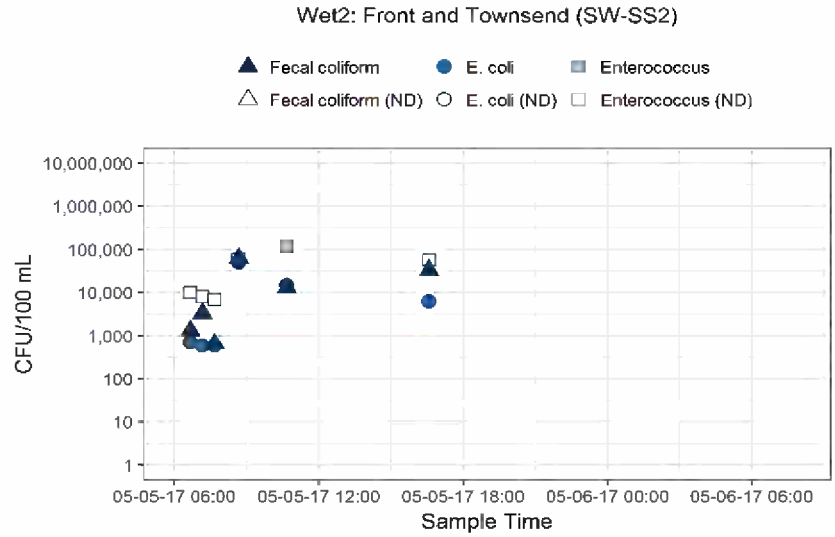


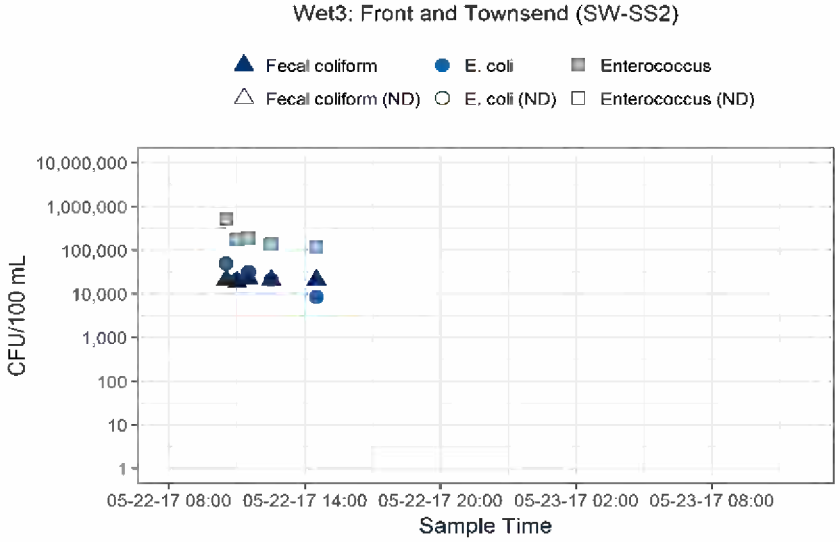




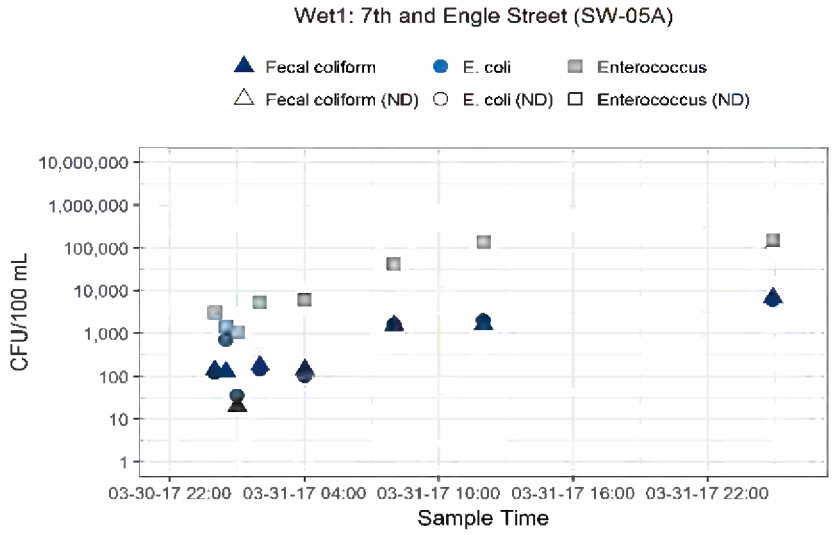
1.15 SW-SS2 Wet

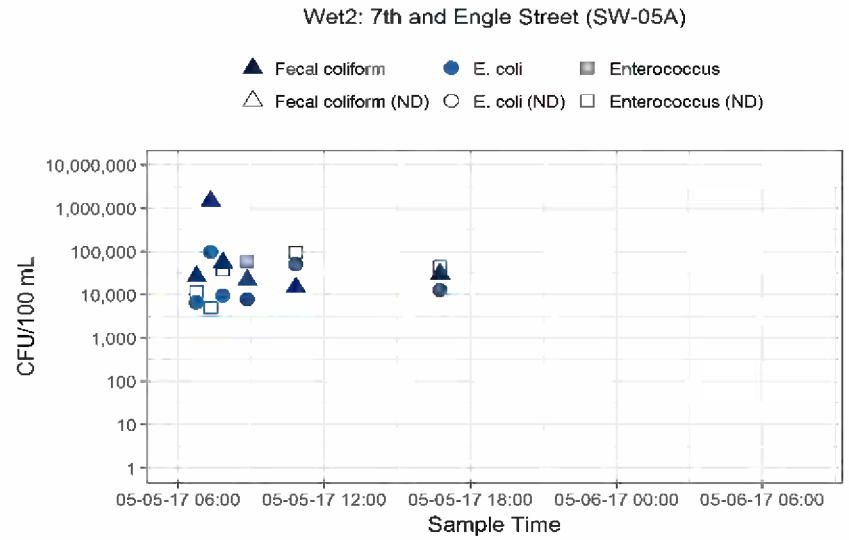


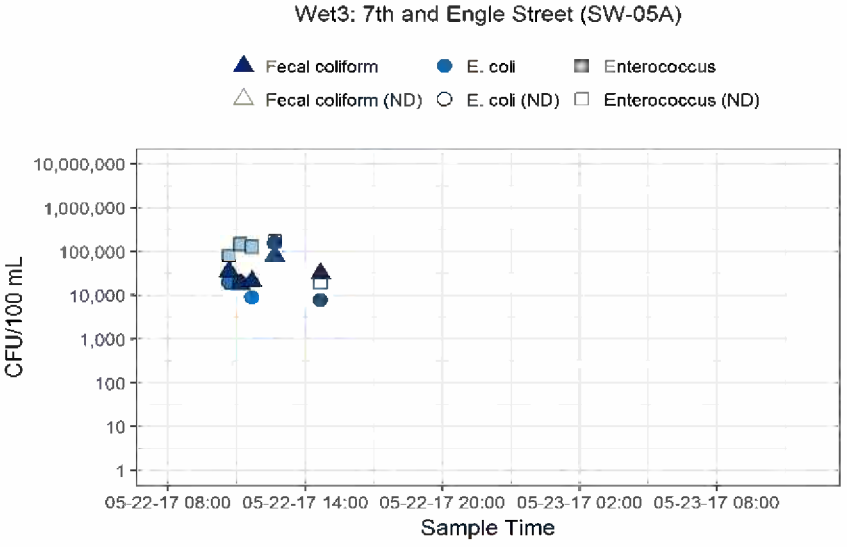




1.16 SW-O5A Wet

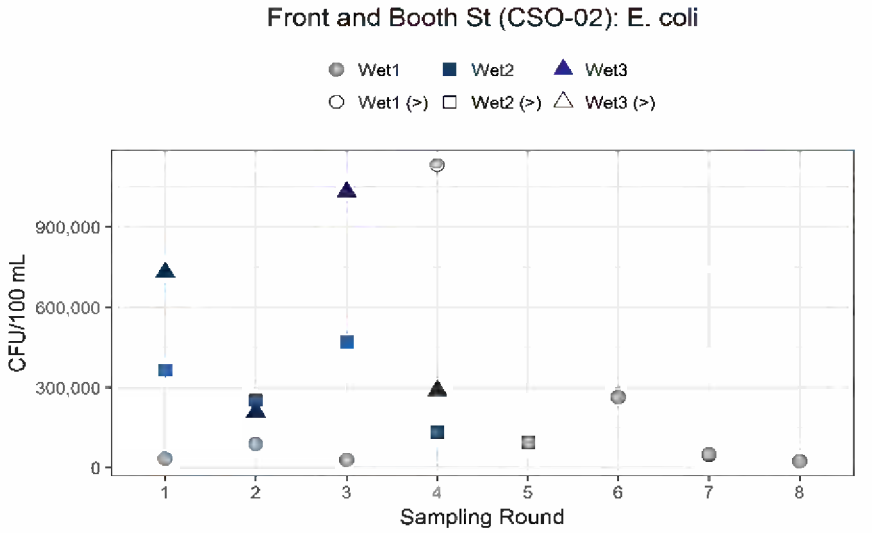


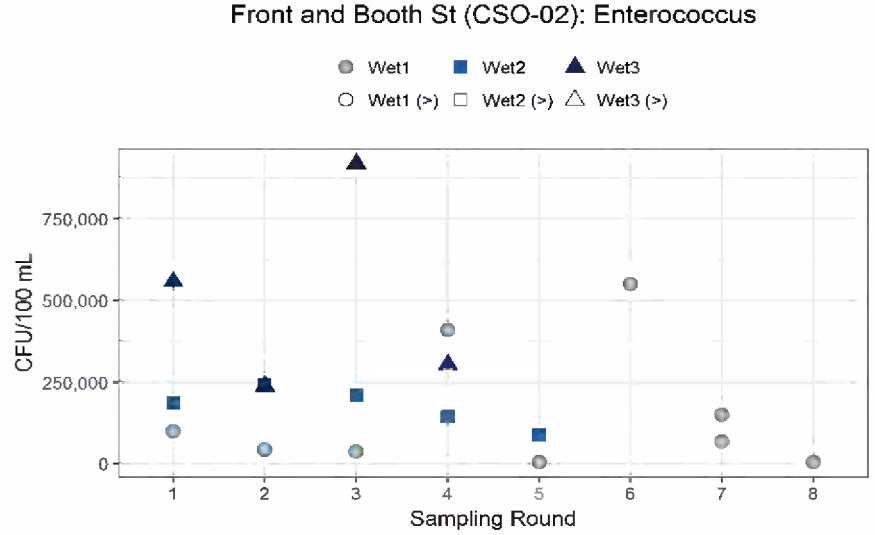


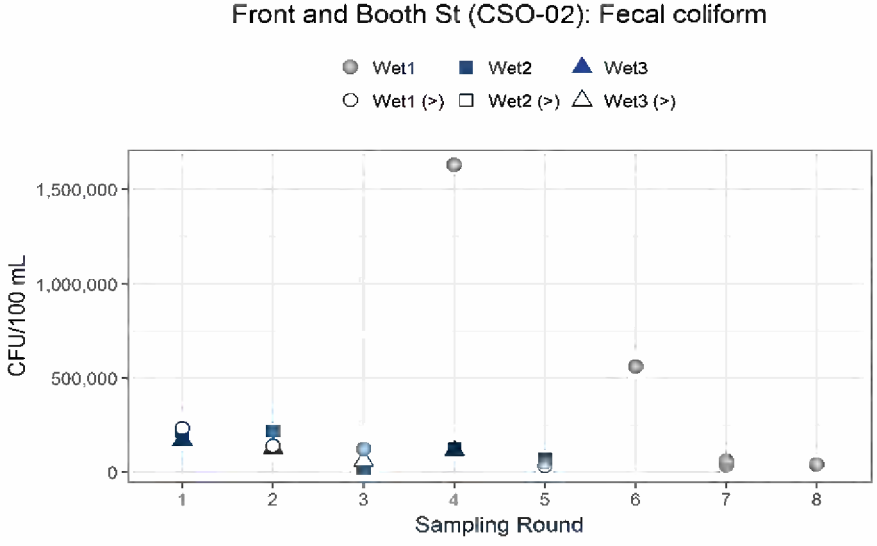


Section 2 First Flush Analysis

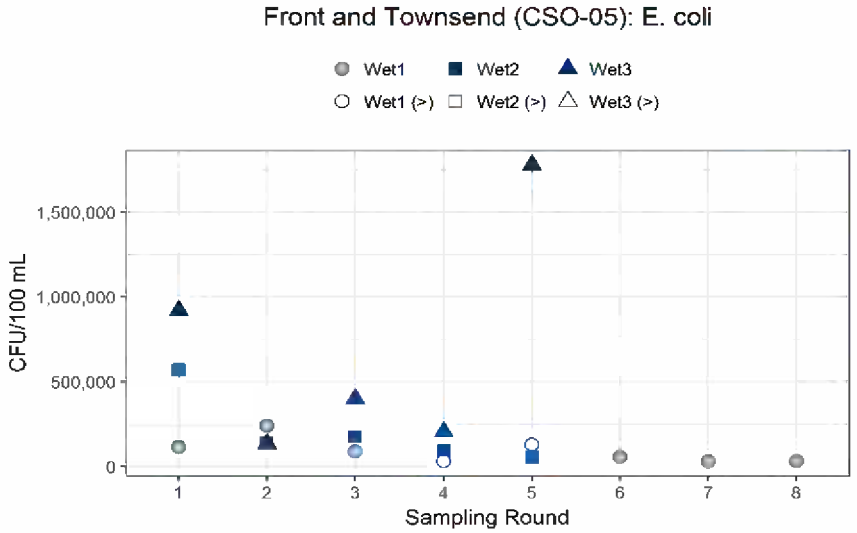
2.1 CSO-02

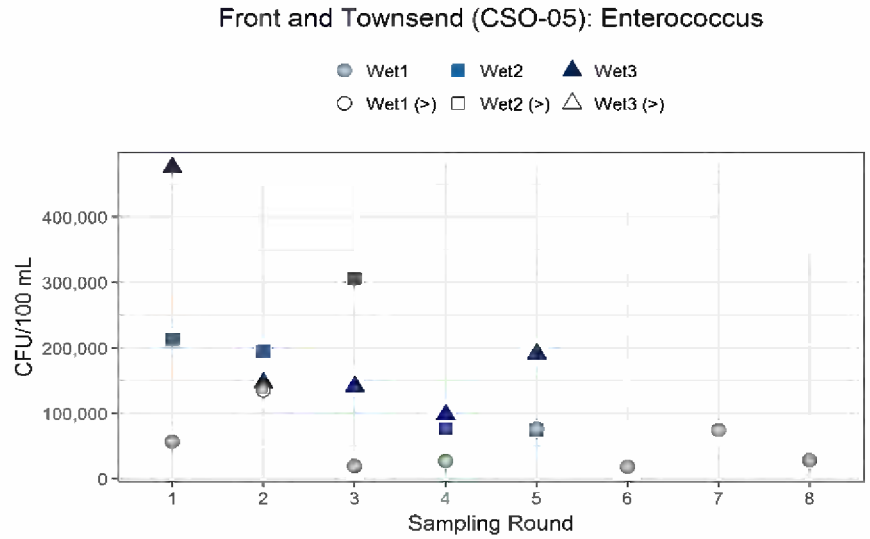

Front and Booth St (CSO-02): E. coli
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
900,000
600,000
300,000
0
1
2
3
4
5
6
7
8
Sampling Round

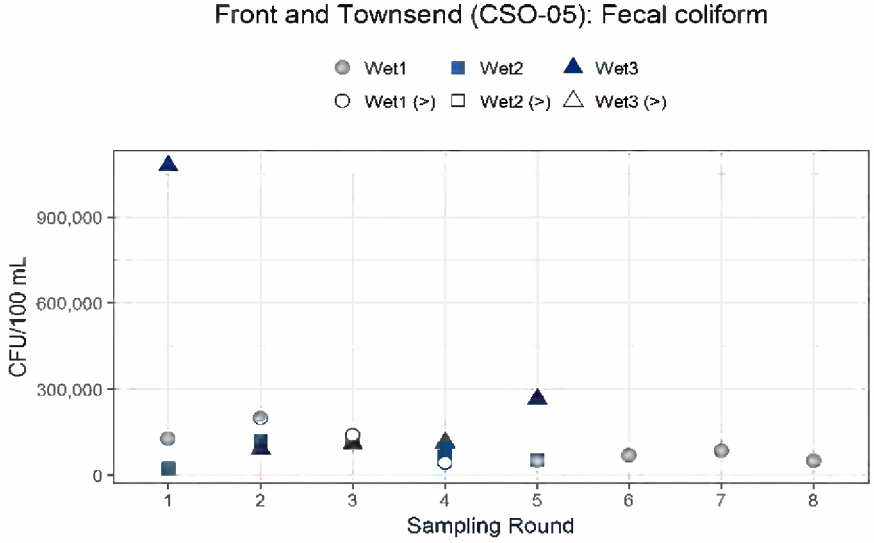

Front and Booth St (CSO-02): Enterococcus
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
750,000
500,000
250,000
0
1
2
3
4
5
6
7
8
Sampling Round


Front and Booth St (CSO-02): Fecal coliform
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
1,500,000
1,000,000
500,000
0
1
2
3
4
5
6
7
8
Sampling Round

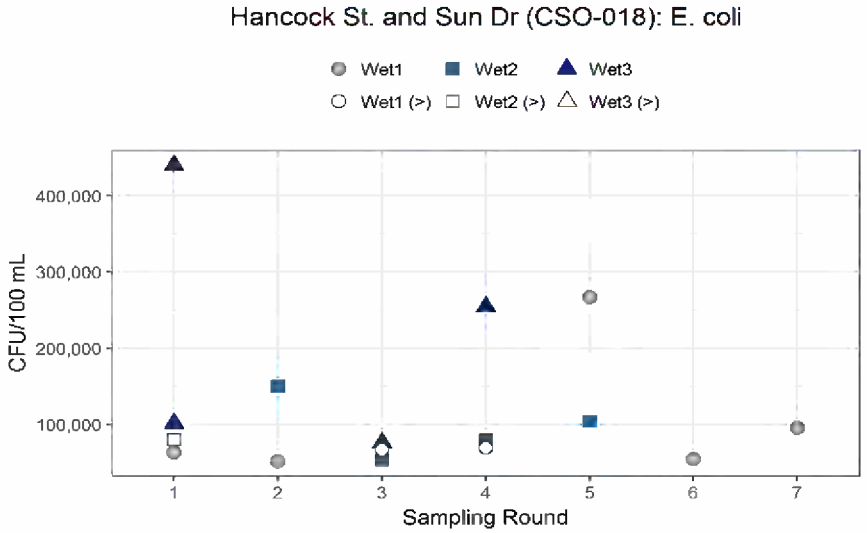
2.2 CSO-05

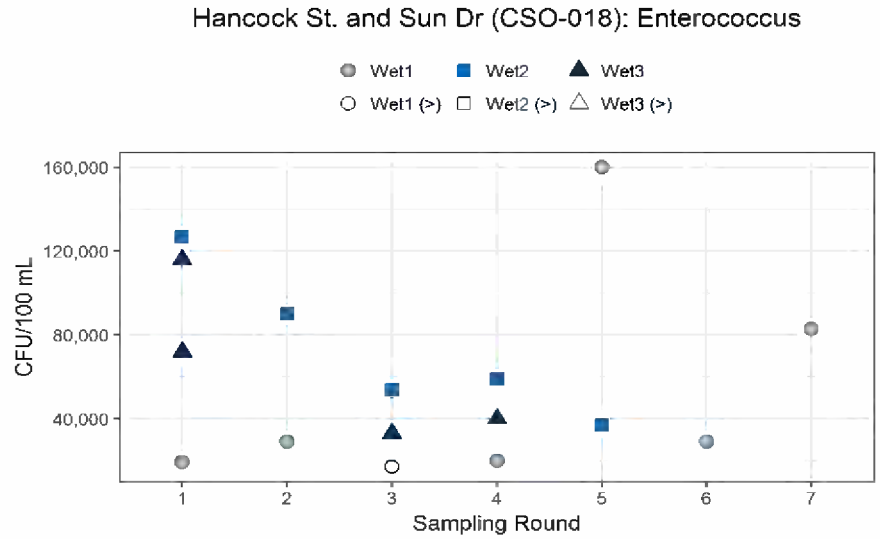

Front and Townsend (CSO-05): E. coli
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
1,500,000
1,000,000
500,000
0
1
2
3
4
5
6
7
8
Sampling Round

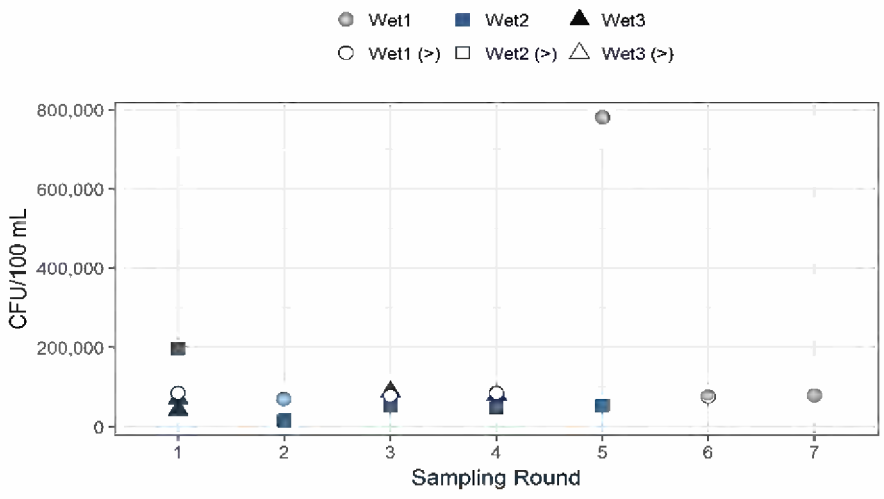

Front and Townsend (CSO-05): Enterococcus
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
400,000
300,000
200,000
100,000
0
1
2
3
4
5
6
7
8
Sampling Round


Front and Townsend (CSO-05): Fecal coliform
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
900,000
600,000
300,000
0
1
2
3
4
5
6
7
8
Sampling Round

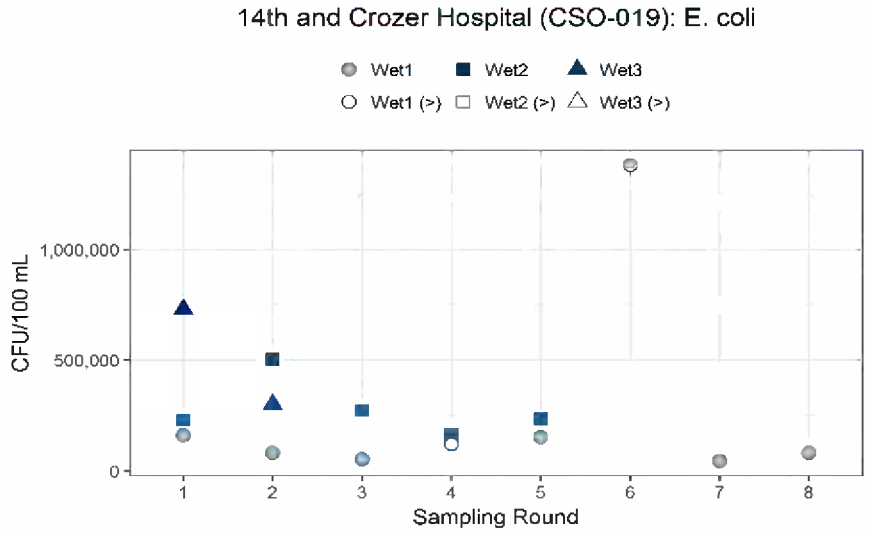
2.3 CSO-018

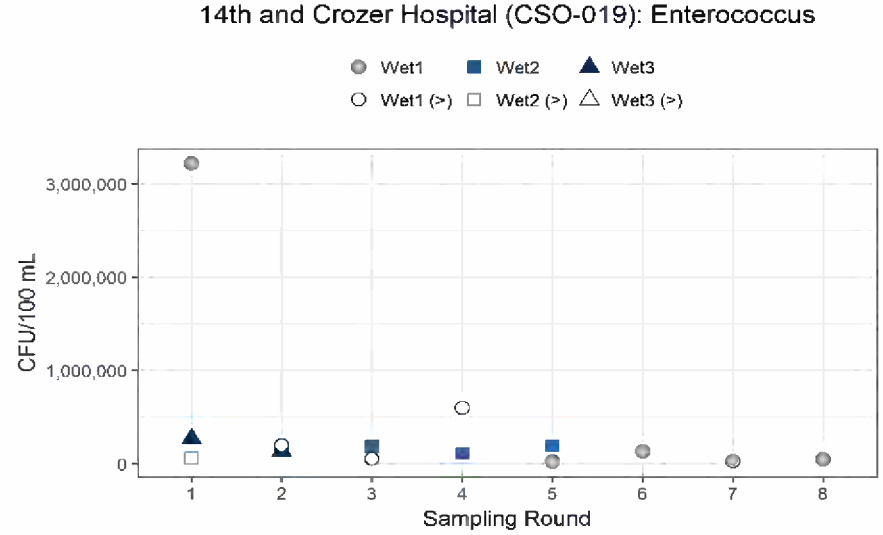

Hancock St. and Sun Dr (CSO-018): E. coli
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
400,000
300,000
200,000
100,000
1
2
3
4
5
6
7
Sampling Round

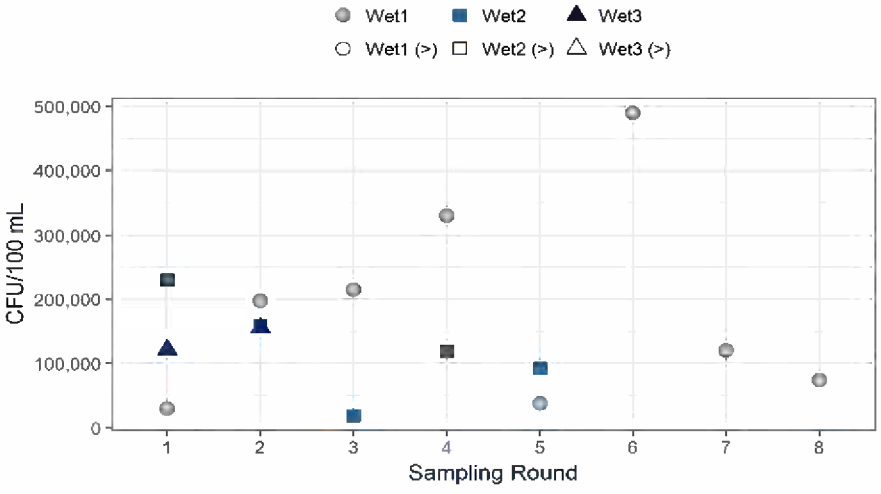

Hancock St. and Sun Dr (CSO-018): Enterococcus
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
160,000
120,000
80,000
40,000
1
2
3
4
5
6
7
Sampling Round


Hancock St. and Sun Dr (CSO-018): Fecal coliform
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
800,000
600,000
400,000
200,000
0
1
2
3
4
5
6
7
Sampling Round

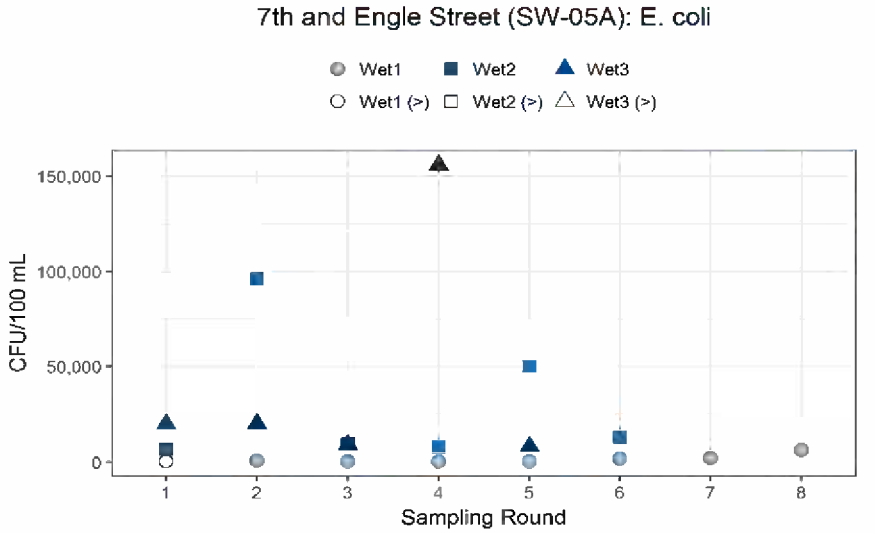
2.4 CSO-019

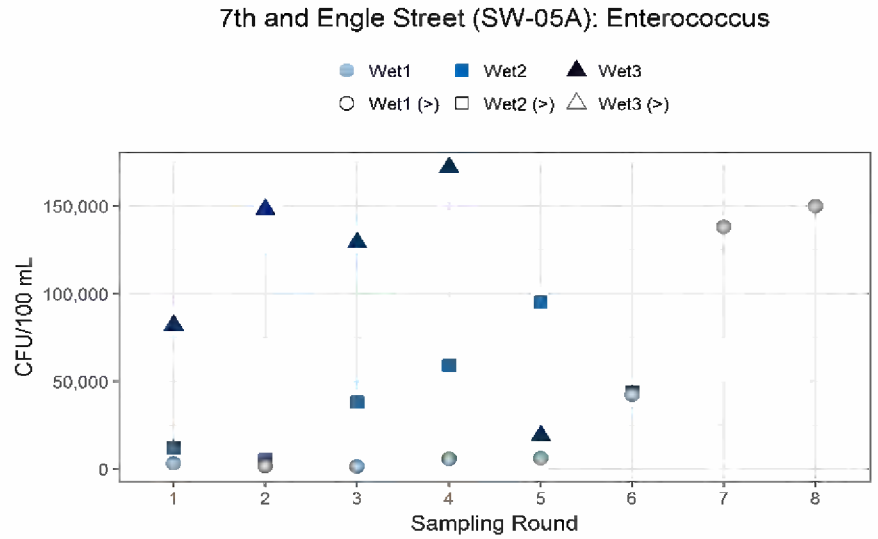

14th and Crozer Hospital (CSO-019): E. coli
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
1,000,000
500,000
0
1
2
3
4
5
6
7
8
Sampling Round

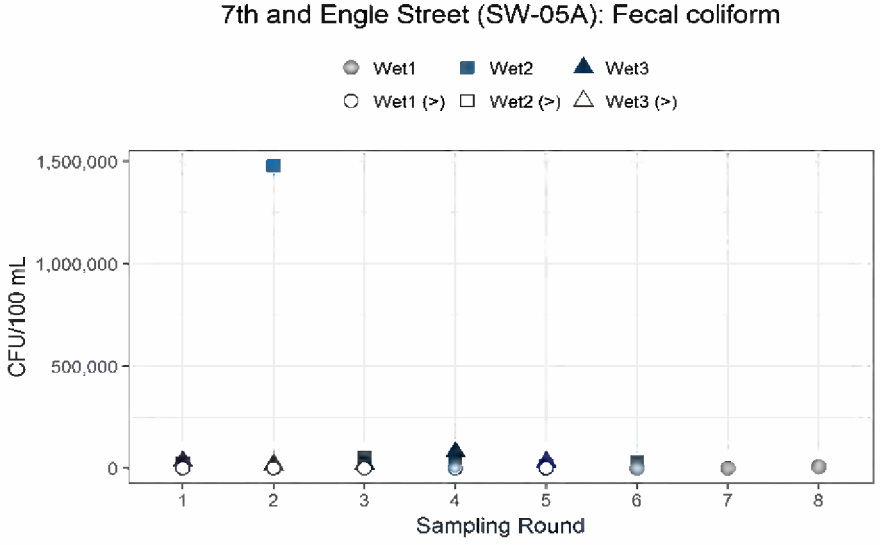

14th and Crozer Hospital (CSO-019): Enterococcus
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
3,000,000
2,000,000
1,000,000
0
1
2
3
4
5
6
7
8
Sampling Round


14th and Crozer Hospital (CSO-019): Fecal coliform
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
500,000
400,000
300,000
200,000
100,000
0
1
2
3
4
5
6
7
8
Sampling Round

2.5 SW-05A

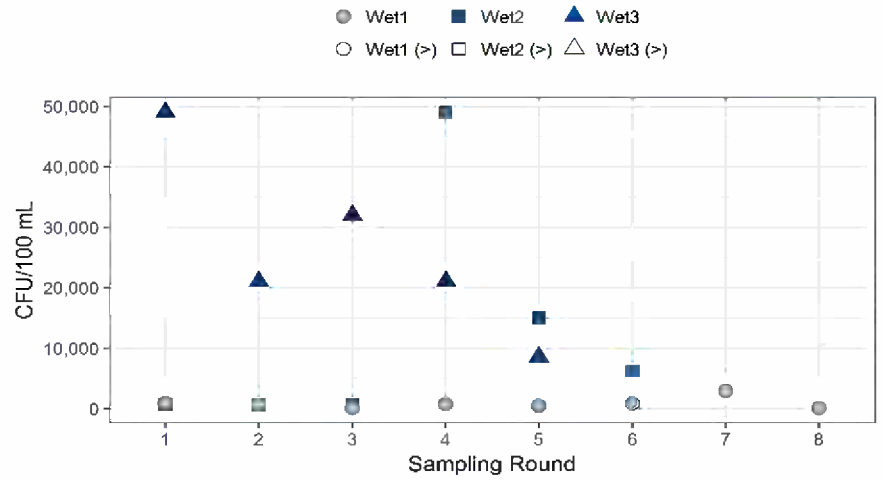

7th and Engle Street (SW-05A): E. coli
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
150,000
100,000
50,000
0
1
2
3
4
5
6
7
8
Sampling Round


7th and Engle Street (SW-05A): Enterococcus
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
150,000
100,000
50,000
0
1
2
3
4
5
6
7
8
Sampling Round

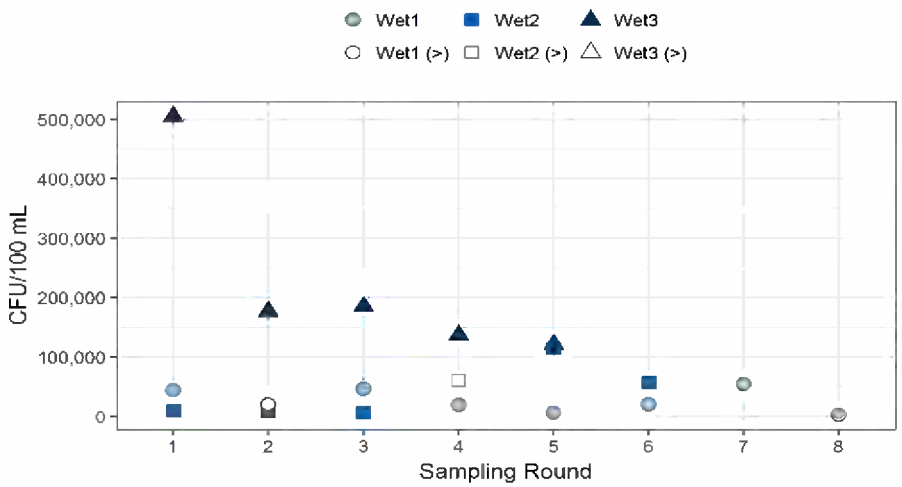

7th and Engle Street (SW-05A): Fecal coliform
Wet1
Wet2
Wet3
Wet1 (>)
Wet2 (>)
Wet3 (>)
CFU/100 mL
1,500,000
1,000,000
500,000
0
1
2
3
4
5
6
7
8
Sampling Round

2.6 SW-SS2

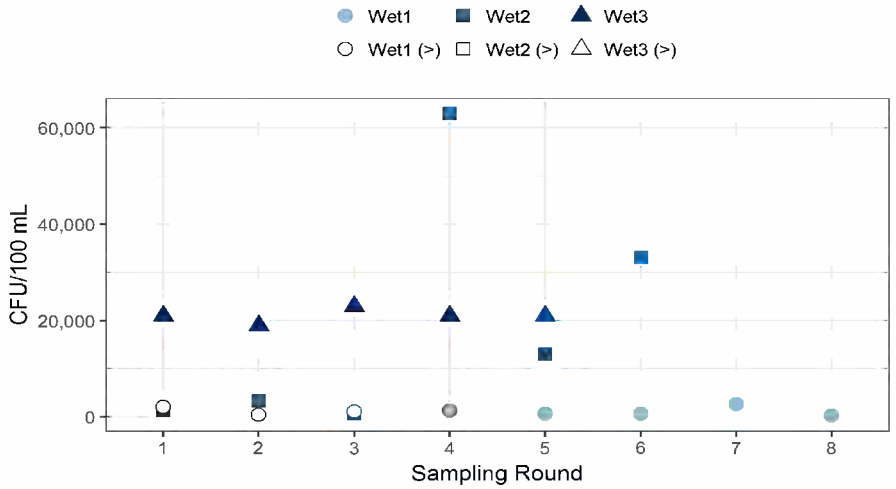
Front and Townsend (SW-SS2): E. coli



Front and Townsend (SW-SS2): Enterococcus

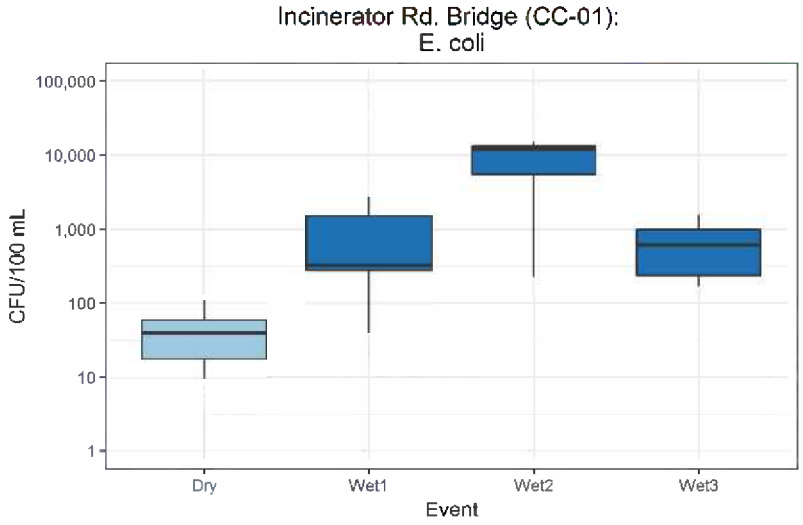


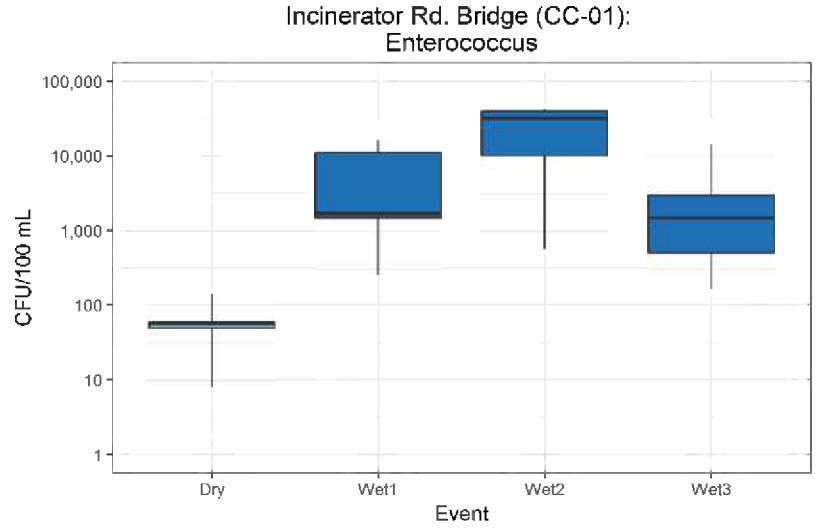
Front and Townsend (SW-SS2): Fecal coliform

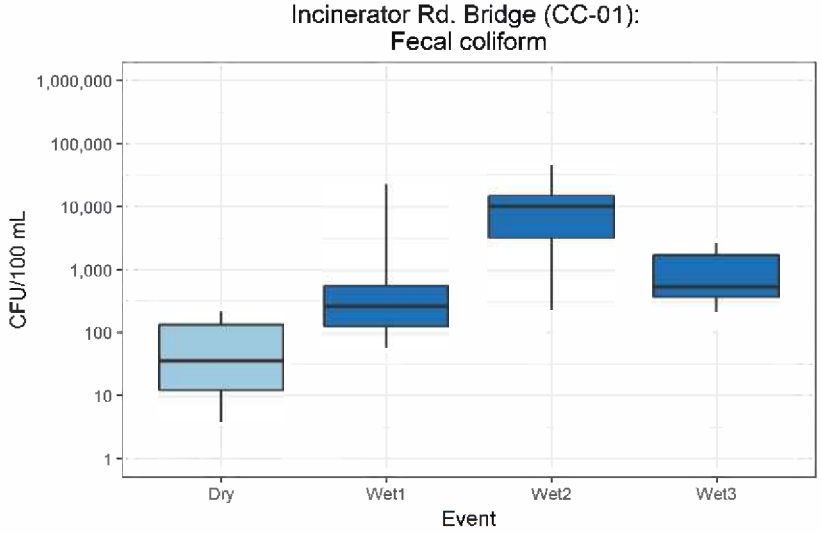


Section 3 Receiving Water Wet Weather Sampling Results

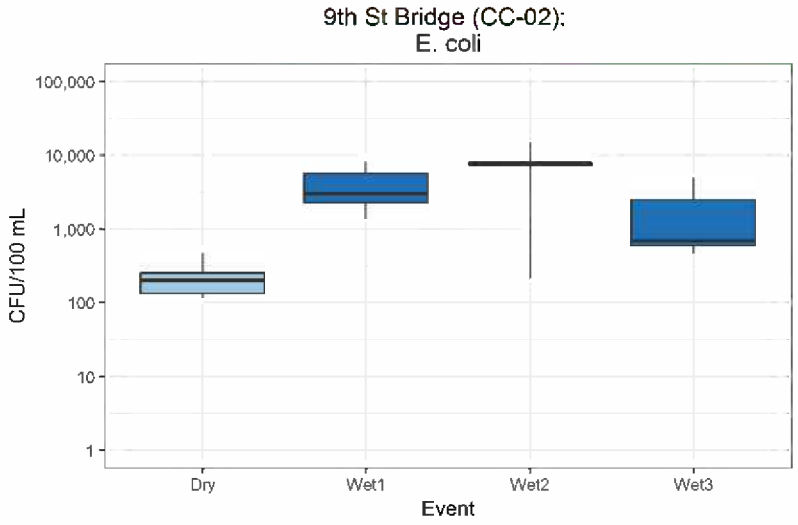
3.1 CC-01

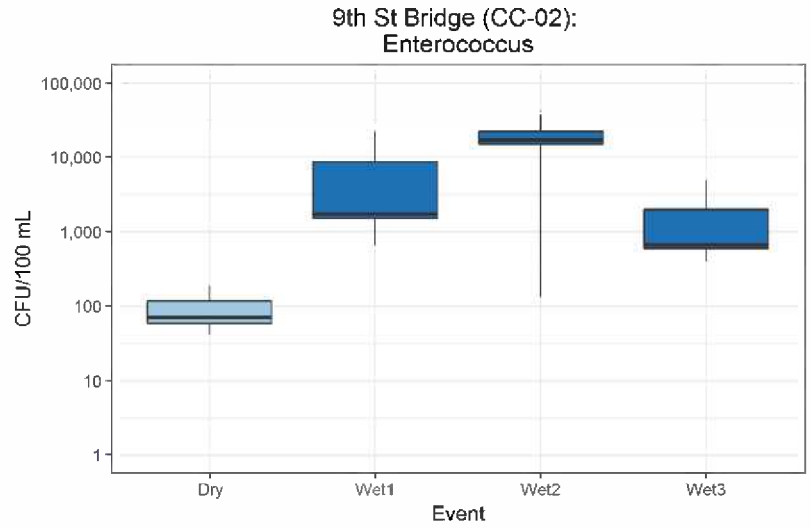

Incinerator Rd. Bridge (CC-01):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

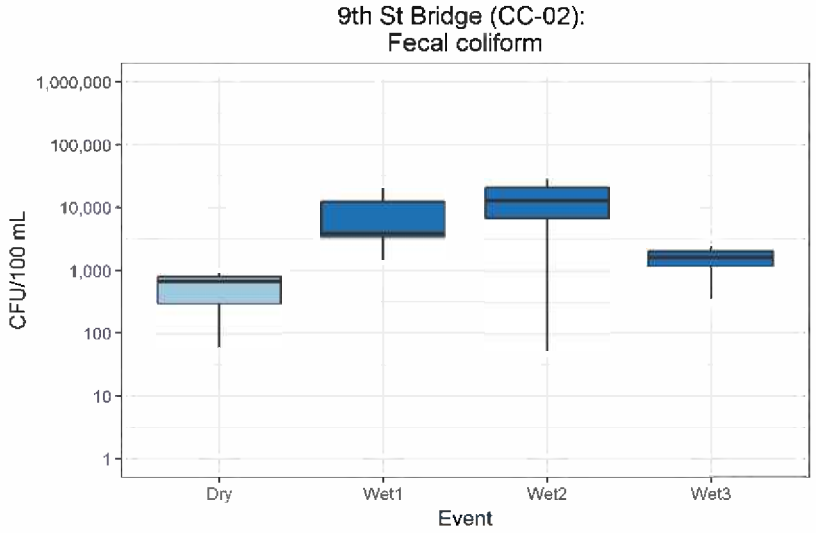

Incinerator Rd. Bridge (CC-01):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


Incinerator Rd. Bridge (CC-01):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

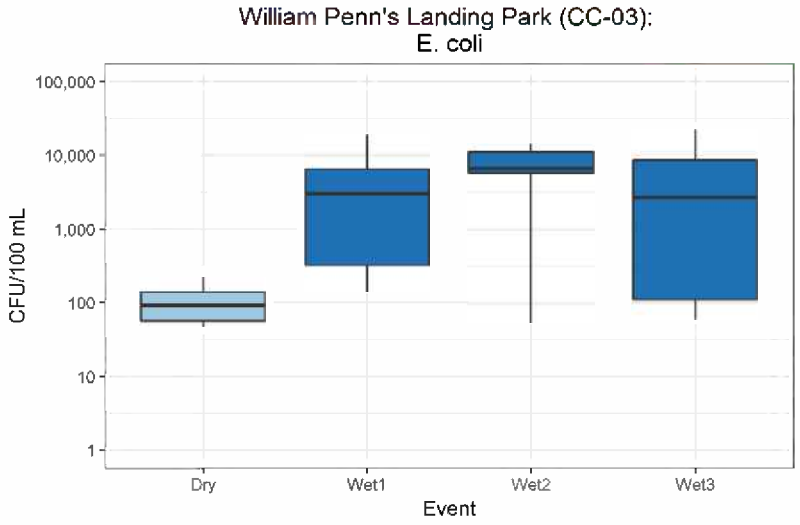
3.2 CC-02

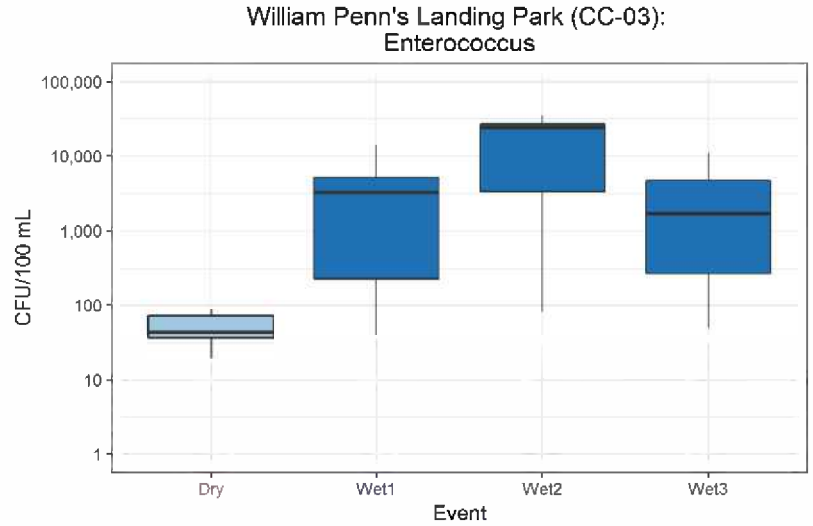

9th St Bridge (CC-02):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

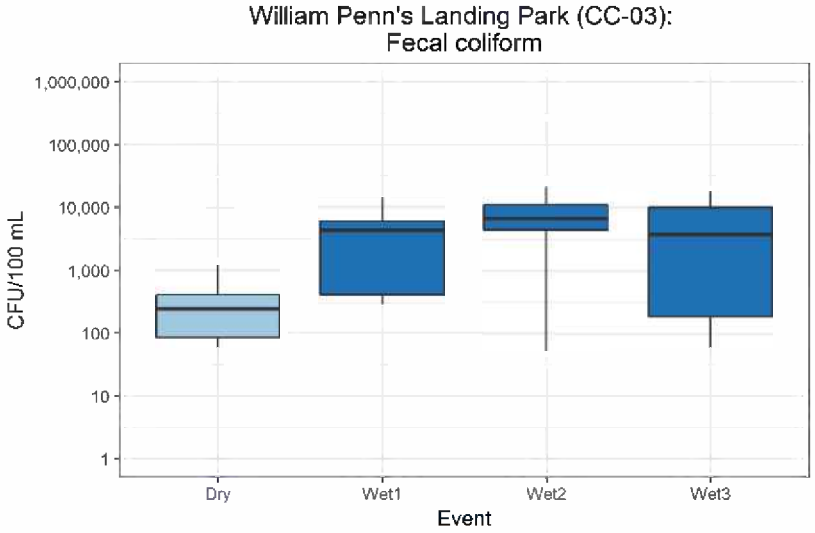

9th St Bridge (CC-02):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


9th St Bridge (CC-02):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

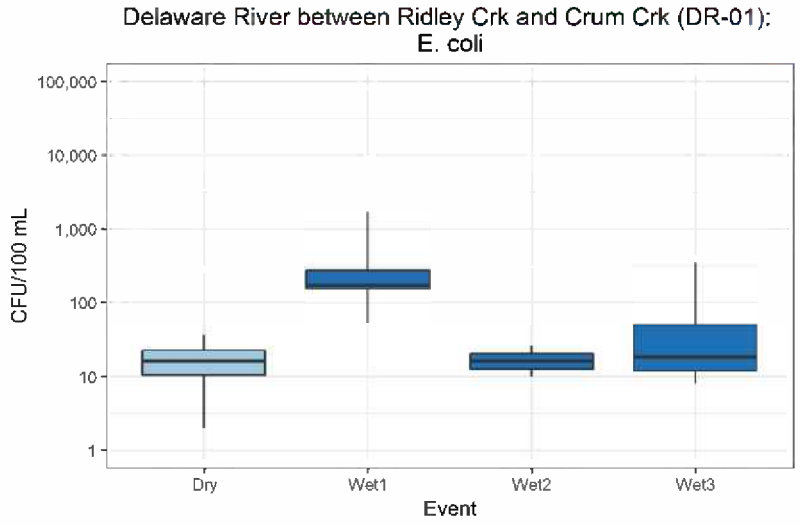
3.3 CC-03

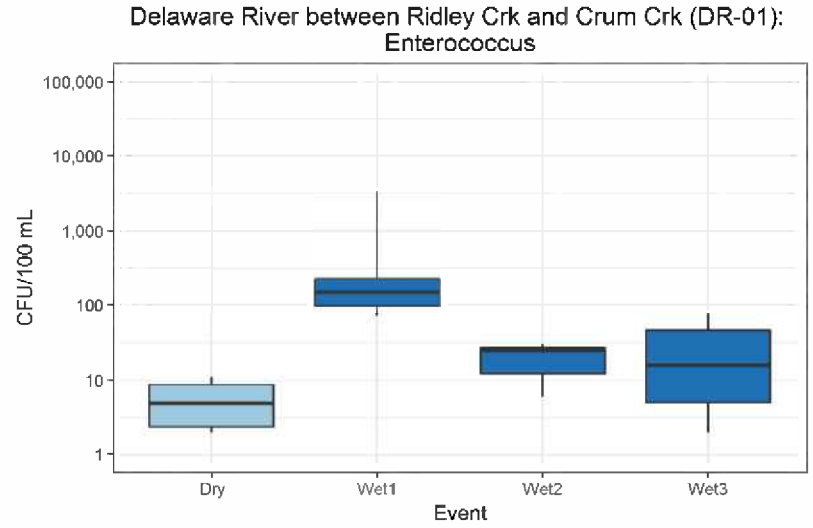

William Penn's Landing Park (CC-03):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

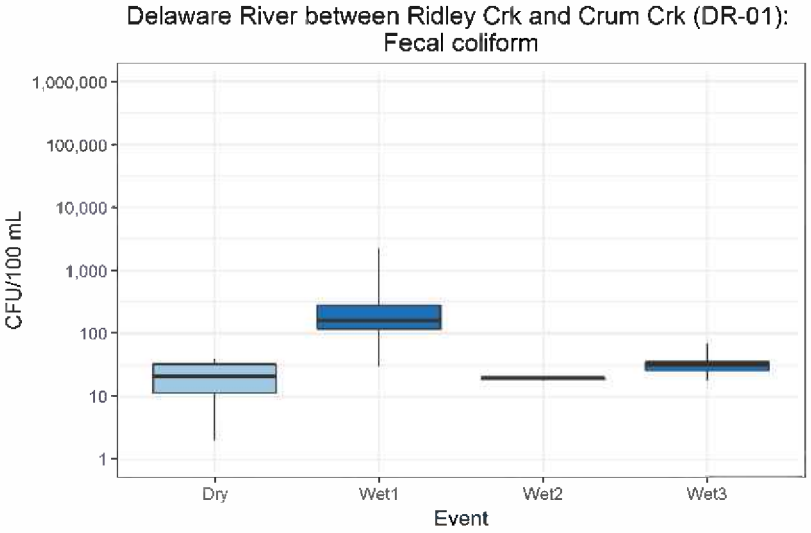

William Penn's Landing Park (CC-03):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


William Penn's Landing Park (CC-03):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

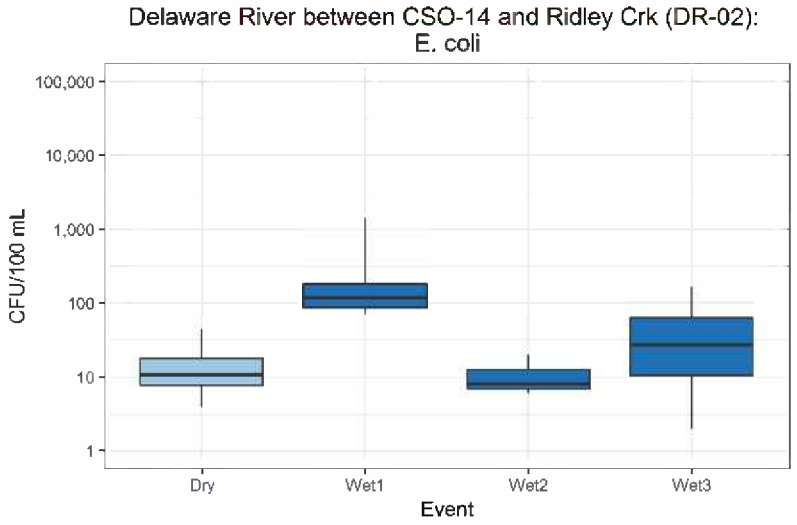
3.4 DR-01

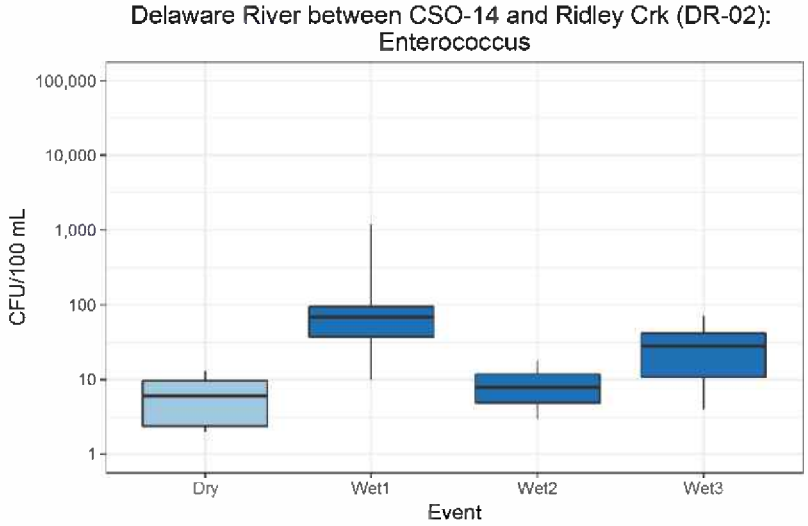

Delaware River between Ridley Crk and Crum Crk (DR-01):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

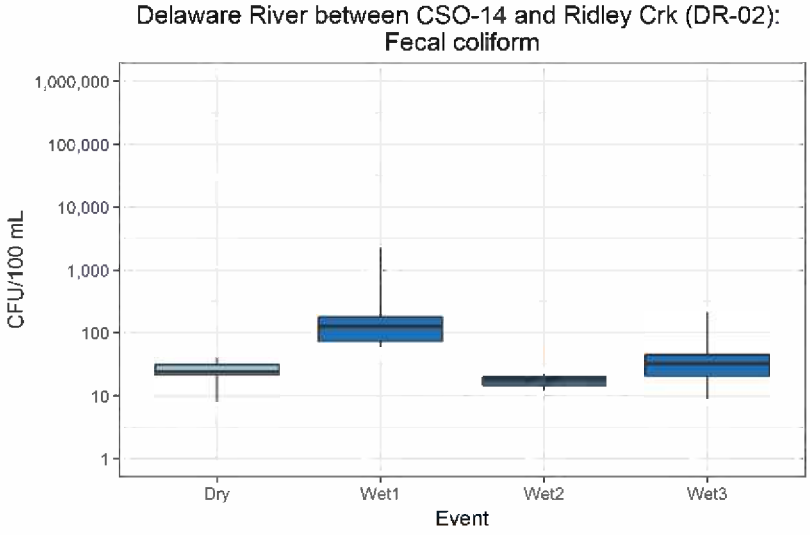

Delaware River between Ridley Crk and Crum Crk (DR-01):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


Delaware River between Ridley Crk and Crum Crk (DR-01):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

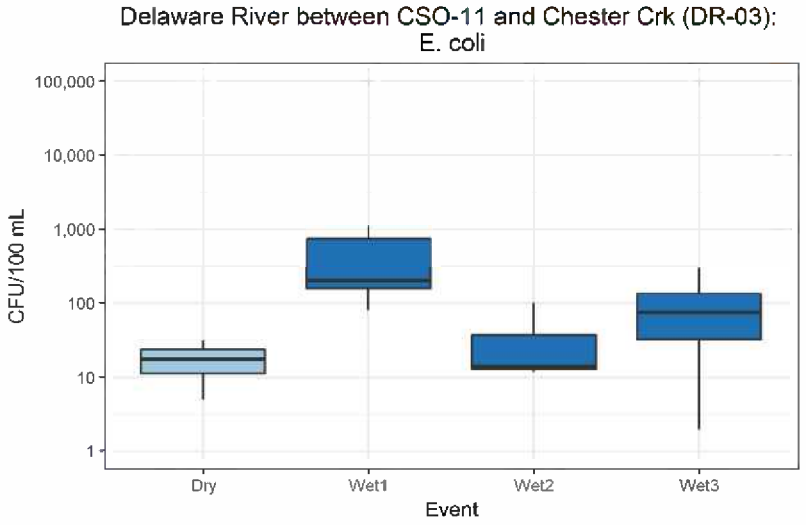
3.5 DR-02

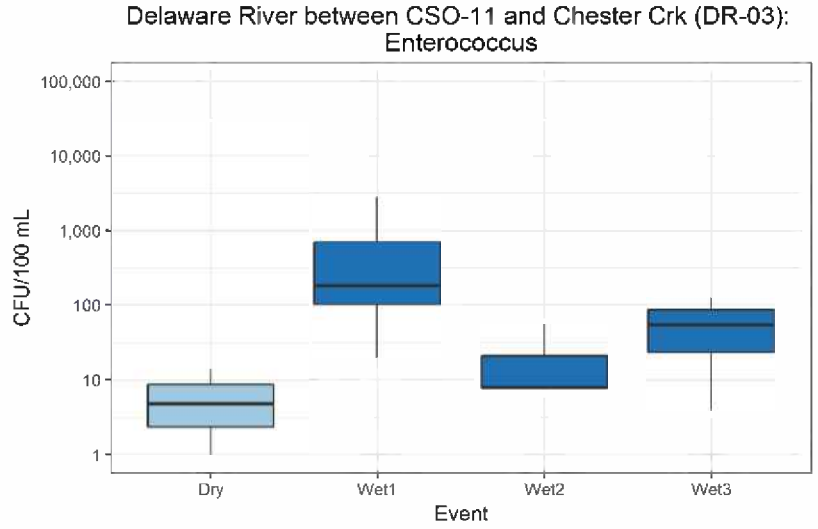

Delaware River between CSO-14 and Ridley Crk (DR-02):
E. coli
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

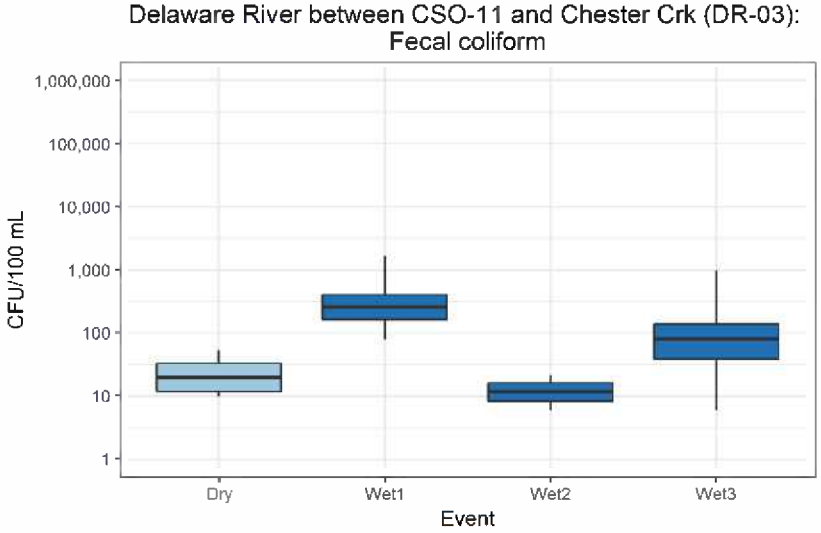

Delaware River between CSO-14 and Ridley Crk (DR-02):
Enterococcus
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event


Delaware River between CSO-14 and Ridley Crk (DR-02):
Fecal coliform
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

3.6 DR-03

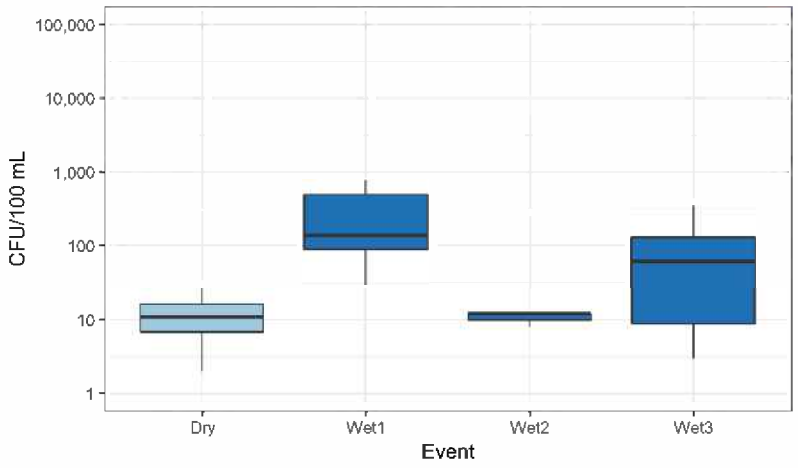

Delaware River between CSO-11 and Chester Crk (DR-03):
E. coli
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event


Delaware River between CSO-11 and Chester Crk (DR-03):
Enterococcus
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

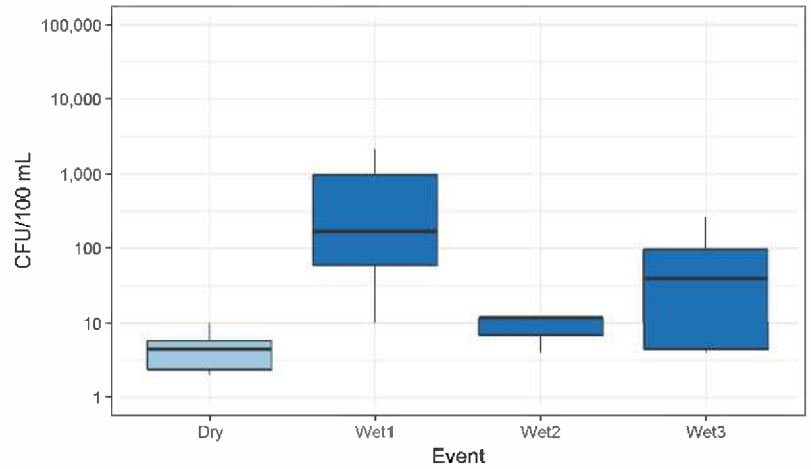

Delaware River between CSO-11 and Chester Crk (DR-03):
Fecal coliform
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

3.7 DR-04

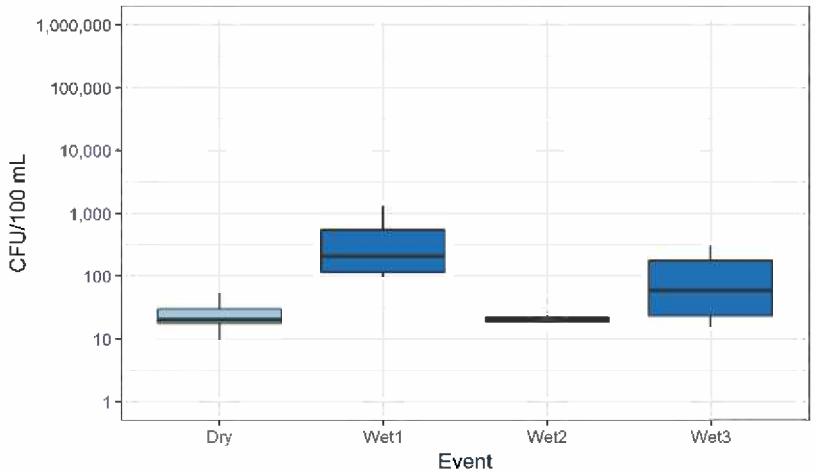
Delaware River at the boat launch off Highway 322 (DR-04): E. coli



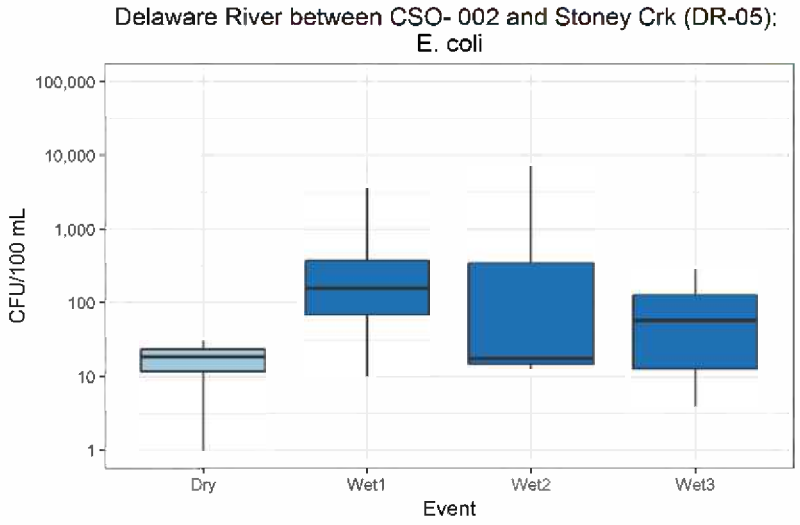
Delaware River at the boat launch off Highway 322 (DR-04): Enterococcus

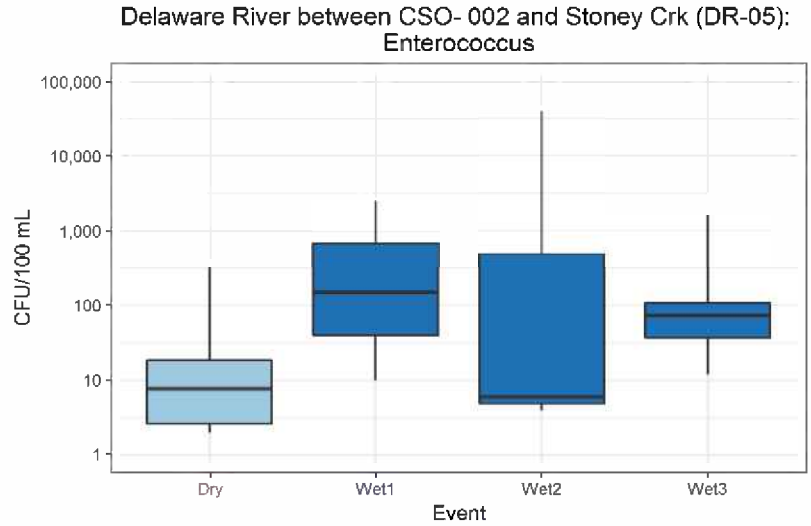


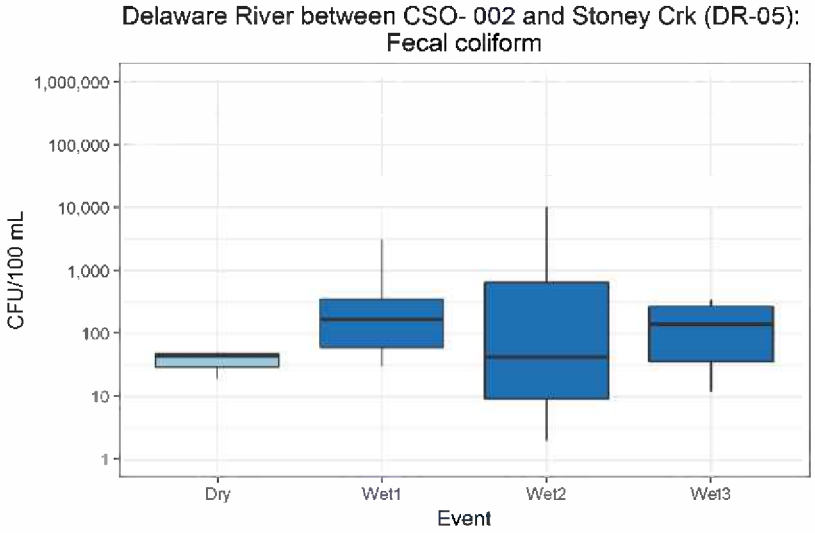
Delaware River at the boat launch off Highway 322 (DR-04): Fecal coliform



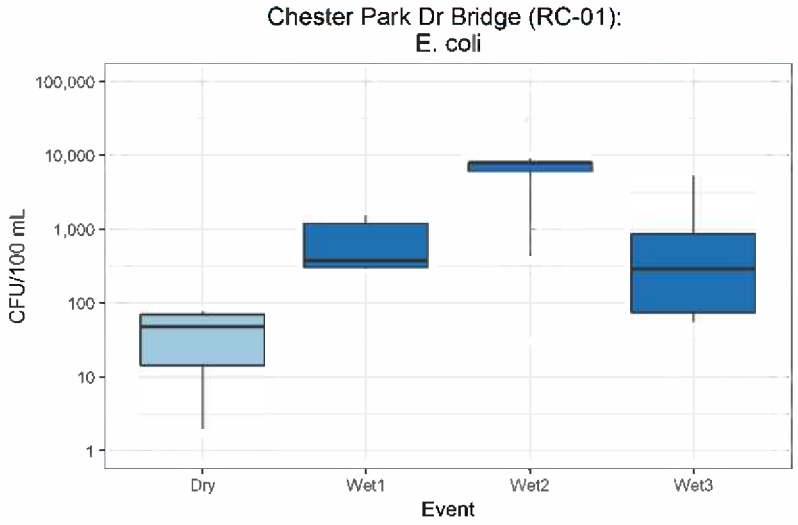
3.8 DR-05

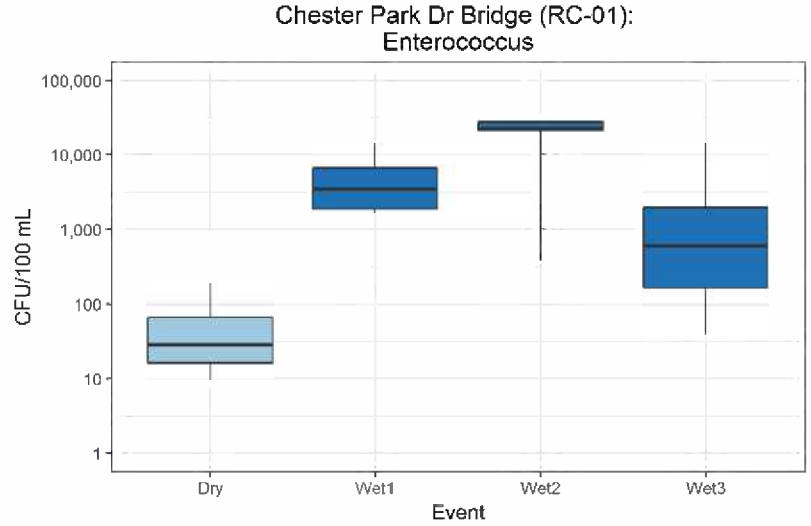

Delaware River between CSO- 002 and Stoney Crk (DR-05):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

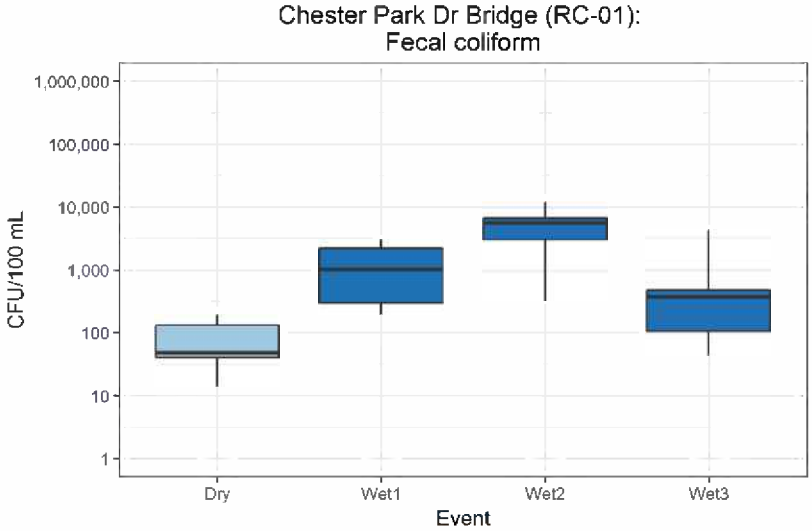

Delaware River between CSO- 002 and Stoney Crk (DR-05):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


Delaware River between CSO- 002 and Stoney Crk (DR-05):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

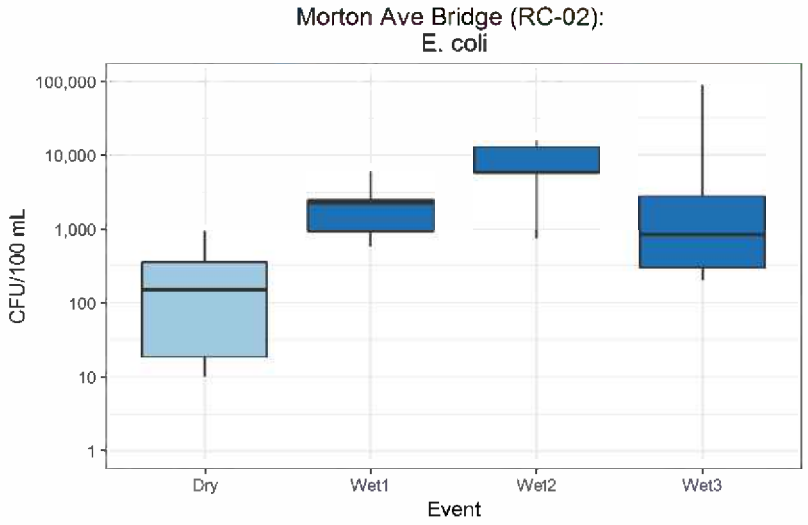
3.9 RC-01

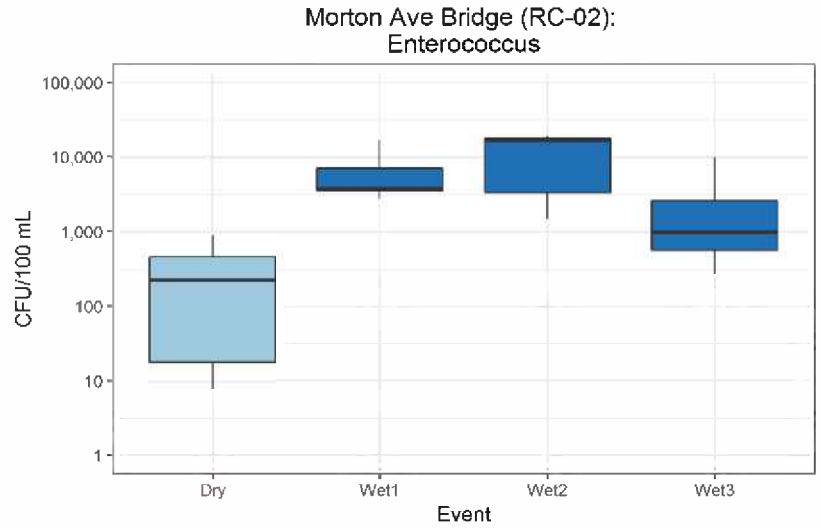

Chester Park Dr Bridge (RC-01):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

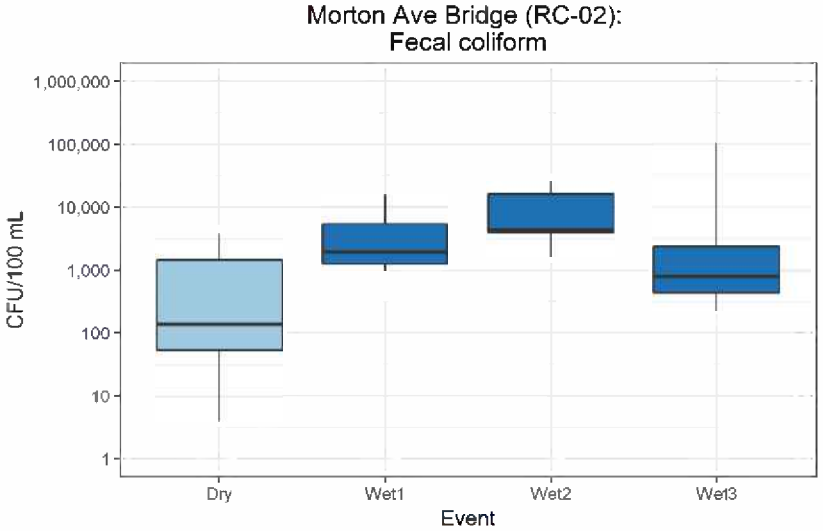

Chester Park Dr Bridge (RC-01):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


Chester Park Dr Bridge (RC-01):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

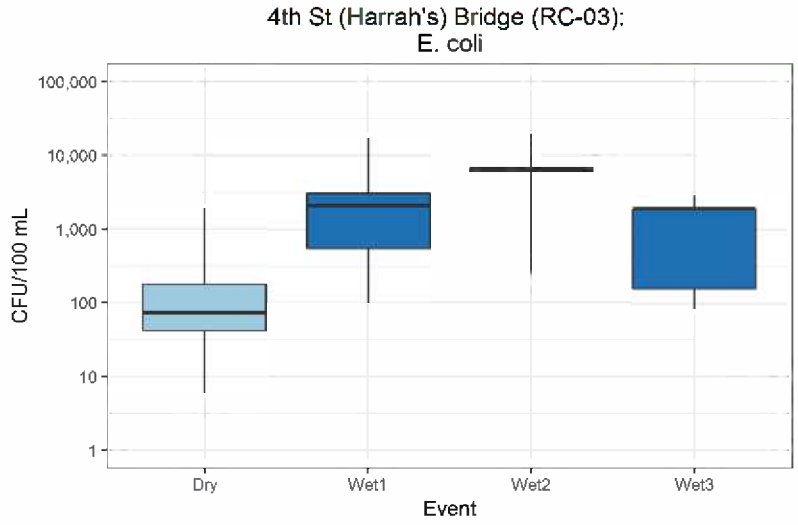
3.10 RC-02

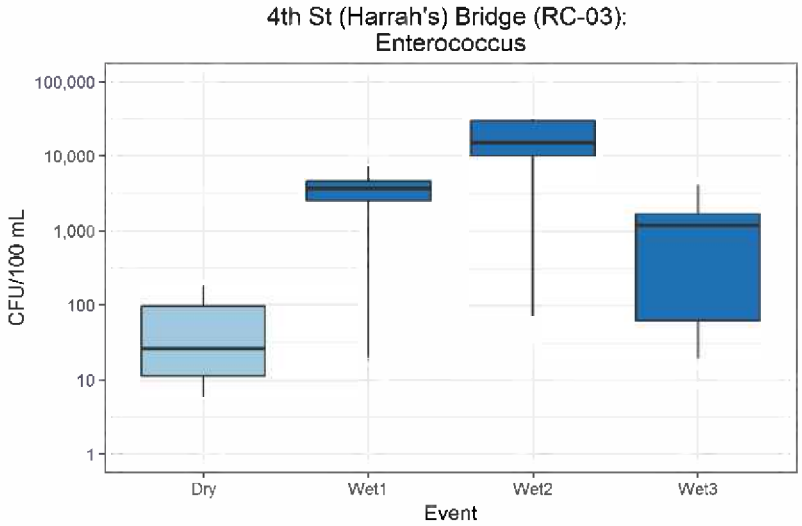

Morton Ave Bridge (RC-02):
E. coli
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

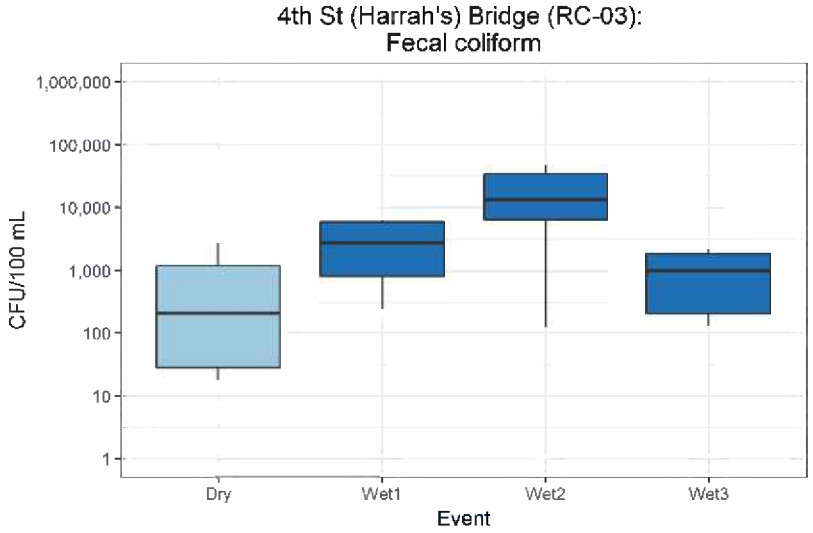

Morton Ave Bridge (RC-02):
Enterococcus
CFU/100 mL
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event


Morton Ave Bridge (RC-02):
Fecal coliform
CFU/100 mL
1,000,000
100,000
10,000
1,000
100
10
1
Dry
Wet1
Wet2
Wet3
Event

3.11 RC-03

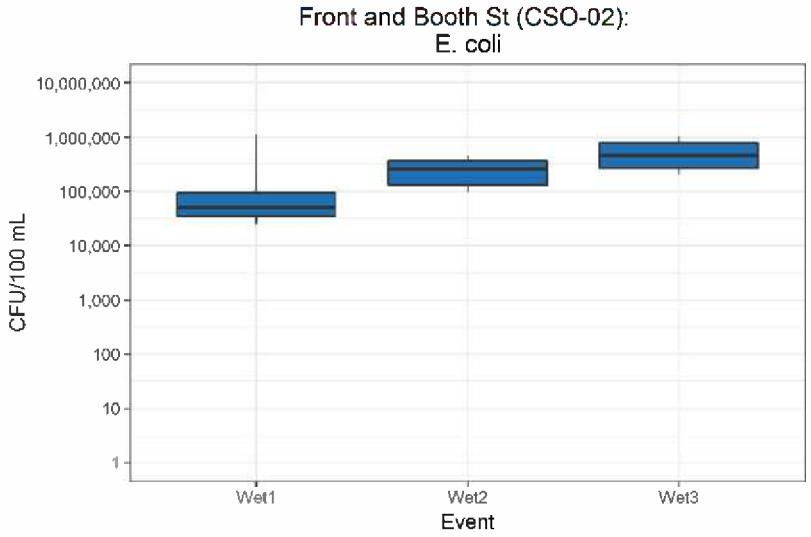

4th St (Harrah's) Bridge (RC-03):
E. coli
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

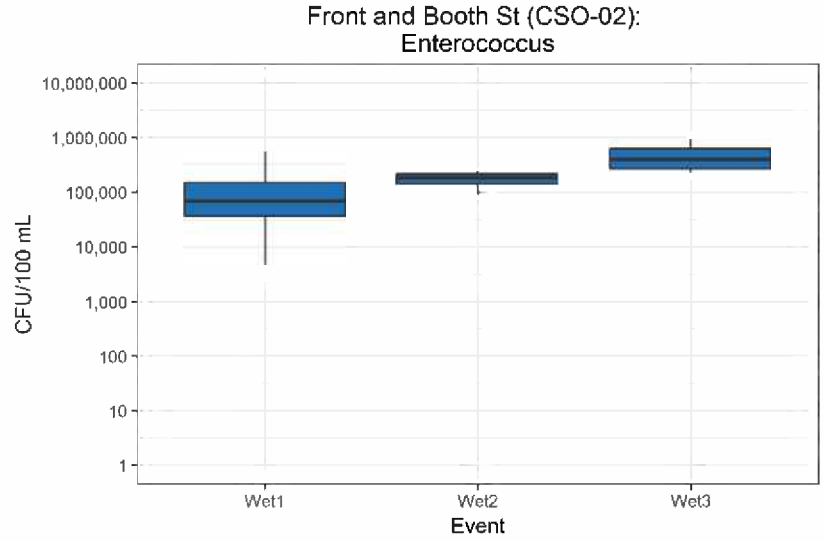

4th St (Harrah's) Bridge (RC-03):
Enterococcus
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

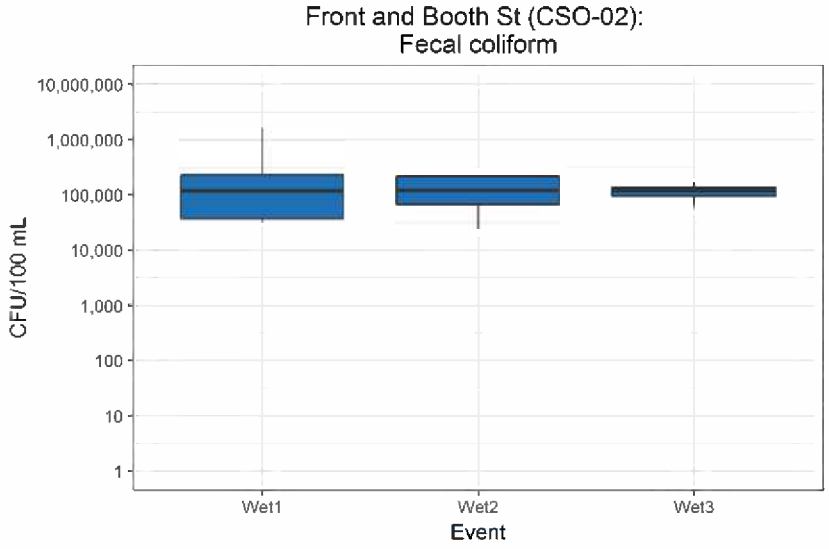

4th St (Harrah's) Bridge (RC-03):
Fecal coliform
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Dry
Wet1
Wet2
Wet3
Event

Section 4 Outfall Wet Weather Sampling Results

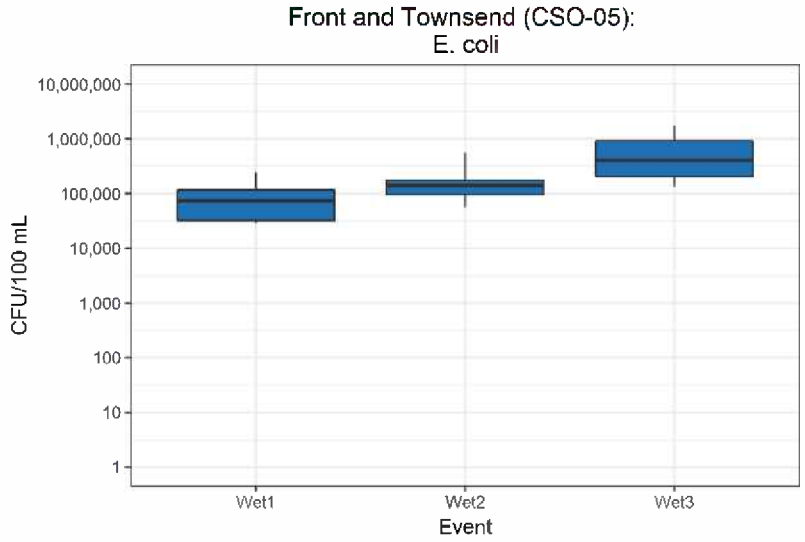
4.1 CSO-02

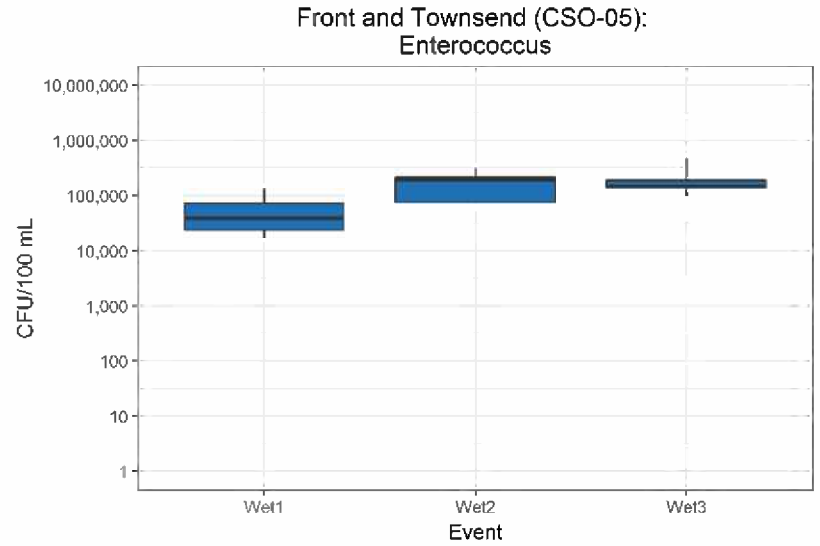

Front and Booth St (CSO-02):
E. coli
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event

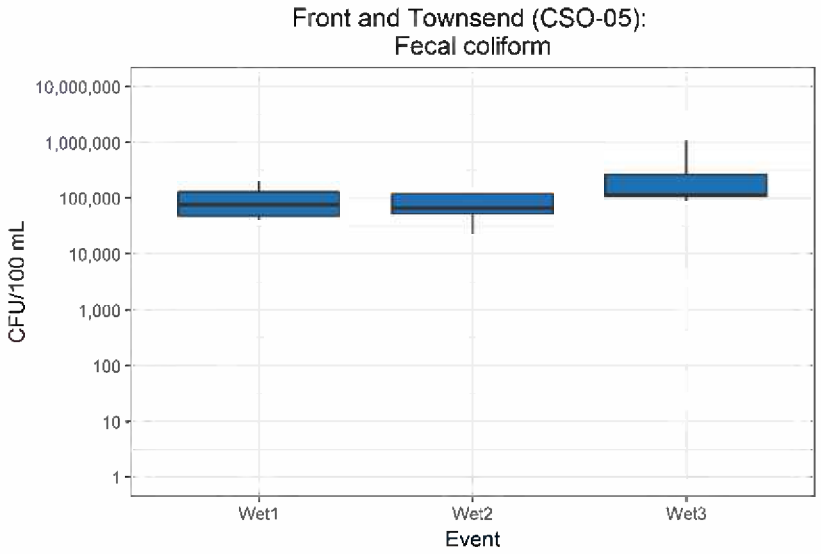

Front and Booth St (CSO-02):
Enterococcus
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event


Front and Booth St (CSO-02):
Fecal coliform
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event

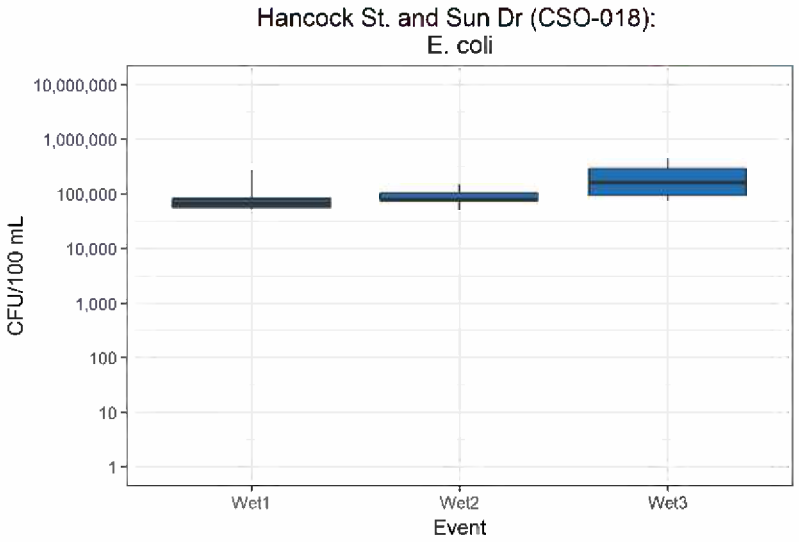
4.2 CSO-05

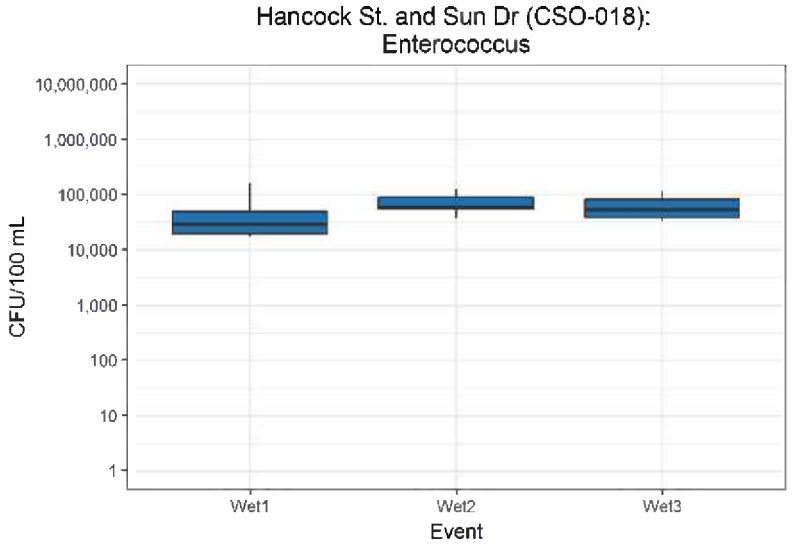

Front and Townsend (CSO-05):
E. coli
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

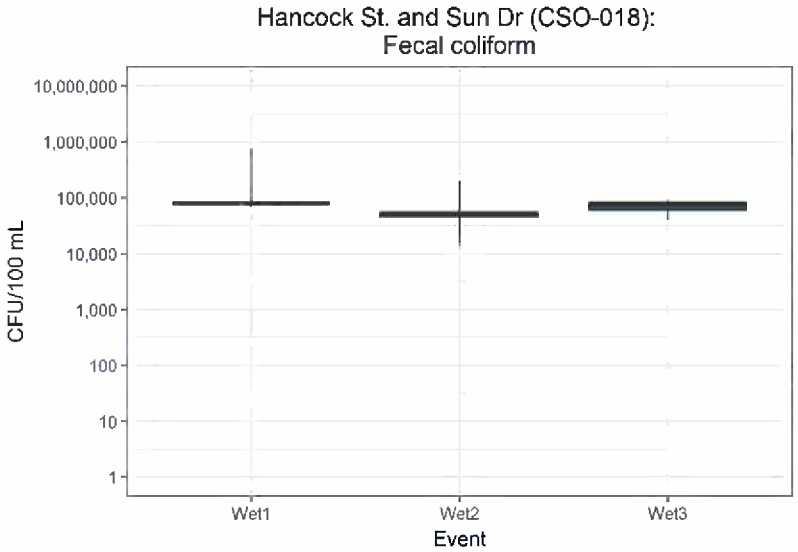

Front and Townsend (CSO-05):
Enterococcus
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event


Front and Townsend (CSO-05):
Fecal coliform
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

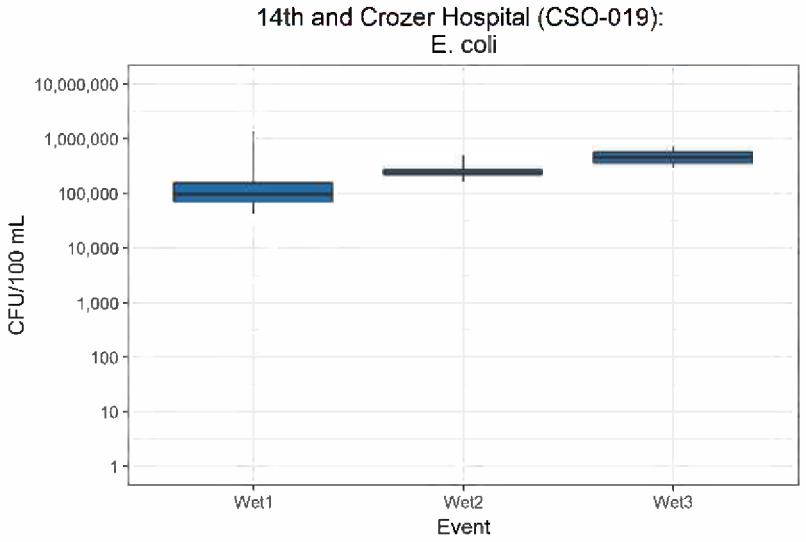
4.3 CSO-018

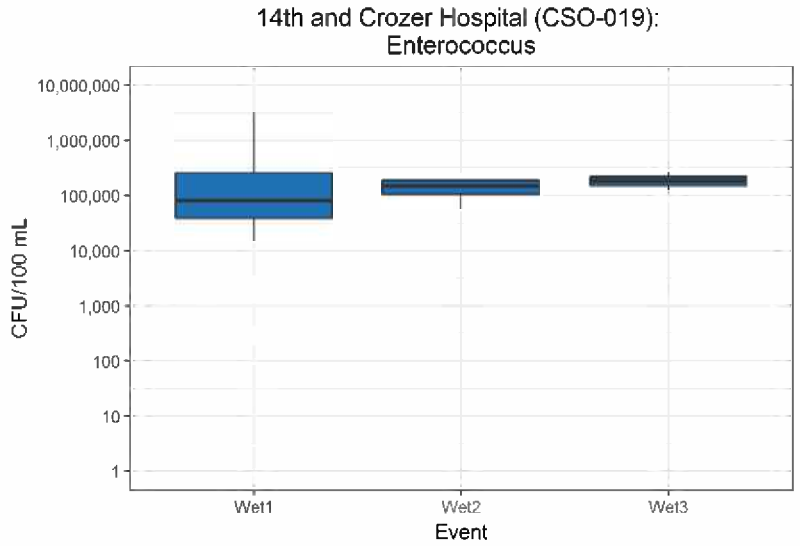

Hancock St. and Sun Dr (CSO-018):
E. coli
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event

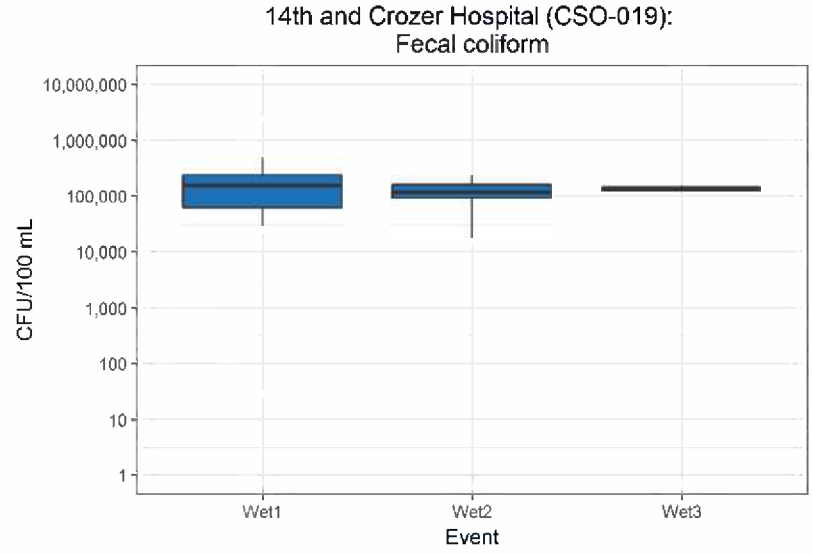

Hancock St. and Sun Dr (CSO-018):
Enterococcus
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event


Hancock St. and Sun Dr (CSO-018):
Fecal coliform
CFU/100 mL
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
Wet1
Wet2
Wet3
Event

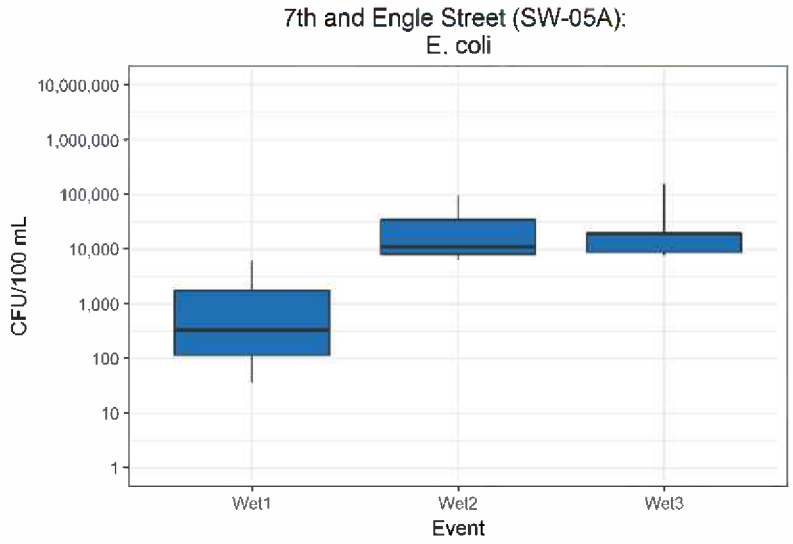
4.4 CSO-019

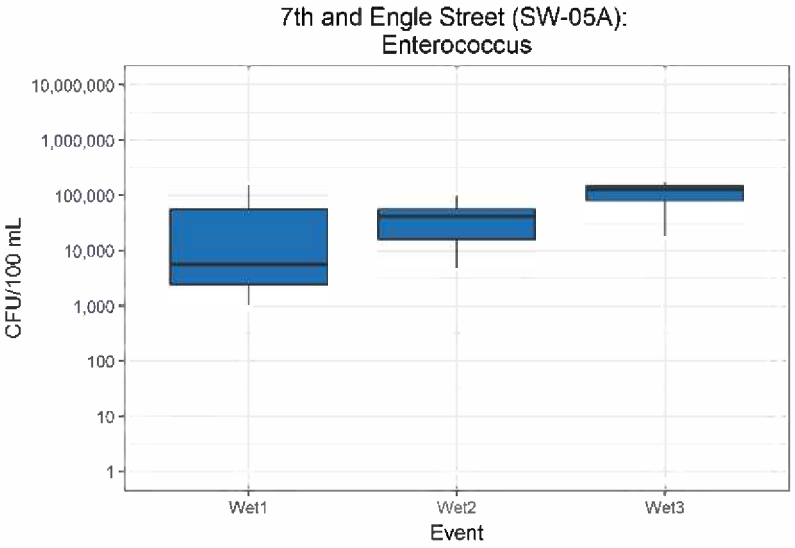

14th and Crozer Hospital (CSO-019):
E. coli
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

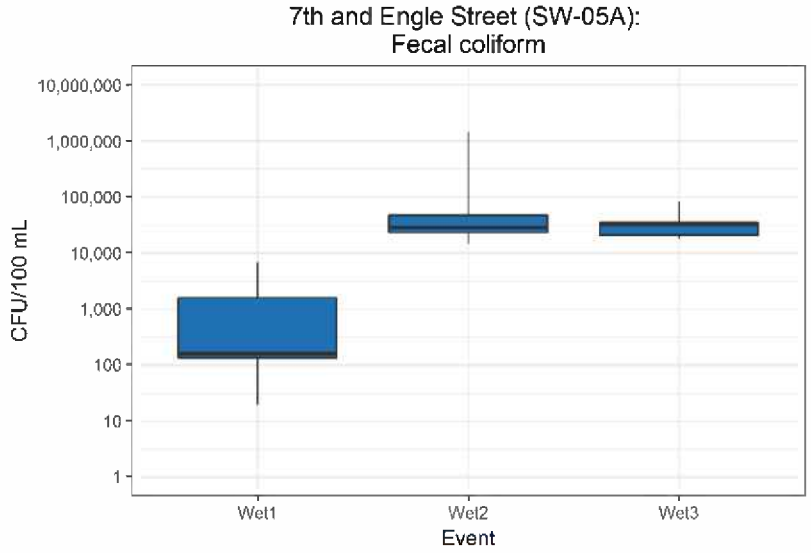

14th and Crozer Hospital (CSO-019):
Enterococcus
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event


14th and Crozer Hospital (CSO-019):
Fecal coliform
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

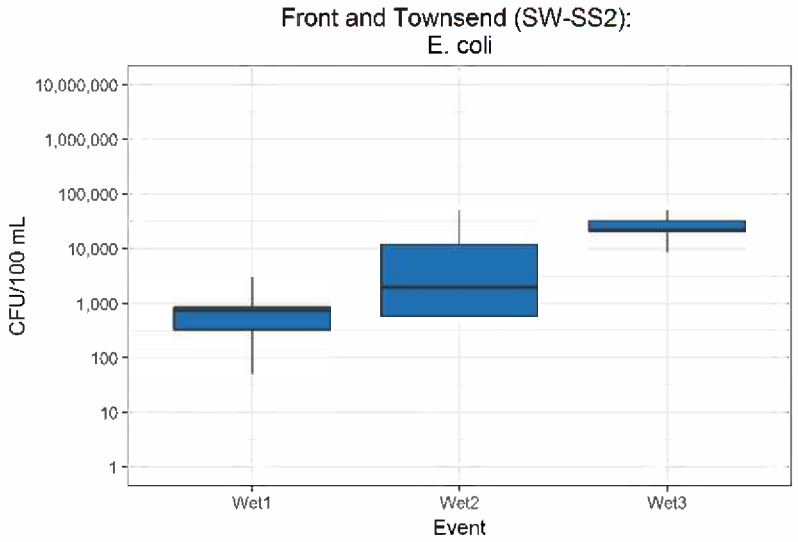
4.5 SW-05A

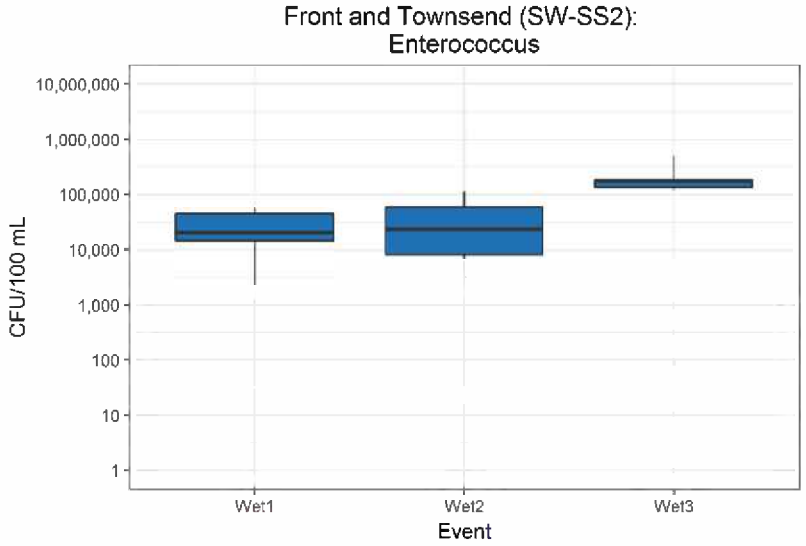

7th and Engle Street (SW-05A):
E. coli
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

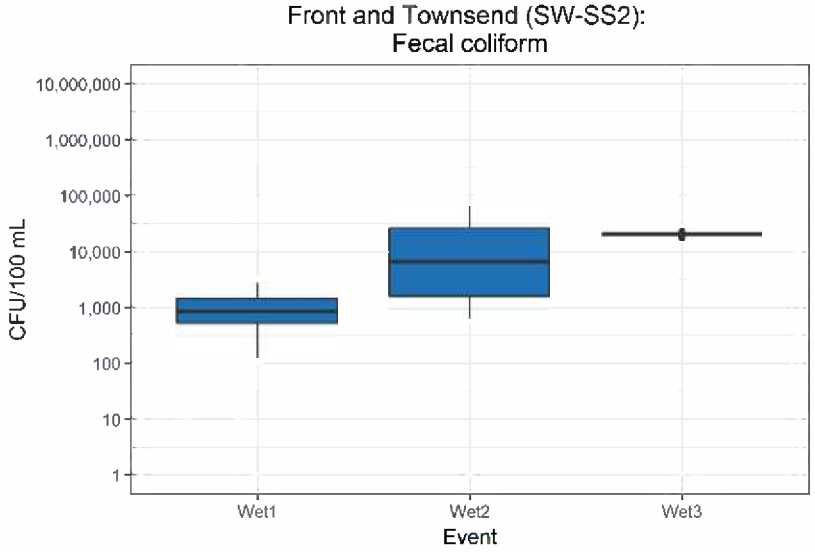

7th and Engle Street (SW-05A):
Enterococcus
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event


7th and Engle Street (SW-05A):
Fecal coliform
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

4.6 SW-SS2


Front and Townsend (SW-SS2):
E. coli
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event


Front and Townsend (SW-SS2):
Enterococcus
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event


Front and Townsend (SW-SS2):
Fecal coliform
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
CFU/100 mL
Wet1
Wet2
Wet3
Event

APPENDIX I
LABORATORY QA/QC DATA

Positive / Negative Control Summary

Date Analyzed	Parameter	OPR POS LIMS #	OPR POS Result	Acceptable (Y/N)	OPR NEG LIMS #	OPR NEG Result	Acceptable (Y/N)
2/20/2017	E. coli 1603	L6645565-4	30	Y	L6645565-5	<1	Y
2/20/2017	Entero 1600	L6645565-1	28	Y	L6645565-2	<1	Y
3/27/2017	E. coli 1603	L6645566-4	30	Y	L6645566-5	<1	Y
3/27/2017	Entero 1600	L6645566-1	26	Y	L6645566-2	<1	Y
3/31/2017	E. coli 1603	L6645566-4	30	Y	L6645566-5	<1	Y
3/31/2017	Entero 1600	L6645566-1	26	Y	L6645566-2	<1	Y
4/24/2017	E. coli 1603	L6645568-4	33	Y	L6645568-5	<1	Y
4 24/2017	Entero 1600	L6645568-1	33	Y	L6645568-2	<1	Y
5/15/2017	E. coli 1603	L6645569-4	14	N	L6645569-5	<1	Y
5/15/2017	Entero 1600	L6645569-1	30	Y	L6645569-2	<1	Y
6/6/2017	E. coli 1603	L6839202-4	7	N	L6839202-5	<1	Y
6/6/2017	Entero 1600	L6839202-1	32	Y	L6839202-2	<1	Y

Matrix Spike Summary

Date Analyzed	Parameter	MS LIMS #	Amount Spiked	MS Result	Sample Result	Amount Recovered	Percent Recovery
5/22/17	E. coli 1603	L6687478-2	30.6	>80	>80	Unknown	Incalculable
5/23/17	Entero 1600	L6687479-2	30.6	25	4	21	68.63
5/22/17	E. coli 1603	L6687480-2	30.6	>80	>80	Unknown	Incalculable
5/22/17	Entero 1600	L6687481-2	30.7	46	2	44	143.32
5/22/17	E. coli 1603	L6687482-2	30.6	21	4	17	55.56
5/23/17	Entero 1600	L6687485-2	30.6	64	24	40	130.72
5/23/17	E. coli 1603	L6687483-2	31.3	45	12	33	105.43
3/31/17	Entero 1600	L6695428-2	29.2	30	<2	30	102.74
5/23/17	E. coli 1603	L6687486-2	31.3	45	8	37	118.21
3 23/17	Entero 1600	L6695441-2	29.2	25	<10	25	85.62
3/23/17	E. coli 1603	L6695439-2	29.6	26	<10	26	87.84
3/31/17	Entero 1600	L6695444-2	29.2	>60	>60	Unknown	Incalculable
3/31/17	E. coli 1603	L6695443-2	30.6	11	Blank	Blank	35.95
3/31/17	Entero 1600	L6695452-2	29.2	>60	>60	Unknown	Incalculable
5/22/17	E. coli 1603	L6695447-2	30.6	<1	2	<1	0
3/31/17	Entero 1600	L6695453-2	29.2	>60	>60	Unknown	Incalculable
3/31/17	E. coli 1603	L6695448-2	30.6	26	<2	26	84.97

5/5/17	Entero 1600	L6695467-2	30.7	25	6	19	61.89
3/31/17	E. coli 1603	L6695449-2	29.6	>60	>60	Unknown	Incalculable
5/22/17	Entero 1600	L6695469-2	30.7	31	12	19	61.89
3/31/17	E. coli 1603	L6695454-2	29.6	>60	>60	Unknown	Incalculable
5/5/17	Entero 1600	L6695475-2	30.7	>60	>60	Unknown	Incalculable
5/5/17	E. coli 1603	L6695468-2	29.6	47	26	21	70.95
6/13/17	Entero 1600	L6815251-2	30.6	23	<1	23	75.16
6/13/17	E. coli 1603	L6815247-2	30.6	14	<1	24	45.75

Lab Replicate Summary

Date Analyzed	Parameter	MS LIMS #	Replicate Result (cfu / 100 mL)	Original Result (cfu / 100 mL)	Relative Percent Difference (%)
5/22/17	E. coli 1603	L6687478-1	>800	401000	Incalculable
5/23/17	Entero 1600	L6687479-1	<10	2	Incalculable
5/22/17	E. coli 1603	L6687480-1	>800	241000	Incalculable
5/22/17	Entero 1600	L6687481-1	180	116	43.24
5/22/17	E. coli 1603	L6687482-1	150	152	1.32
5/23/17	Entero 1600	L6687485-1	550	580	5.31
5/23/17	E. coli 1603	L6687483-1	360	300	18.18
3/31/17	Entero 1600	L6695428-1	40	6600	197.59
5/23/17	E. coli 1603	L6687486-1	160	112	35.29
3/23/17	Entero 1600	L6695441-1	<10	<10	Incalculable
3/23/17	E. coli 1603	L6695439-1	<10	<10	Incalculable
3/31/17	Entero 1600	L6695444-1	>600	200000	Incalculable
3/31/17	E. coli 1603	L6695443-1	80	100	22.22
3/31/17	Entero 1600	L6695452-1	>600	550000	Incalculable
5/22/17	E. coli 1603	L6695447-1	<10	Blank	Incalculable
3/31/17	Entero 1600	L6695453-1	>600	3300	Incalculable
3/31/17	E. coli 1603	L6695448-1	50	40	22.22
5/5/17	Entero 1600	L6695467-1	<10	12	Incalculable
3/31/17	E. coli 1603	L6695449-1	>600	2020	Incalculable
5/22/17	Entero 1600	L6695469-1	20	12	50
3/31/17	E. coli 1603	L6695454-1	>600	19000	Incalculable
5/5/17	Entero 1600	L6695475-1	>600	37000	Incalculable
5/5/17	E. coli 1603	L6695468-1	240	230	4.26
6/13/17	Entero 1600	L6815251-1	180	150	18.18
6/13/17	E. coli 1603	L6815247-1	200	200	0

BioBall SingleShot

Certificate of Analysis

Lot Number: B3628

Reference Material Data

Organism:	*Escherichia coli*
Designation:	NCTC 9001
Reference:	413832 10 Vials
	56033 20 Vials
BTF Internal Reference:	B-EC9001-30-10
	B-EC9001-30-20
Date of Manufacture:	19 July 2016
Expiry Date:	19 July 2018
Extended Expiry Date*:	N/A

Quantification Data
(Method Ref: BB-001)
cfu Count per BioBall ©

Mean cfu	SD
29.6	2.6

95% Prediction Interval

Lower Limit	Upper Limit
24.3	34.8

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Nutrient agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are indicated from the original strain assuming original strain is zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Frank Pollock

19 August 2016

NATA

Accredited for compliance with ISO Guide 34

Accredited Reference Material Producer
Accreditation Number: 14063
Site Number: 15276

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF occasionally extends the expiry dates on selected BioBall products. Please check the BioBall website http://bioball.com/bioball/certificate-of-analysis/ to determine whether or not the shelf life of your BioBall batch has been extended.

Manufactured by:
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Sydney Australia
Tel. 61 (0) 2 8977 9100
Fax 61 (0) 2 8977 9599
www.bioball.com

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Sales and General enquiries:
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Fax 33 (0) 4 78 87 20 90
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BioBall SingleShot

Certificate of Analysis

Lot Number: B3827

Reference Material Data

Organism:	*Escherichia coli*
Designation:	NCTC 12923
Reference:	413833 10 Vials
	56034 25 Vials
BTF Internal Reference:	B-EC12923-30-10
	B-EC12923-30-20
Date of Manufacture:	22 November 2016
Expiry Date:	22 November 2018
Extended Expiry Date*:	N/A

Quantification Data

(Method Ref: BB-001)

cfu Count per BioBall ©

Mean cfu	SD
30.6	2.3

95% Prediction Interval

Lower Limit	Upper Limit
25.9	35.3

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Nutrient agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are indicated from the original strain assuming original strain is zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Pietro Petech

14 December 2016

NATA

Accredited for compliance with ISO Guide 34

Accredited Reference Material Producer
Accreditation Number: 1403
Site Number: 15215

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF occasionally extends the expiry dates on standard BioBall products. Please check the BioBall website http://bioball.com/bioball/certificate-of-analysis/ to determine whether or not the shelf life of your BioBall batch has been extended.

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INDUSTRY

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BioBall SingleShot

Certificate of Analysis

Lot Number: B3458

Reference Material Data

Organism:	*Escherichia coli*
Designation:	NCTC 9001
Reference:	413832 10 Vials
	56033 20 Vials
BTF Internal Reference:	B-EC9001-30-10
	B-EC9001-30-20
Date of Manufacture:	14 March 2016
Expiry Date:	14 March 2018
Extended Expiry Date*:	N/A

Quantification Data
(Method Ref: BB-001)

cfu Count per BioBall ©

Mean cfu	SD
31.3	2.1

95% Prediction Interval

Lower Limit	Upper Limit
27.1	35.5

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Nutrient agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are counted from the original strain obtained original strain is zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Linh Le

6 April 2016

NATA

Accredited for compliance with ISO Guide 34

Accredited Reference Material Producer
Accreditation Number: 14993
Site Number: 15376

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF regularly extends the expiry dates on standard BioBall products. Please check the BTF website www.bioball.com/cgi-bin/expiry.pl to determine whether or not the shelf life of your BioBall batch has been extended

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BioBall SingleShot

Certificate of Analysis

Lot Number: B3778

Reference Material Data

Organism:	*Enterococcus faecalis*
Designation:	NCTC 775
Reference:	413850 10 Vials
	56032 20 Vials
BTF Internal Reference:	B-EF775-30-10
	B-EF775-30-20
Date of Manufacture:	24 October 2016
Expiry Date:	24 October 2018
Extended Expiry Date*:	N/A

Quantification Data
(Method Ref: BB-001)
cfu Count per BioBall ©

Mean cfu	SD
29.2	2.6

95% Prediction Interval

Lower Limit	Upper Limit
23.9	34.6

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Horse Blood agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are indicated from the original strain obtained original strain is zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Fiona Pollock

28 November 2016

NATA
Accredited for compliance with ISO Guide 34
Accredited Reference Material Producer
Accreditation Number: 14993
Site Number: 13276

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF occasionally extends the expiry dates on standard BioBall products. Please check the BioBall website http://bioball.com/bioball/certificate-of-analysis/ to determine whether or not the shelf life of your BioBall batch has been extended.

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BioBall SingleShot

Certificate of Analysis

Lot Number: B3698

Reference Material Data

Organism:	*Enterococcus faecalis*
Designation:	NCTC 775
Reference:	413850 10 Vials
	56032 20 Vials
BTF Internal Reference:	B-EF775-30-10
	B-EF775-30-20
Date of Manufacture:	30 August 2016
Expiry Date:	30 August 2018
Extended Expiry Date*:	N/A

Quantification Data
(Method Ref: BB-001)

cfu Count per BioBall ©

Mean cfu	SD
30.7	2.5

95% Prediction Interval

Lower Limit	Upper Limit
25.6	35.8

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Horse Blood agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are indicated from the original strain stock using original strain as zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Pedro Pallais

15 September 2016

NATA
Accredited for compliance with ISO Guide 34
Accredited Reference Material Producer
Accreditation Number: 14060
Site Number: 15376

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF occasionally extends the expiry dates on standard BioBall products. Please check the BioBall website http://bioball.com/bioball/certificate-of-analysis/ to determine whether or not the shelf life of your BioBall batch has been extended

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BioBall SingleShot

Certificate of Analysis

Lot Number: B3347

Reference Material Data

Organism:	*Enterococcus faecalis*
Designation:	NCTC 775
Reference:	413850 10 Vials
	56032 20 Vials
BTF Internal Reference:	B-EF775-30-10
	B-EF775-30-20
Date of Manufacture:	19 November 2015
Expiry Date:	18 November 2017
Extended Expiry Date*:	N/A

Quantification Data
(Method Ref: BB-001)

cfu Count per BioBall ©

Mean cfu	SD
30.6	2.2

95% Prediction Interval

Lower Limit	Upper Limit
26.2	34.9

For an explanation of the Prediction Interval see the BioBall Instructions For Use on the BioBall website - www.bioball.com

Culture Information

No. of Passages:	4
QC Media:	Horse Blood agar
Plate Incubation Time (hrs):	14 - 24
Plate Incubation Temp °C:	37 Aerobic

Note: Number of passages are counted from the original strain assuming original strain is zero

Strain Confirmation

Bacteria strains are confirmed by genetic typing. Yeast and Mould strains are confirmed by Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Quality Officer:

Fiona Pollock

5 December 2015

NATA

Accredited for compliance with ISO Guide 34

Accredited Reference Material Producer
Accreditation Number: 14993
Site Number: 15376

Strain sourced from NCTC (National Collection of Type Cultures)

*BTF regularly extends the expiry dates on standard BioBall products. Please check the BTF website www.bioball.com/eols.php to determine whether or not the shelf life of your BioBall batch has been extended.

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Issue 7 - May 2012

APPENDIX J

CITY OF CHESTER MAP AND LETTER

Monitoring Sample Locations

- CSO Sampling Location
- SW Sampling Location
- RW Sampling Location
- Western Regional Treatment Plant

N

RC-01
CC-01
CSO-19
CSO-18
RC-02
SW-05A
CC-02
RC-03
CC-03
CSO-02
CSO-05
SW-SS2
DR-01
DR-02
DR-03
DR-04
DR-05
DR-06
DR-07

Ridley Creek
Chester Creek
Delaware River
PENNSYLVANIA
NEW JERSEY

Sampled only during wet weather and as river conditions permit

0 0.5 1 Miles

Station ID	GPS Coordinates	Address/Location
CC-01	39.850122, -75.386348	Upland Rd., Incinerator Rd. Bridge
CC-02	39.850709, -75.365530	9th St Bridge; 54 W 9th St
CC-03	39.845227, -75.360284	Intersection of Edgmont and 2nd street; William Penn's Landing Park; 126 E 2nd St
RC-01	39.873264, -75.375183	Chester Park Drive Bridge; 298 East Elkington Blvd
RC-02	39.863016, -75.348686	Morton Ave. Bridge; 1300 Sun Drive
RC-03	39.853435, -75.346350	4th Street (Harrah's) Bridge; aka Bridge No. 157 (Chester-Eddystone Bridge); 1050 East 4th St Eddystone
DR-01	39.85282, -75.3299	Delaware River between Ridley Creek and Crum Creek
DR-02	39.84715, -75.3462	Delaware River between CSO-14 and Ridley Creek
DR-03	39.8398, -75.3606	Delaware River between CSO-11 and Chester Creek
DR-04	39.83132, -75.3766	Delaware River at the boat launch off Highway 322
DR-05	39.82182, -75.3917	Delaware River between CSO- 002 and Stoney Creek
DR-06	39.82636, -75.371	Delaware River mid-stream along the transect of DR-04
DR-07	39.82203, -75.3665	Delaware River far shore (left descending bank) along the transect of DR-04
CSO-02	39.828334, -75.392570	Front and Booth St; 100 Booth St
CSO-05	39.832598, -75.383958	Front and Townsend; 101 Townsend St
CSO-18	39.863501, -75.349203	Hancock St. and Sun Dr.; 1310 Sun Dr
CSO-19	39.857132, -75.366105	14th and Crozer Hospital; 1 Medical Center Blvd
SW-SS2	39.832853, -75.384193	Front and Townsend; 105 Townsend St
SW-05A	39.838501, -75.387708	7th and Engle Street; by tennis courts

CSO Long Term Control Plan Update
Delaware County Regional Water Quality Control Authority

GREELEY AND HANSEN

LimnoTech

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. BOX 999 • CHESTER, PA 19016-0999

March 17, 2017

To Whom It May Concern:

The Delaware County Water Quality Control Authority (DELCORA) is a municipal authority located in Chester, PA, established in 1970 with the acquisition and upgrade of the City of Chester's wastewater treatment plant to become DELCORA's Western Regional Treatment Plant (WRTP). DELCORA owns, operates and maintains collection systems that serve approximately a half million people in the Greater Philadelphia area, including 42 municipalities in Delaware and Chester Counties.

DELCORA entered into a Consent Decree (CD) with the United States Government to establish a schedule for implementation of Long Term Control Plan Update (LTCPU) to achieve full compliance with the Clean Water Act and the regulations and Clean Streams Law and regulations. As part of the DELCORA LTCPU, water quality monitoring is required.

Greeley and Hansen LLC currently serves as a consultant to DELCORA for the LTCPU Project in an effort to address combined sewer overflows (CSO) associated with the Consent Decree.

Greeley and Hansen's work incudes conducting receiving stream surveys and collecting samples from manholes, outfalls and surface waters. As such, Greeley and Hansen's employees, as well as employees from Greeley and Hansen's sub-consultants, will be working along shorelines and in boats and will be temporarily stopped in vans on local roadways to access sampling points from the spring of 2017 through the summer of 2017. Representatives of Greeley and Hansen LLC and their sub-consultants who are carrying out these responsibilities should not be deemed as trespassers as they are authorized to conduct these field surveys on behalf of DELCORA.

Should you have any questions, please do not hesitate to contact me by telephone at (610) 876-5523 or (267) 212-4559 or by e-mail at hurstc@delcora.org.

Thank you.

Sincerely,

Charles Hurst, P.E.

c: Robert Willert, DELCORA
Michael DiSantis, DELCORA
Edwin Bothwell, DELCORA
Margaret Hill, Blank Rome LLP

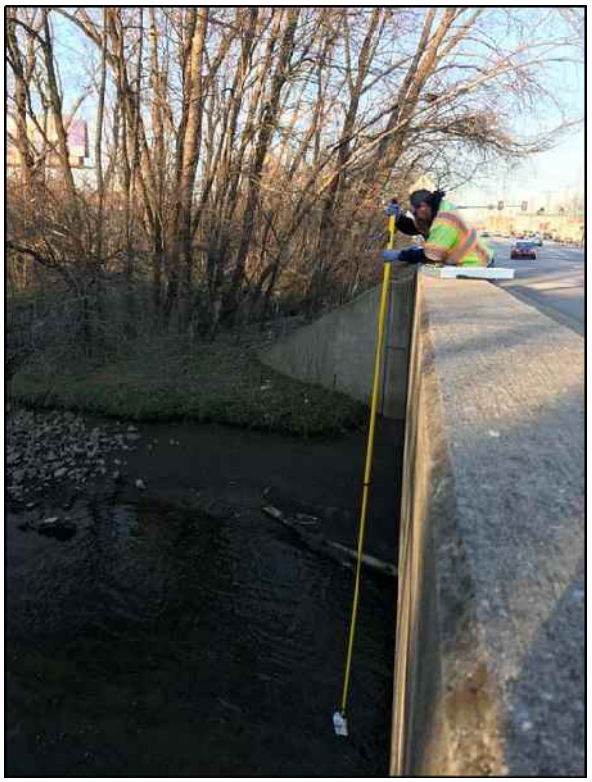
APPENDIX K
SAMPLING PHOTOS

All water quality samples were collected and transeffered into 250 mL bottles provided by Eurofins QC, Inc. The samples were preserved immideatley on ice for transfer to the laboratory for further analysis.

A view of the Delaware River, looking out from the bulkhead wall at the WRTP toward sampling location DR-05.

Sampling off of overpass bridges at Chester Creek (CC-03) and Ridley Creek (RC-03) sampling locations.

Sampling off of the overpass bridge at Ridley Creek (RC-03) sampling location required use of a Bailer Bottle Sampler due to the increased height requirements at the site.



Sampling off of an overpass bridge at Ridley Creek (RC-02) sampling location.

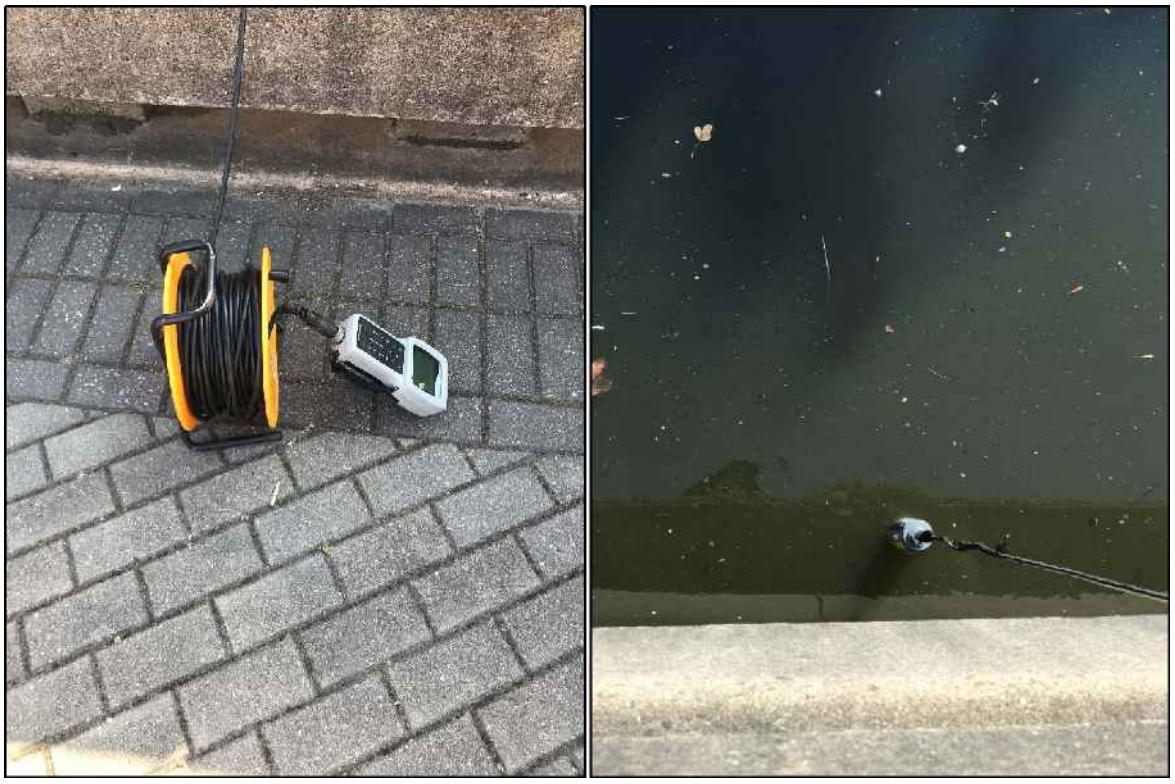
Sampling off of an overpass bridge at Ridley Creek (RC-01) sampling location.

Sampling off of an overpass bridge at Chester Creek (CC-01) sampling location.

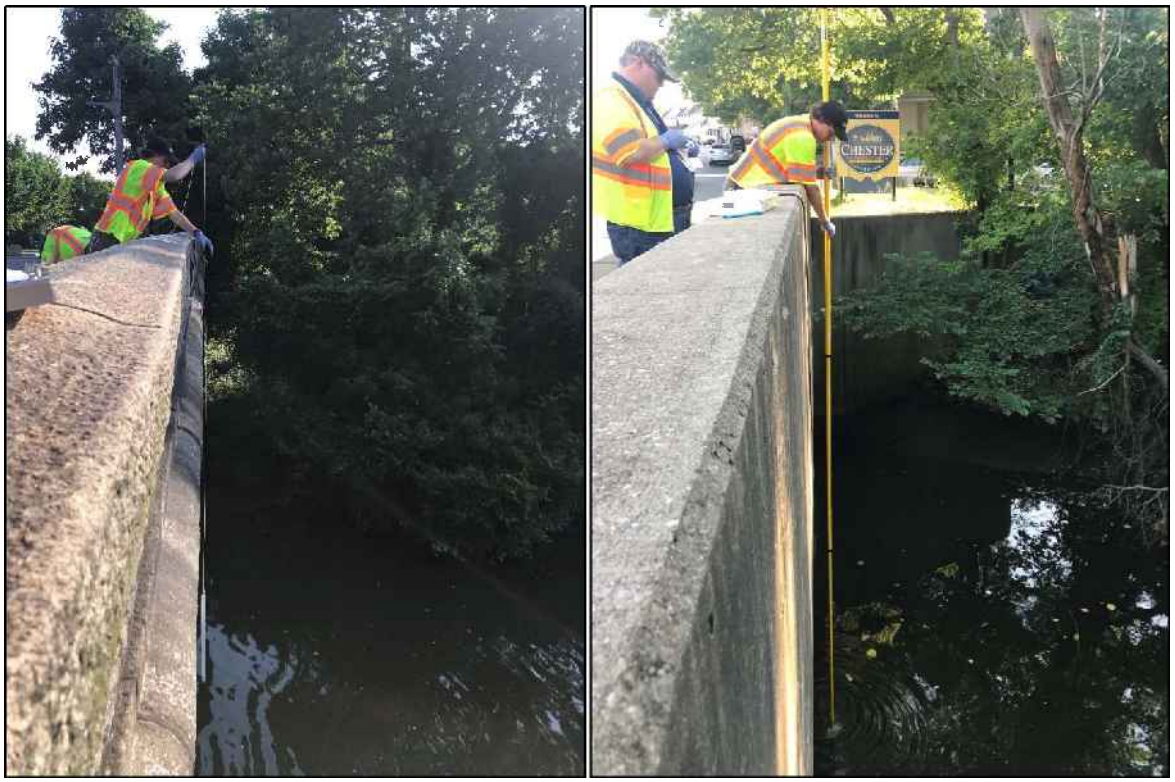
Sampling off of an overpass bridge at Chester Creek (CC-02) sampling location.

During the third wet-weather sampling event, one of the two boats in the Delaware River had to be removed from the river due to punctures in its hull. Grab samples were collected at accessible points along the Delaware shore in proximity to DR-03 and DR-04.

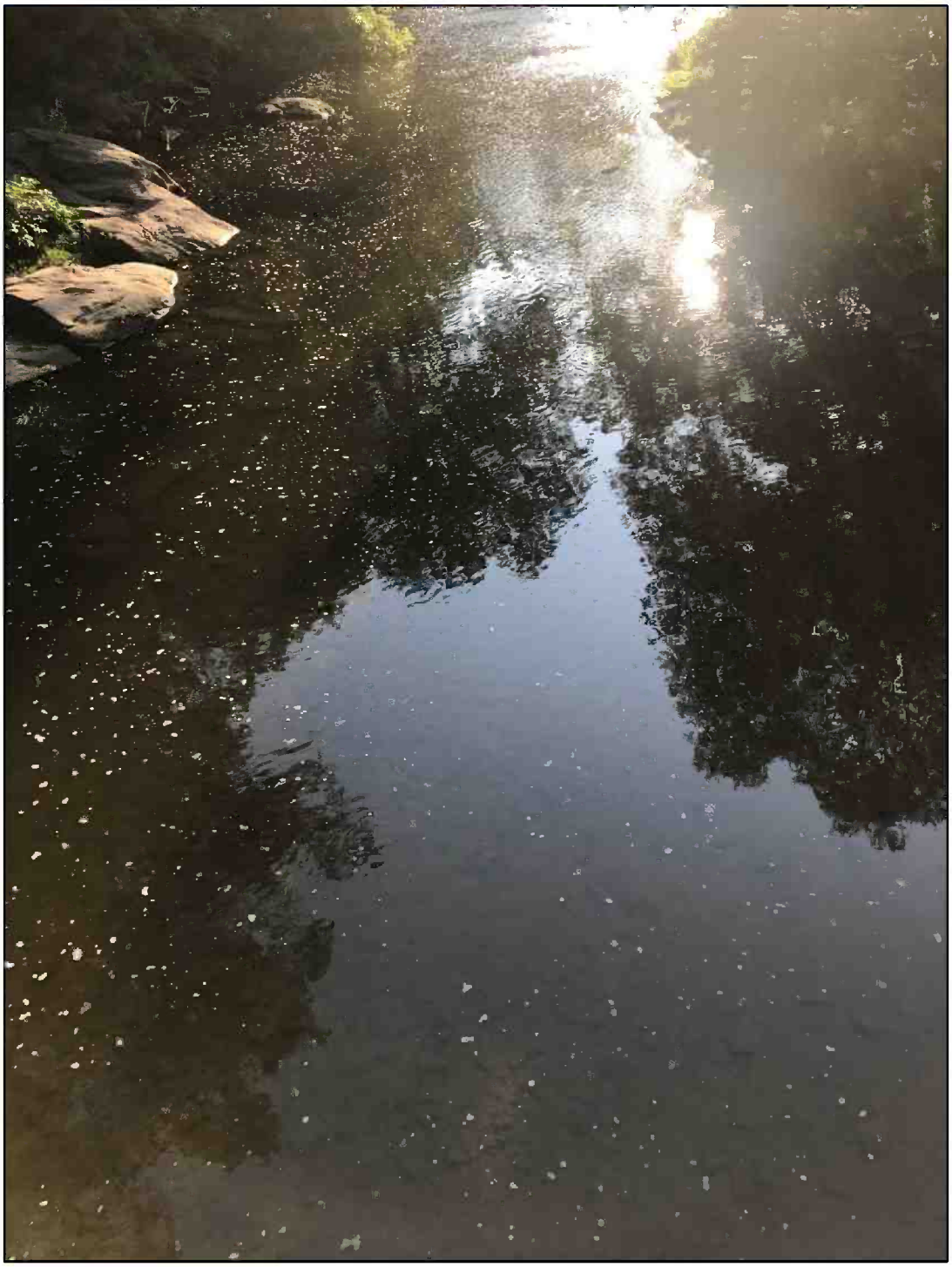
During the second wet-weather sampling event, boat activities were halted in the Delaware due to hazardous conditions (lightning and visibility issues). Conditions eventually improved, allowing for the resumption of boat activities after approximately four hours.



In-situ field measurements were taken using a YSI Model 556 with a 6920 V2 sonde. These measurements included water temperature, salinity, and conductivity in the receiving waters.



Sampling off of an overpass bridges at Ridley Creek (RC-02) sampling location.



APPENDIX L

SAMPLING ANALYSIS PLAN (SAP)

(Sampling Analysis Plan (SAP) provided in digital form only on CD attached to this report)

Greeley and Hansen LLC
1700 Market Street, Suite 2130
Philadelphia, PA 19103
(215) 563-3460
www.greeley-hansen.com

GREELEY AND HANSEN

APPENDIX C
Water Quality Model Calibration Results

Notes:

1. The 2017 Dry Weather Event in-stream sampling typically has two results per POC, per event, and per location. One sample was taken on the incoming tide and one sample was taken on the outgoing tide. There was no dry weather sampling at DR-05 and DR-06.
2. The 2017 Wet Weather Event in-stream sampling typically has five or more results per POC, per event, and per location. These were taken at t=0 (onset of rain) and then at approximately every 2 hours after that.
3. More information on the 2017 in-stream sampling results can be found in DELCORA's "Water Quality Sampling Report" (DELCORA, 2017).
4. More information on the 2012 DRBC boat run program can be found online at http://www.state.nj.us/drbc/programs/quality/boat-run.html

Fecal Coliform

Fecal Coliform—2017 Dry Weather Calibration

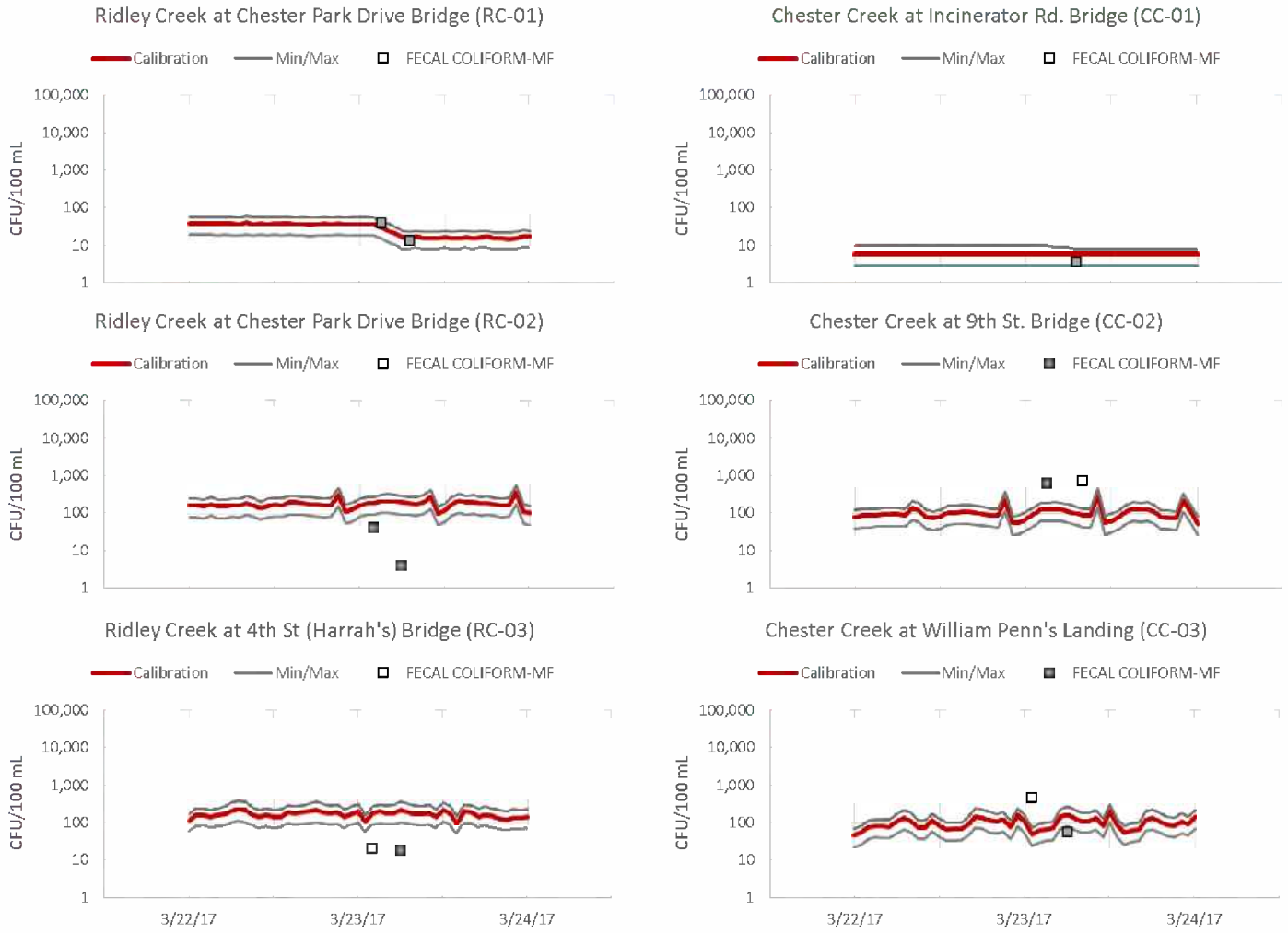


Figure 1. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #1, 3/23/17)

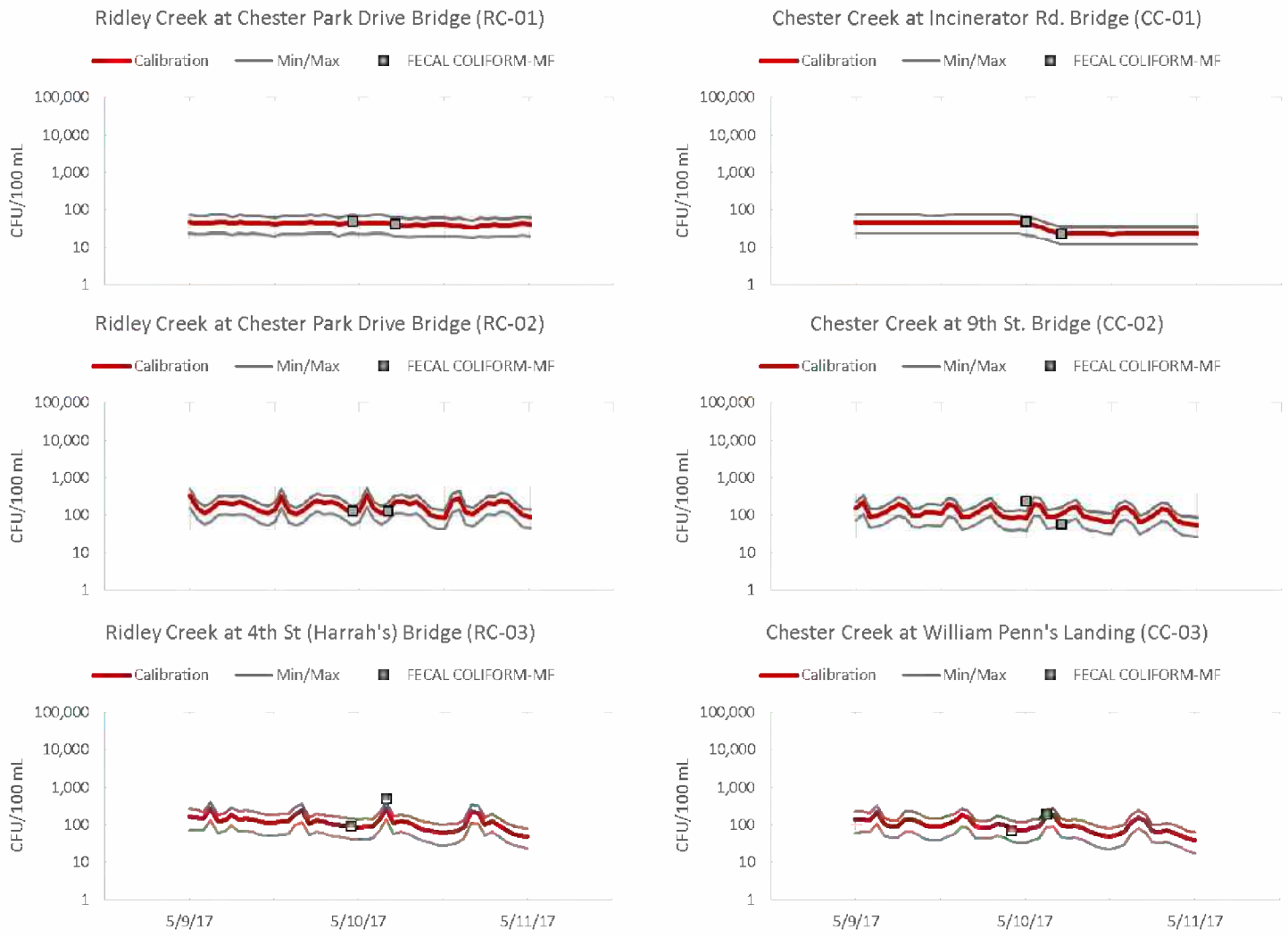


Figure 2. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #2, 5/10/17)

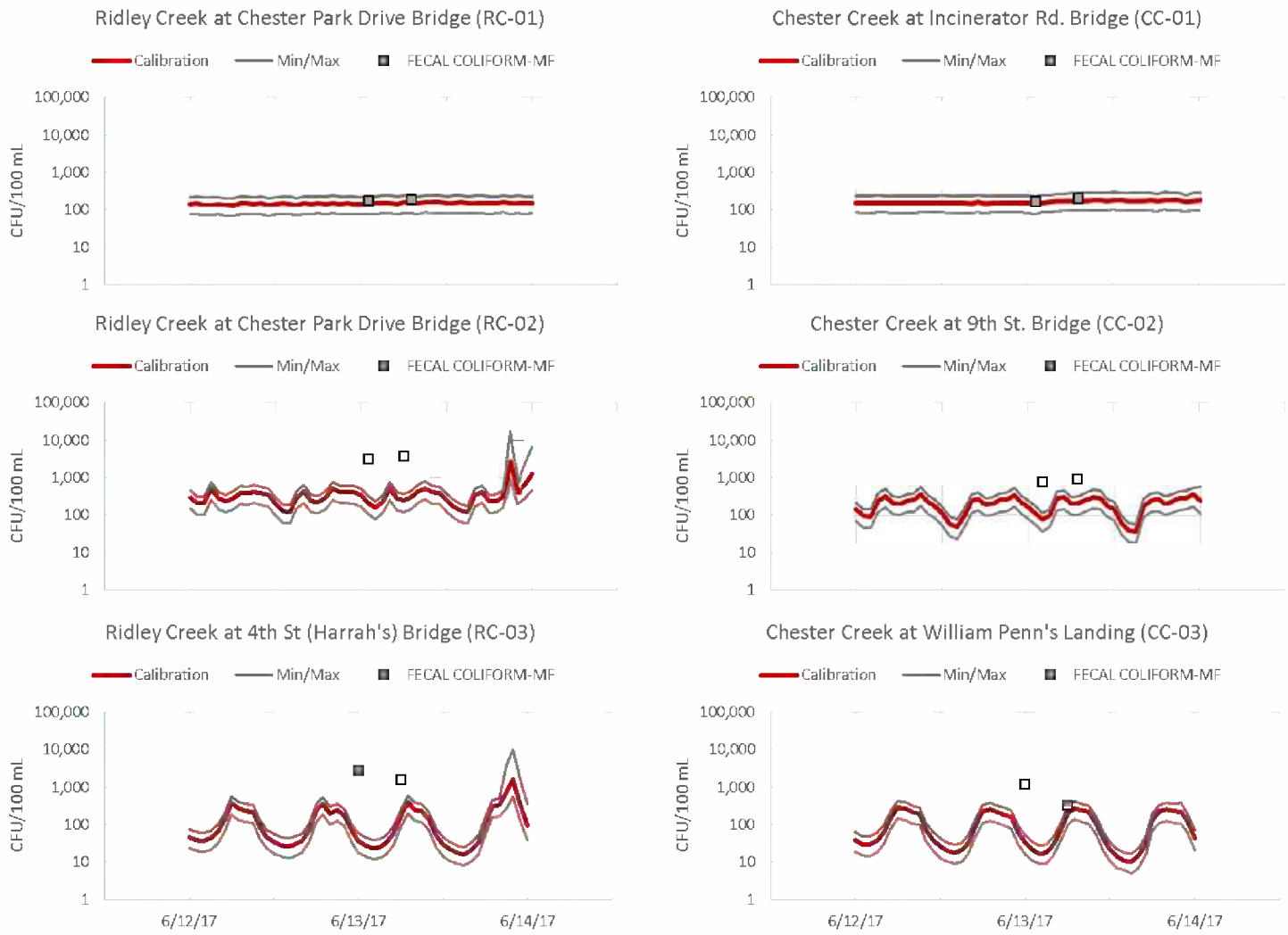


Figure 3. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #3, 6/13/17)

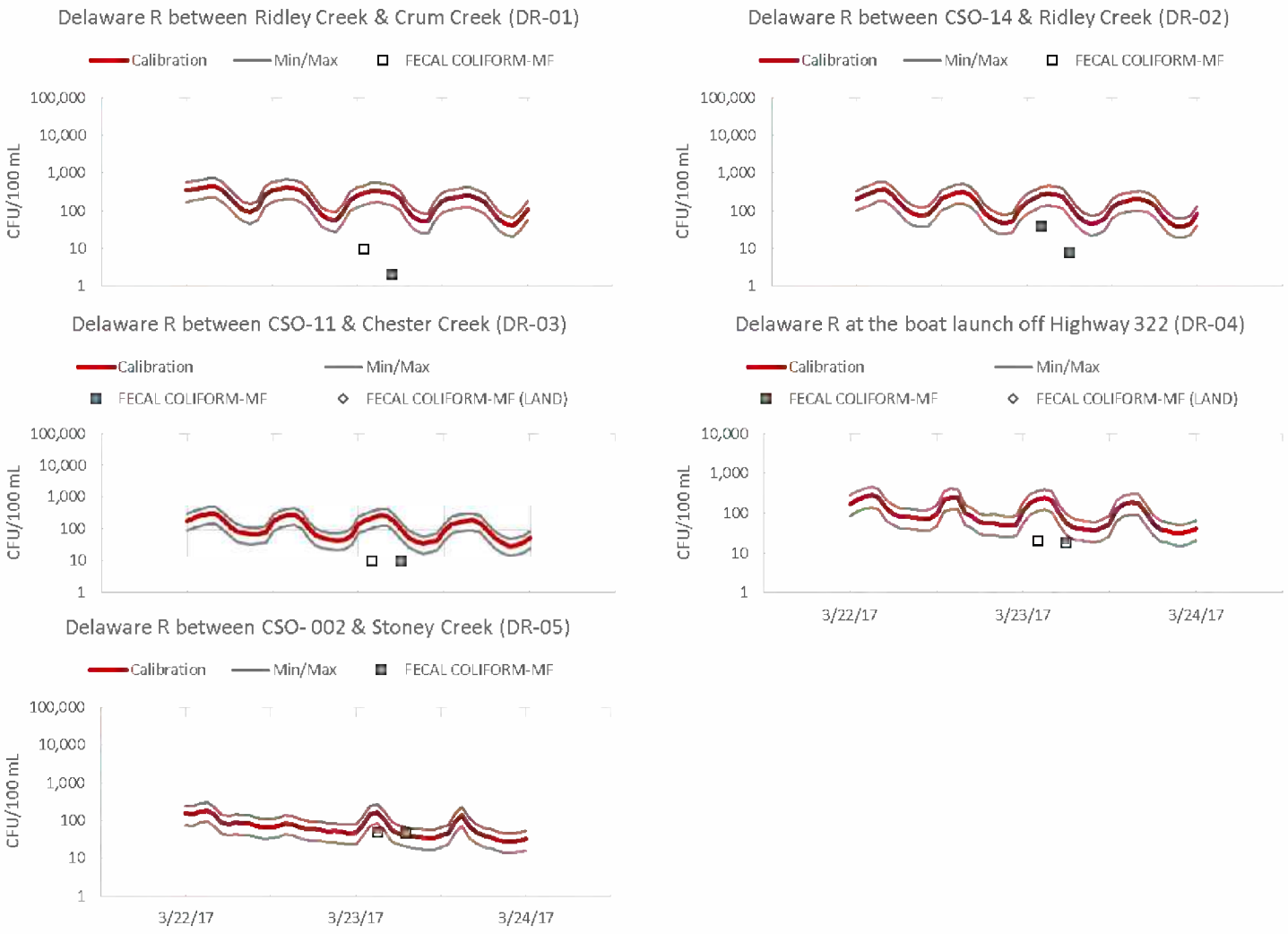


Figure 4. Fecal Coliform Calibration at Delaware River Stations (Dry Weather Event #1, 3/23/17)

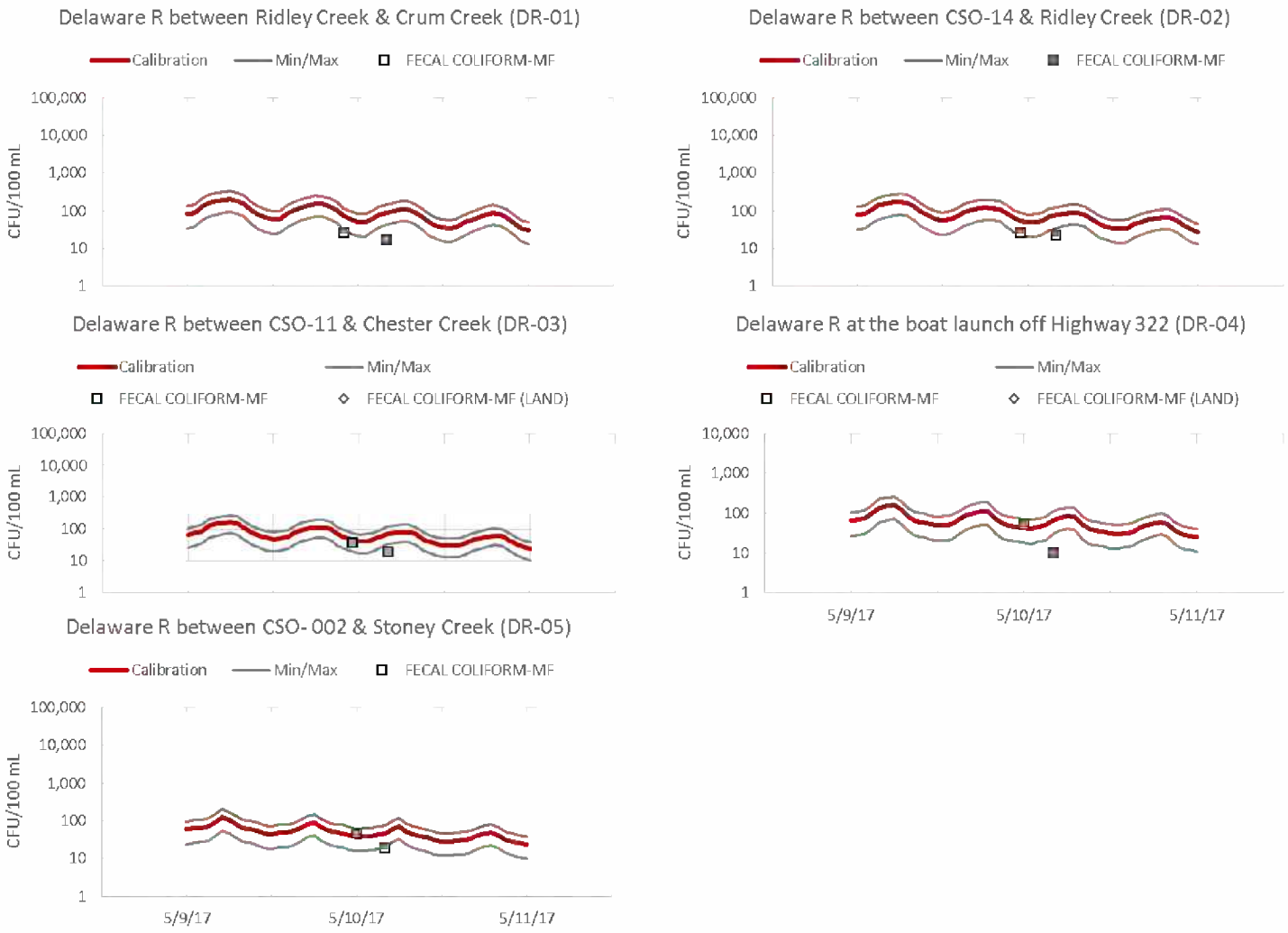


Figure 5. Fecal Coliform Calibration at Delaware River Stations (Dry Weather Event #2, 5/10/17)

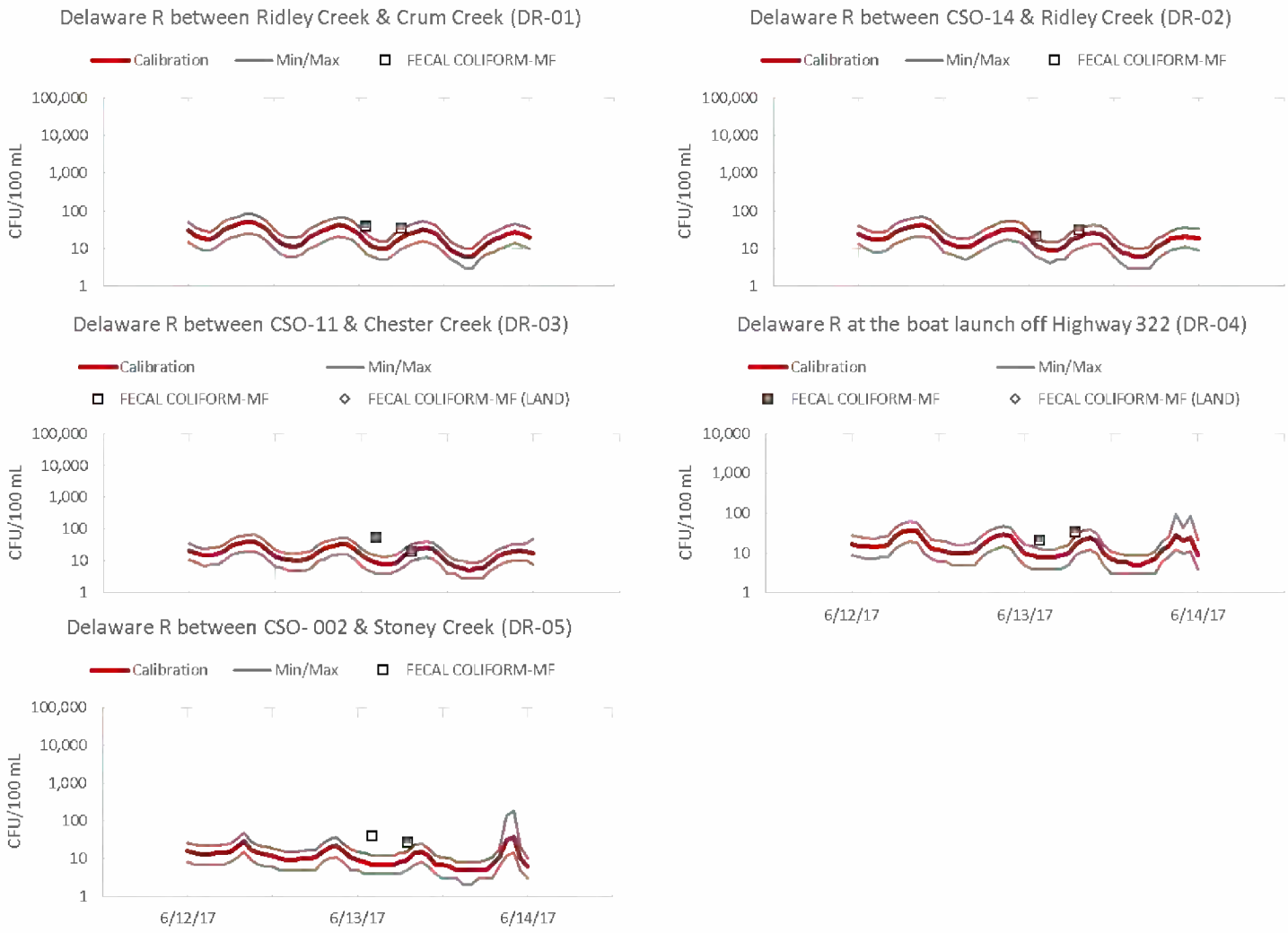


Figure 6. Fecal Coliform Calibration at Delaware River Stations (Dry Weather Event #3, 6/13/17)

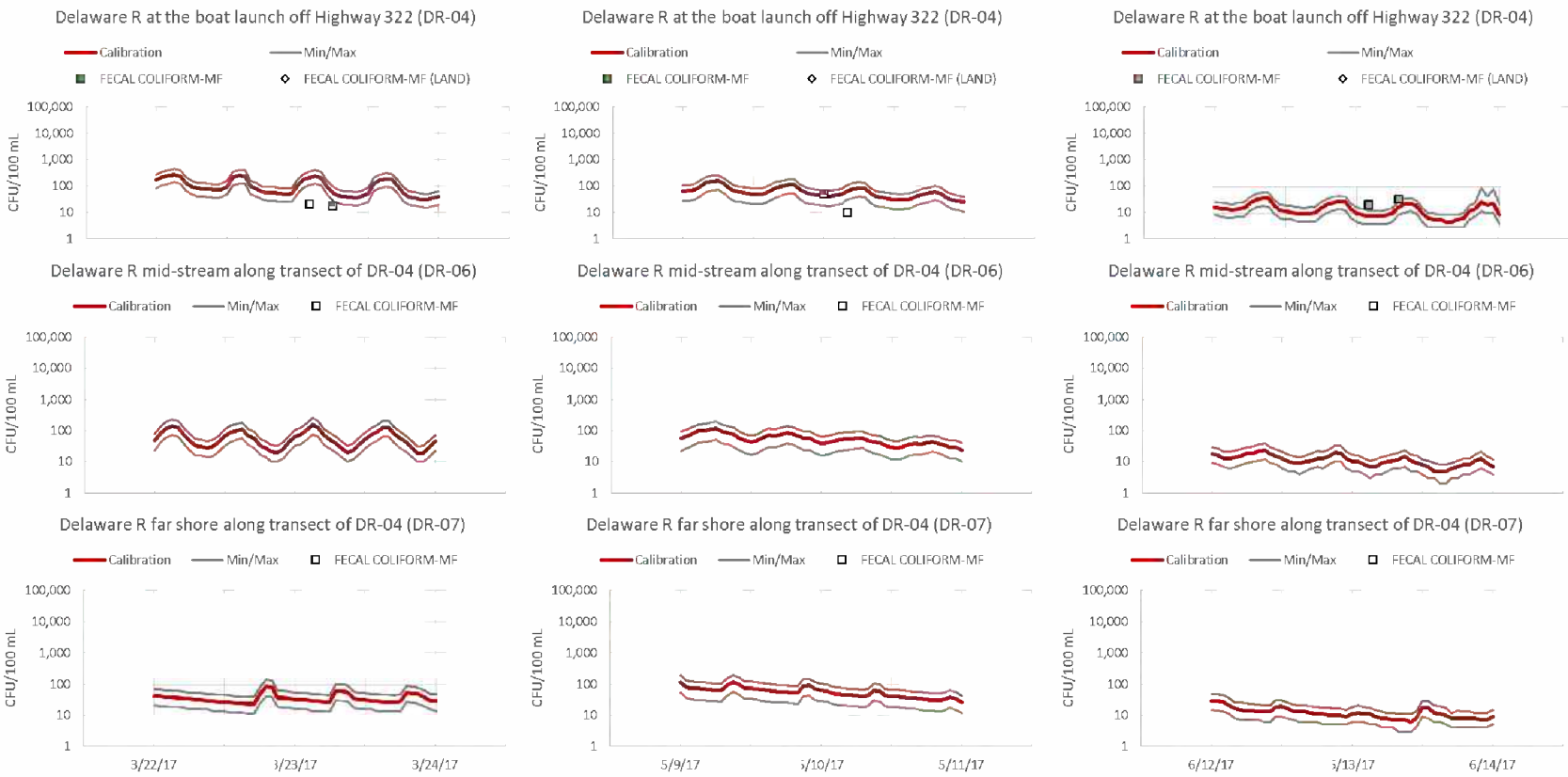


Figure 7. Fecal Coliform Calibration at Delaware River Cross Section (Dry Weather Events #1-3)

Fecal Coliform—2017 Wet Weather Calibration

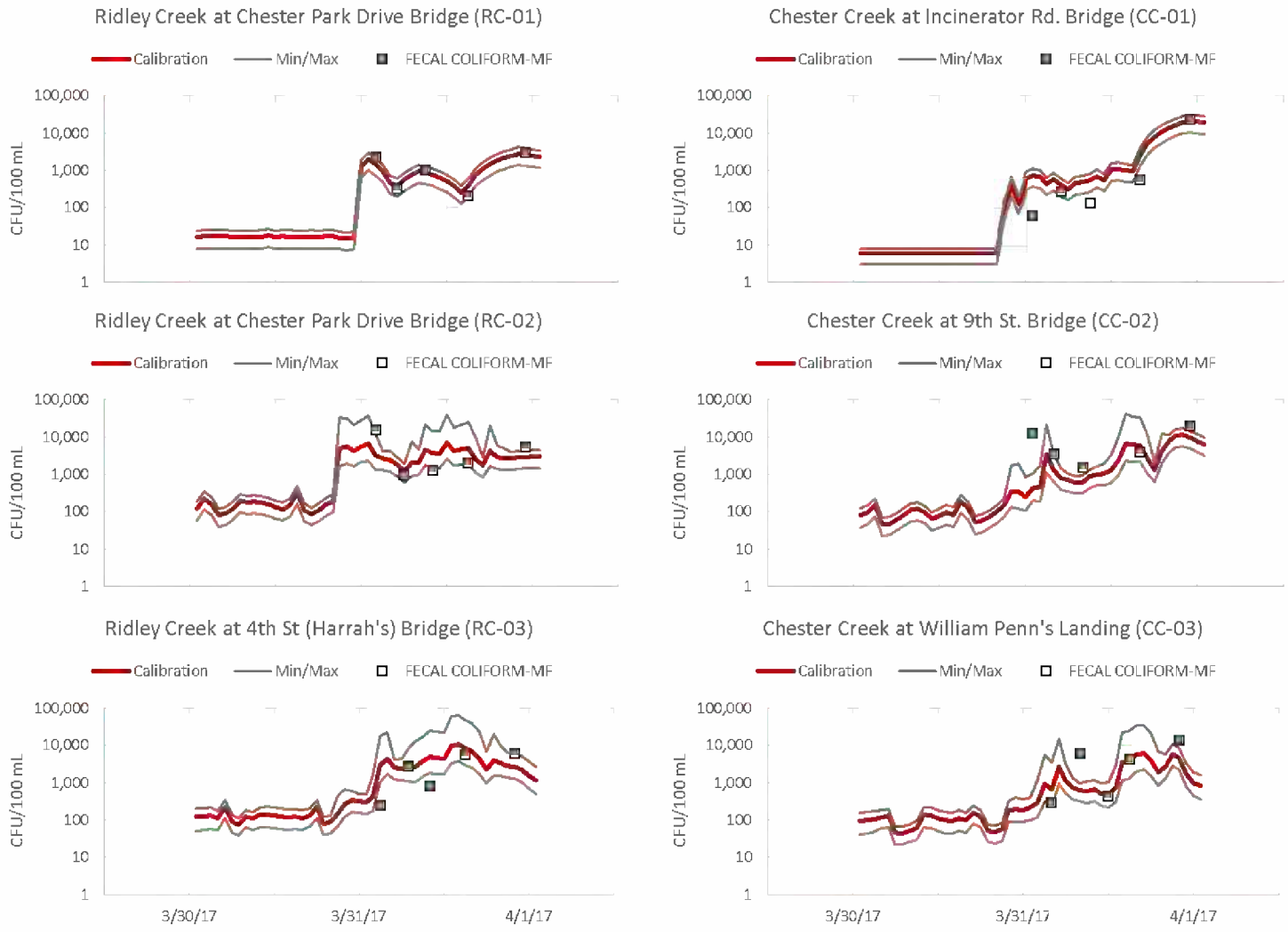


Figure 8. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #1, 3/30/17-4/1/17)

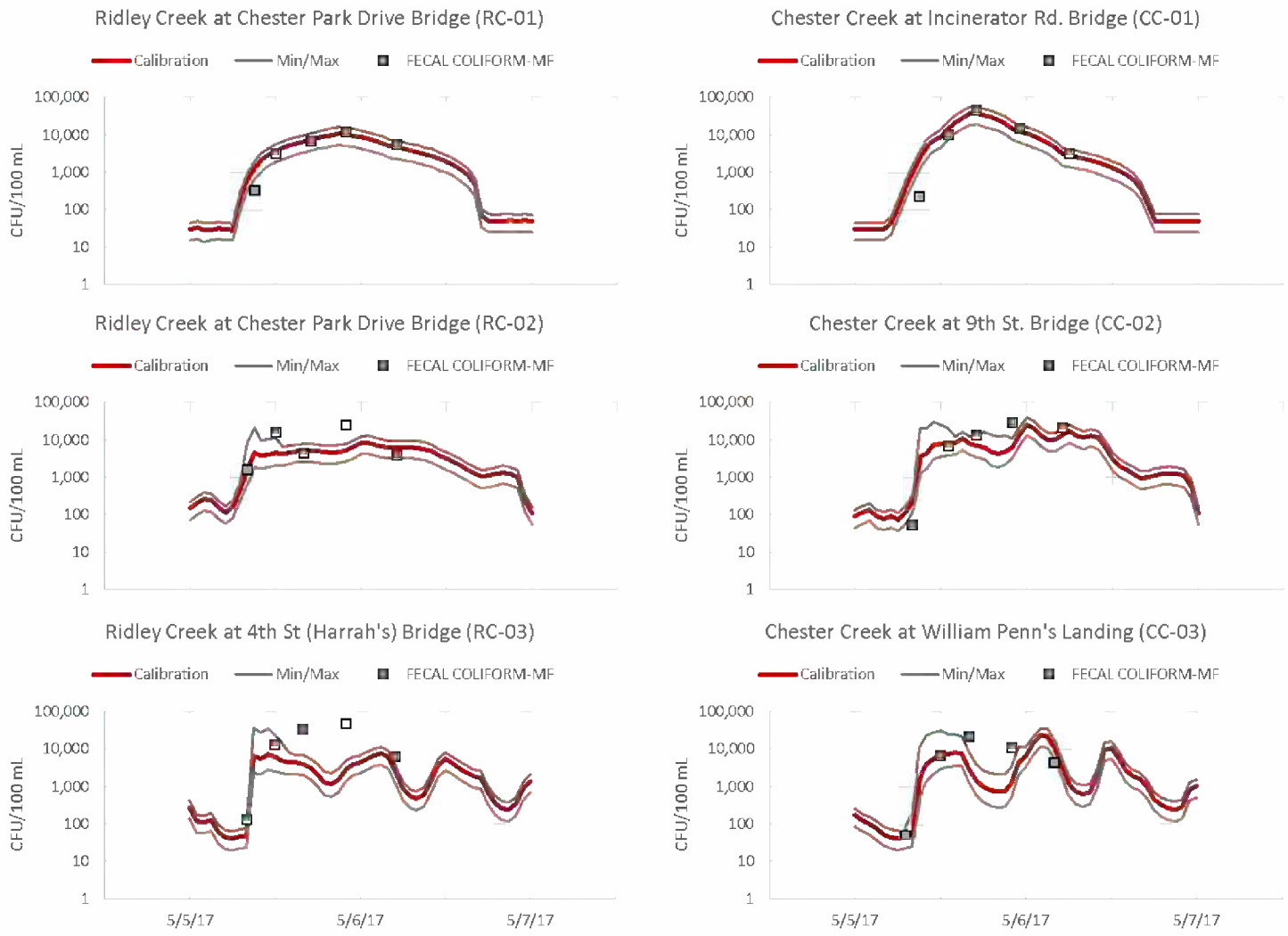


Figure 9. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #2, 5/5/17-5/6/17)

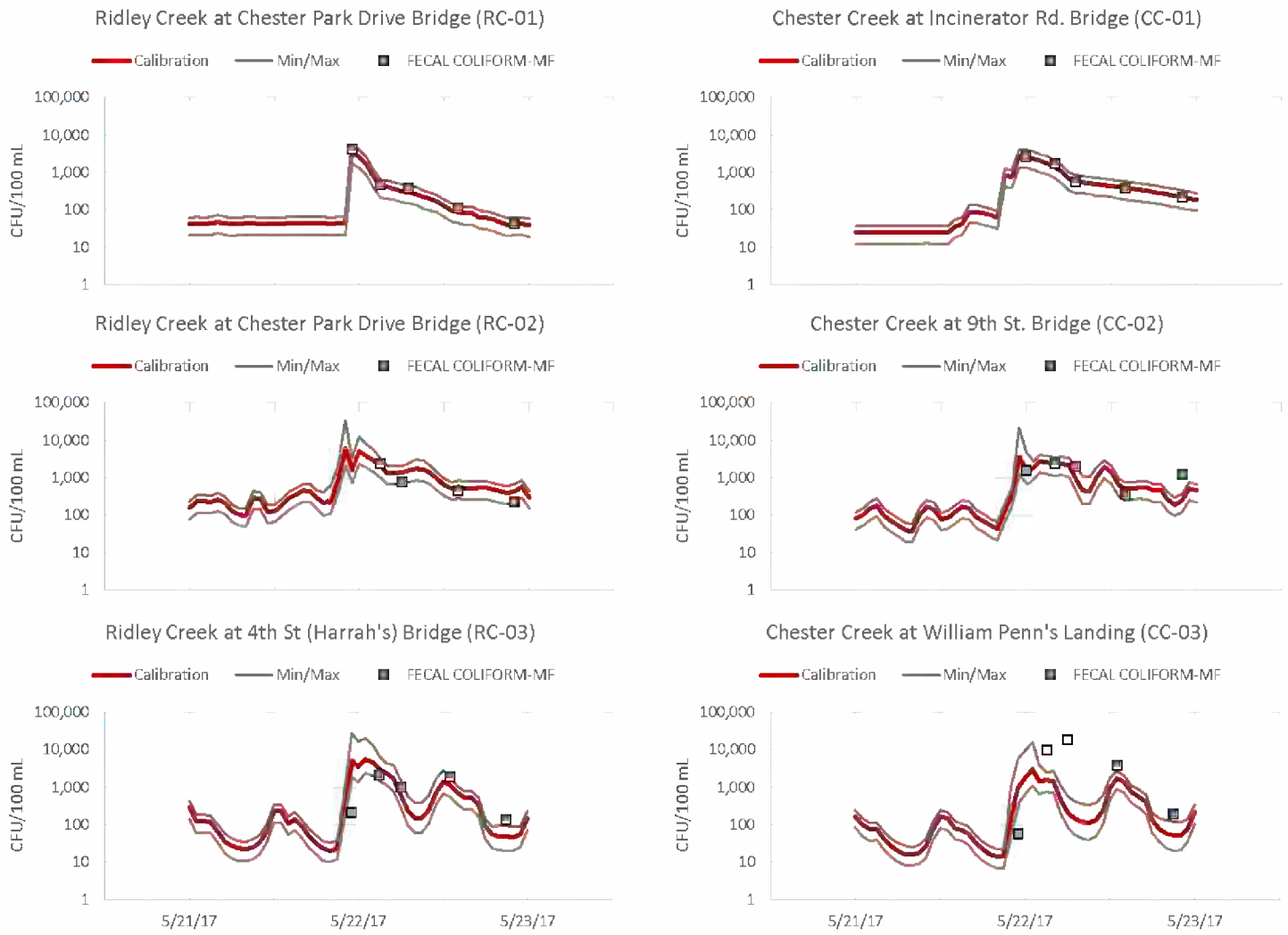


Figure 10. Fecal Coliform Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #3, 5/22/17-5/23/17)

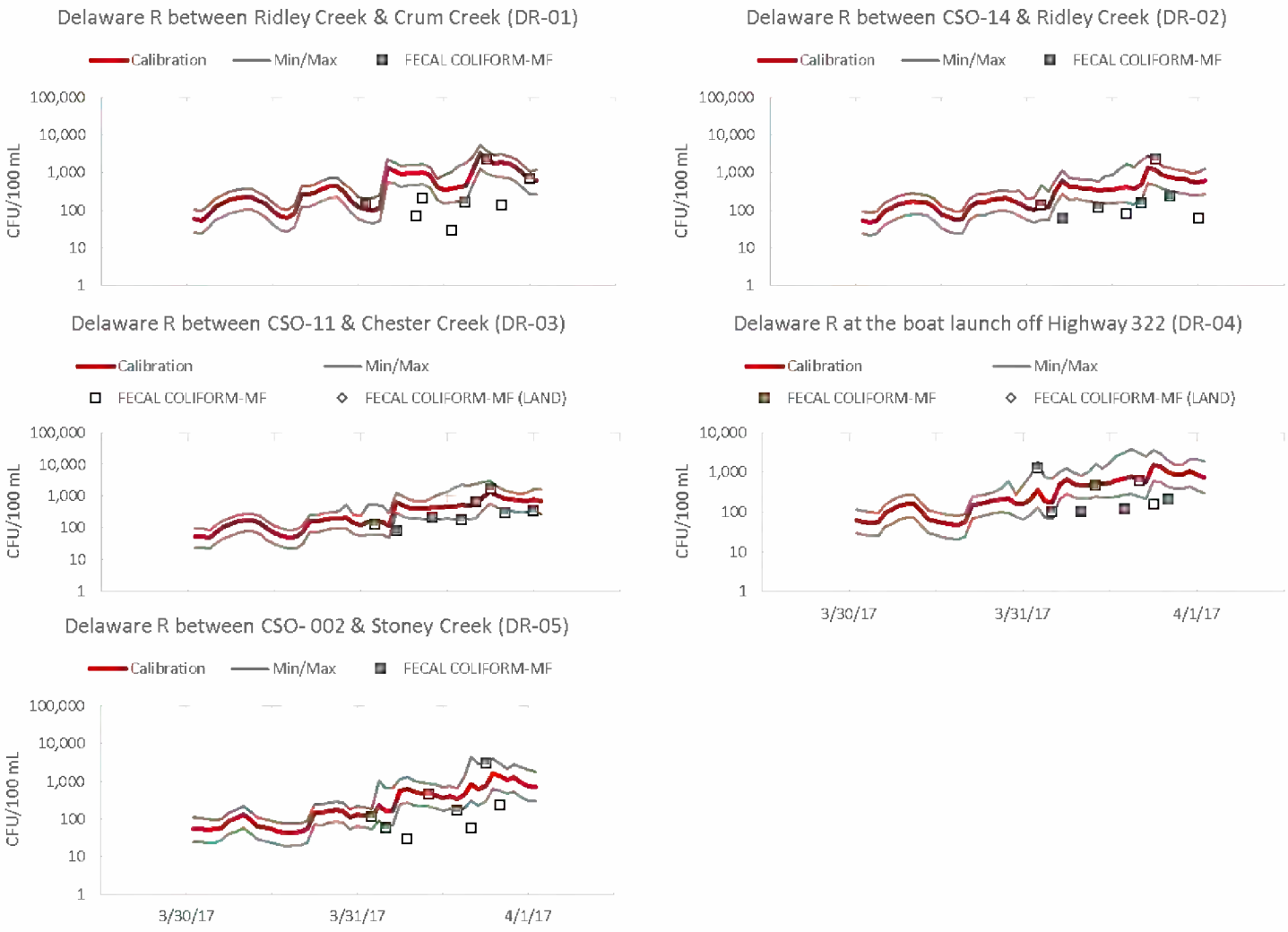


Figure 11. Fecal Coliform Calibration at Delaware River Stations (Wet Weather Event #1, 3/30/17-4/1/17)

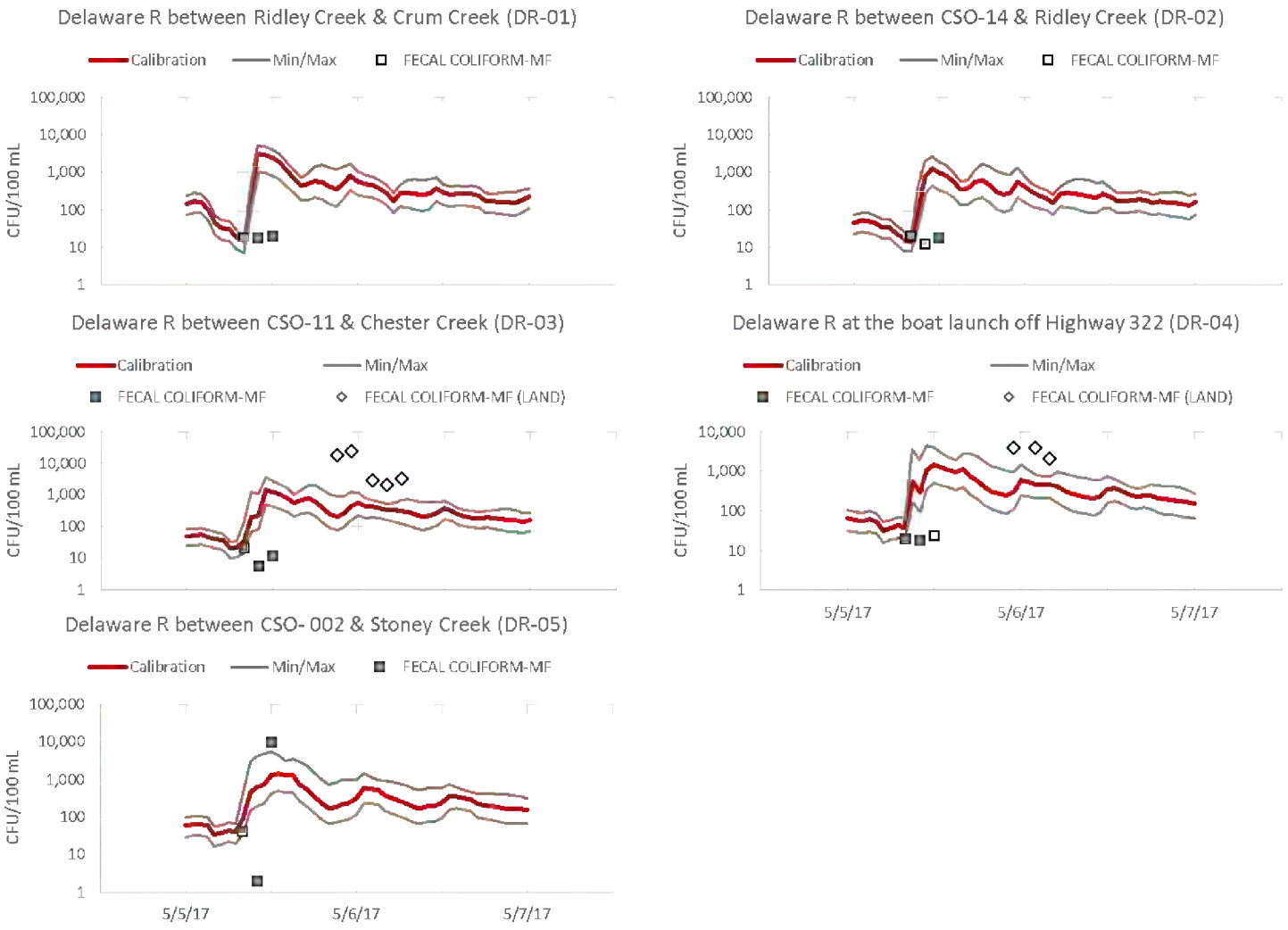


Figure 12. Fecal Coliform Calibration at Delaware River Stations (Wet Weather Event #2, 5/5/17-5/6/17)

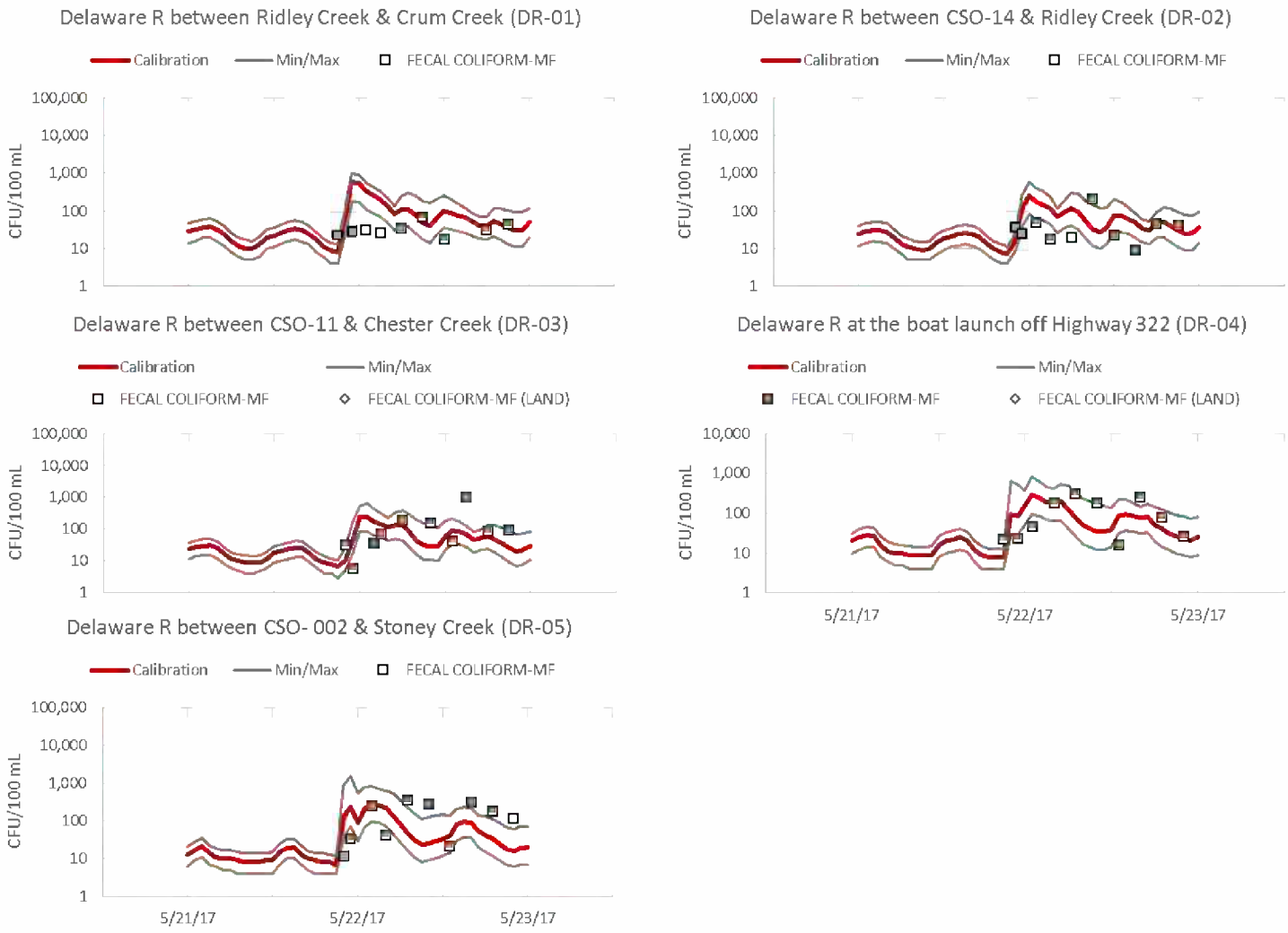


Figure 13. Fecal Coliform Calibration at Delaware River Stations (Wet Weather Event #3, 5/22/17-5/23/17)

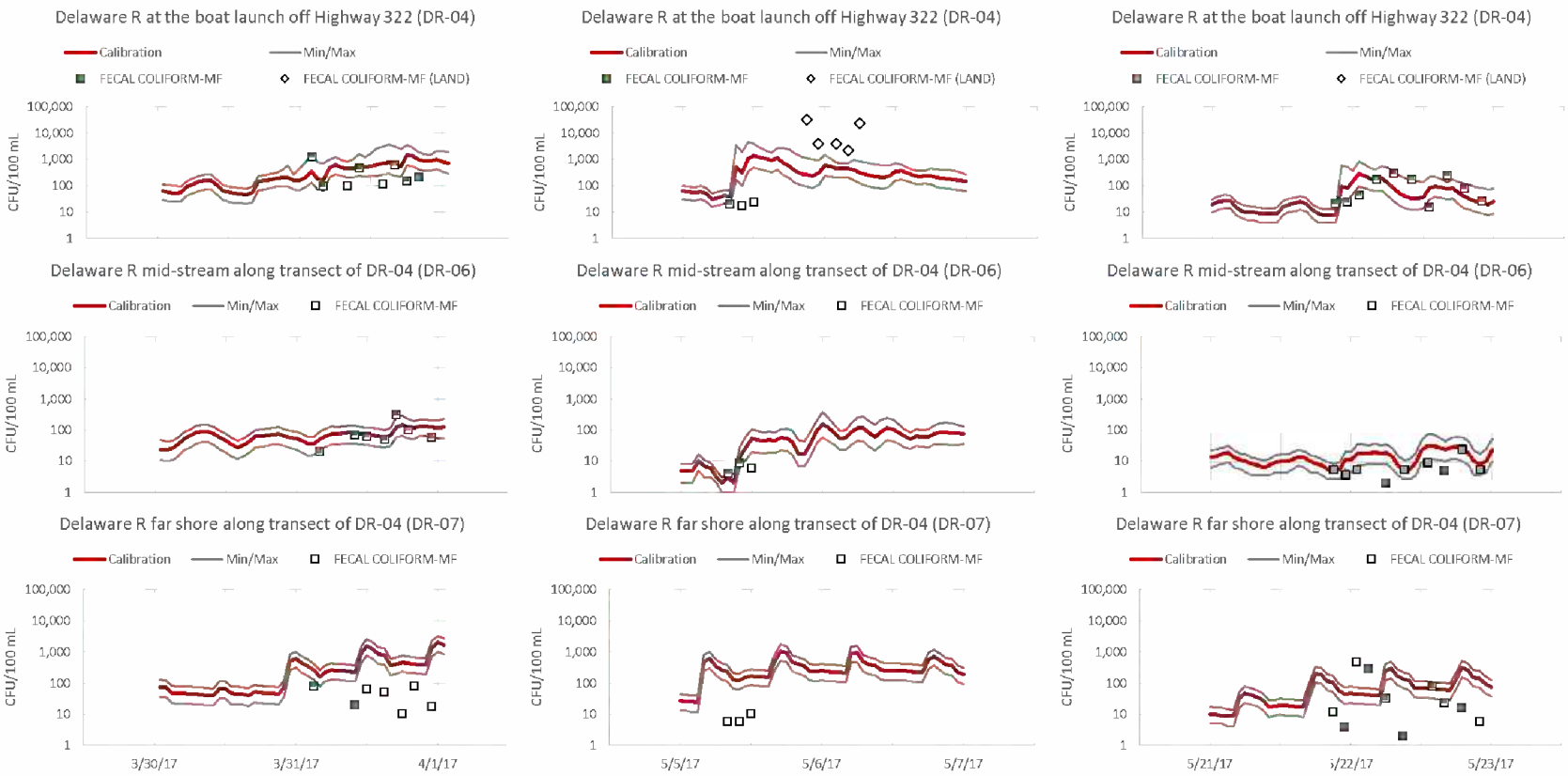


Figure 14. Fecal Coliform Calibration at Delaware River Cross Section (Wet Weather Events #1-3)

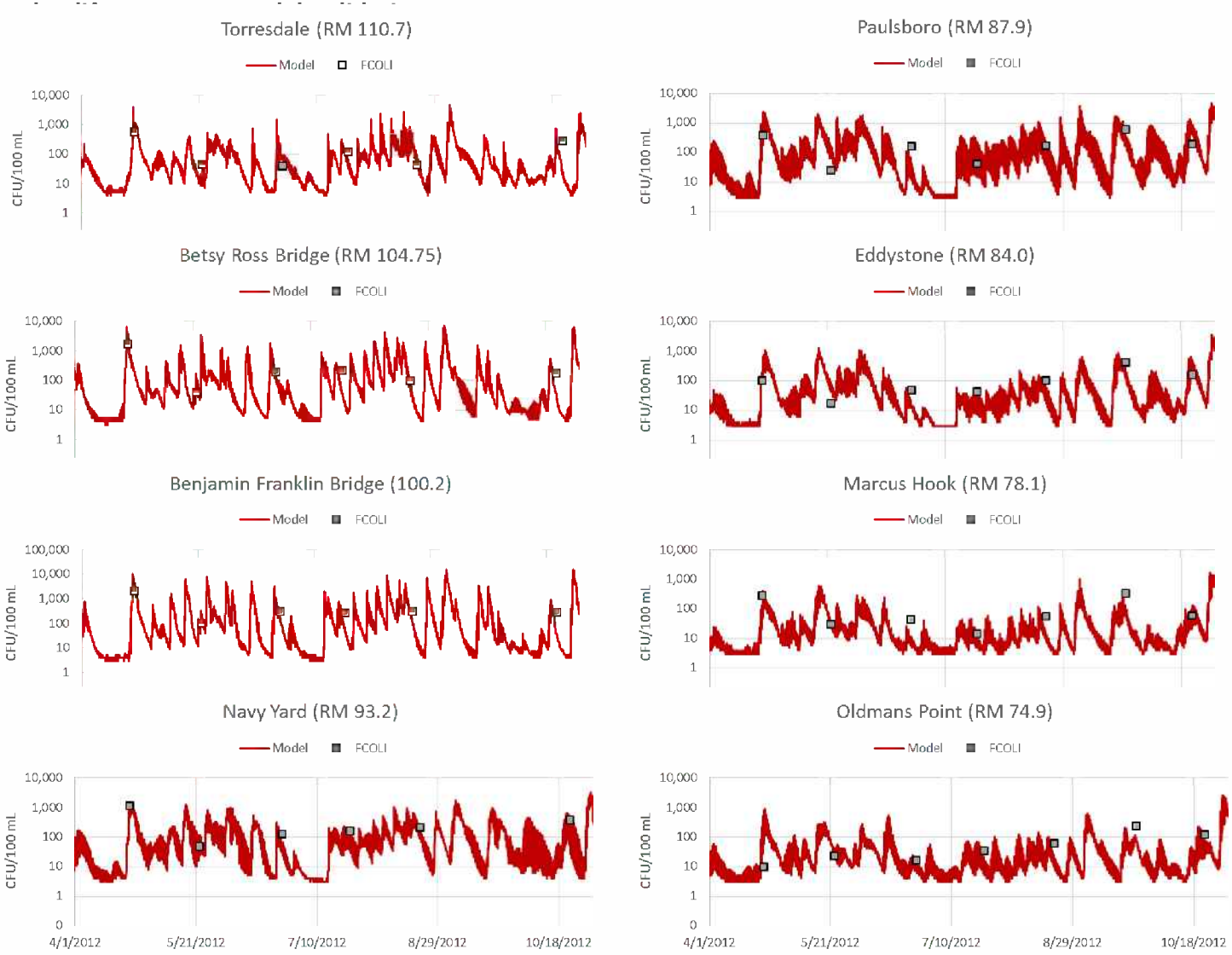


Figure 15. Fecal Coliform Model Validation at DRBC Delaware River Sampling Stations (2012)

E. coli

E. coli—2017 Dry Weather Calibration

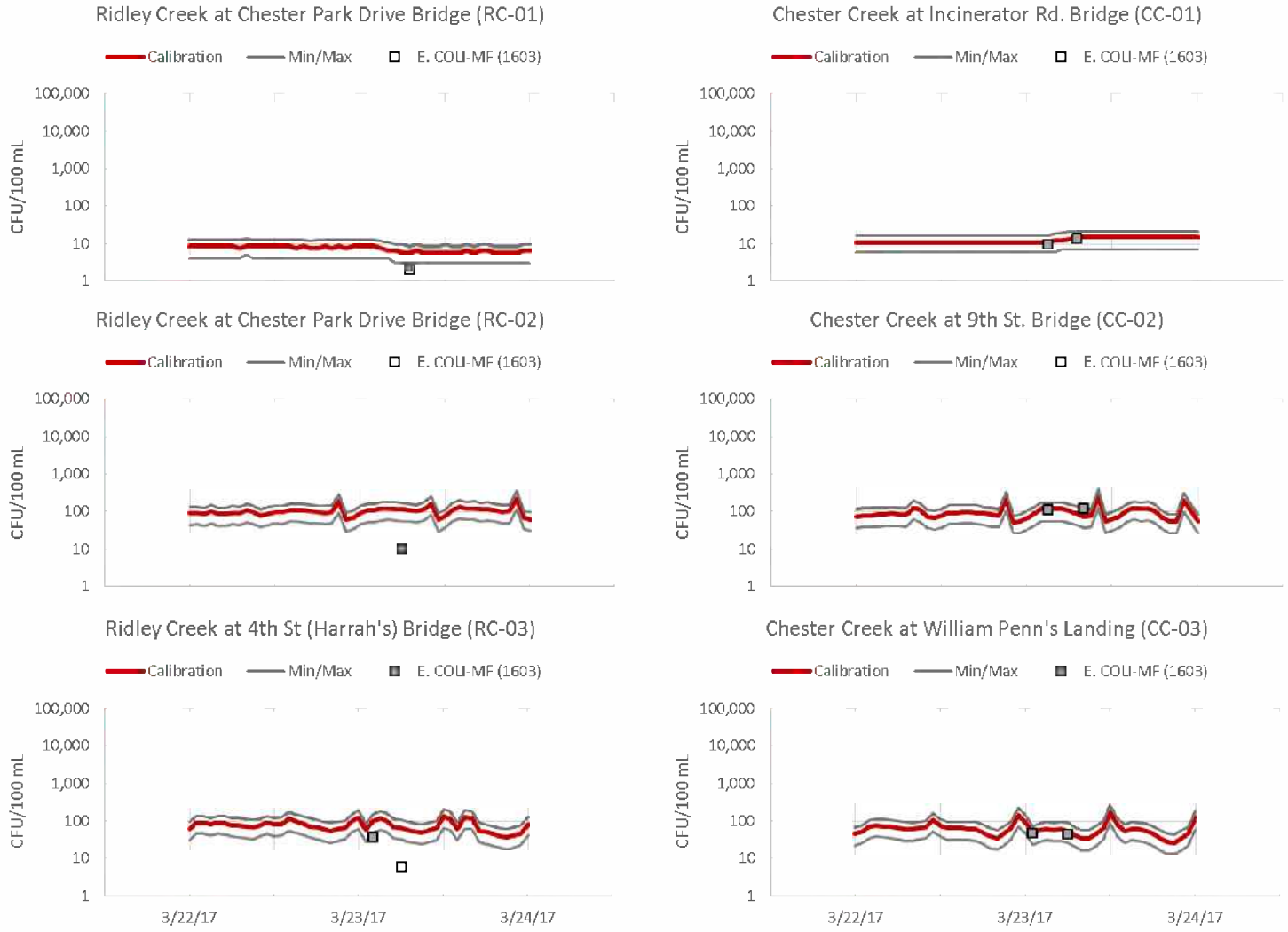


Figure 16. E. coli Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #1, 3/23/17)

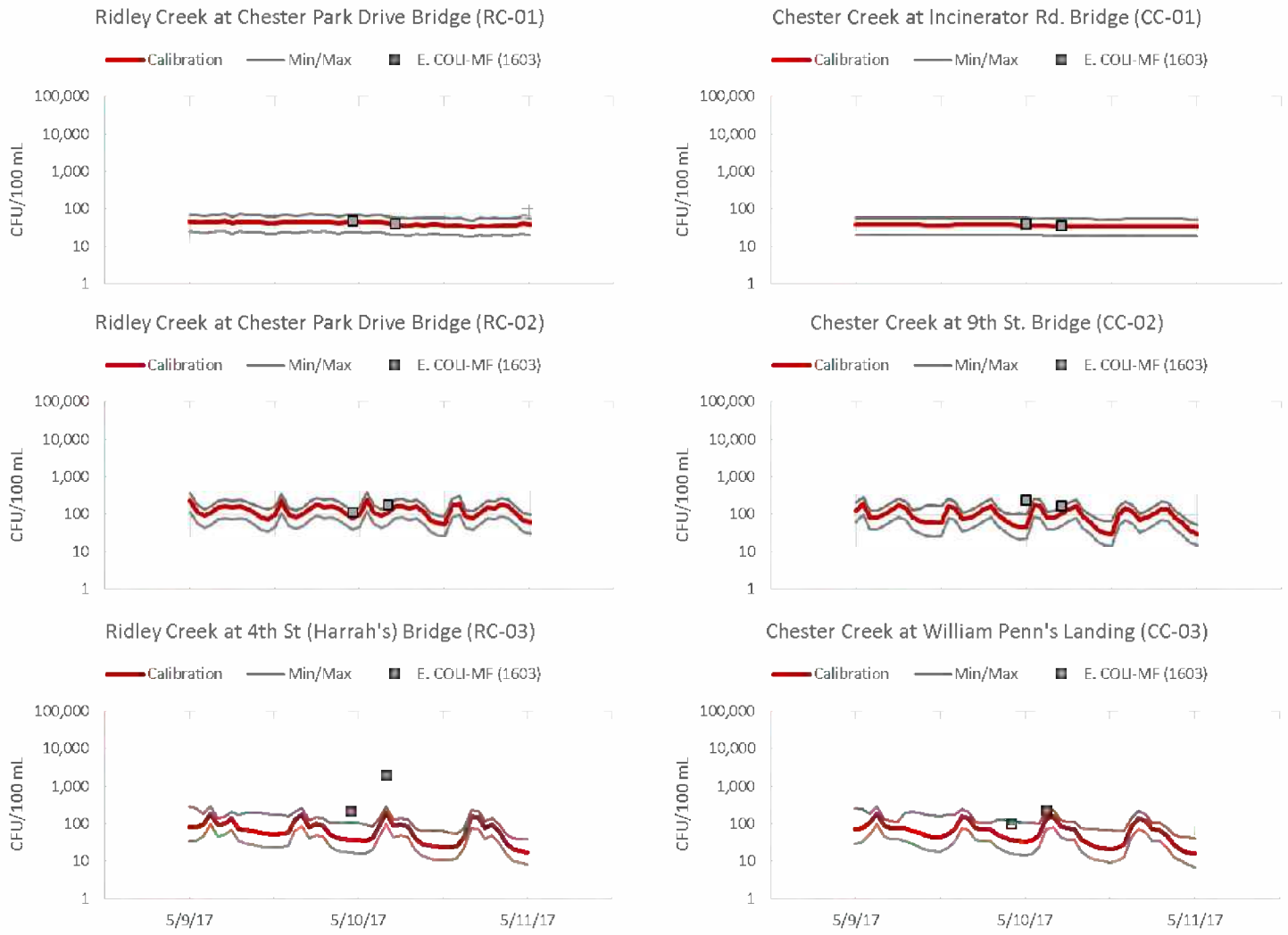


Figure 17. E. coli Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #2, 5/10/17)

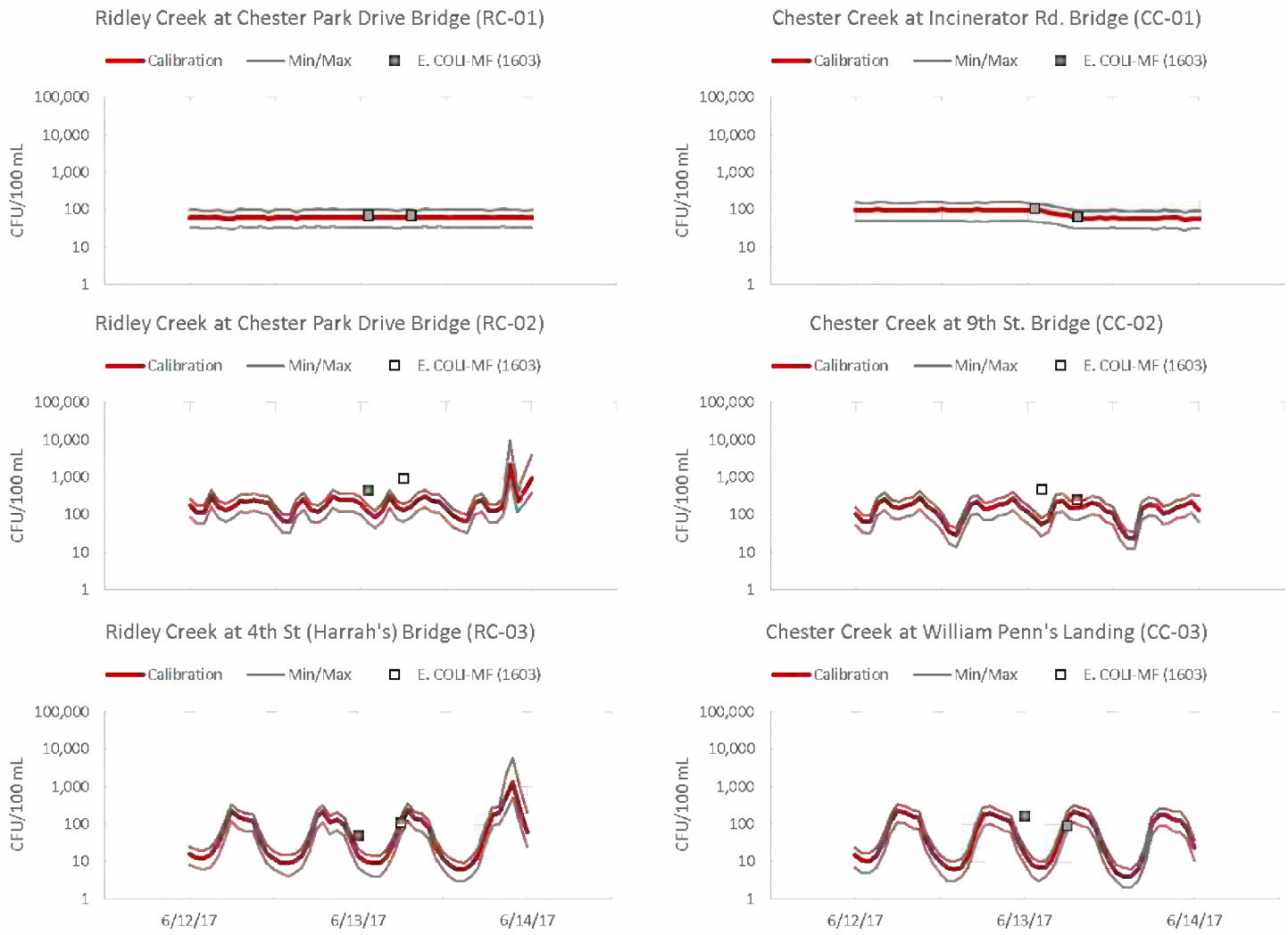


Figure 18. E. coli Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #3, 6/13/17)

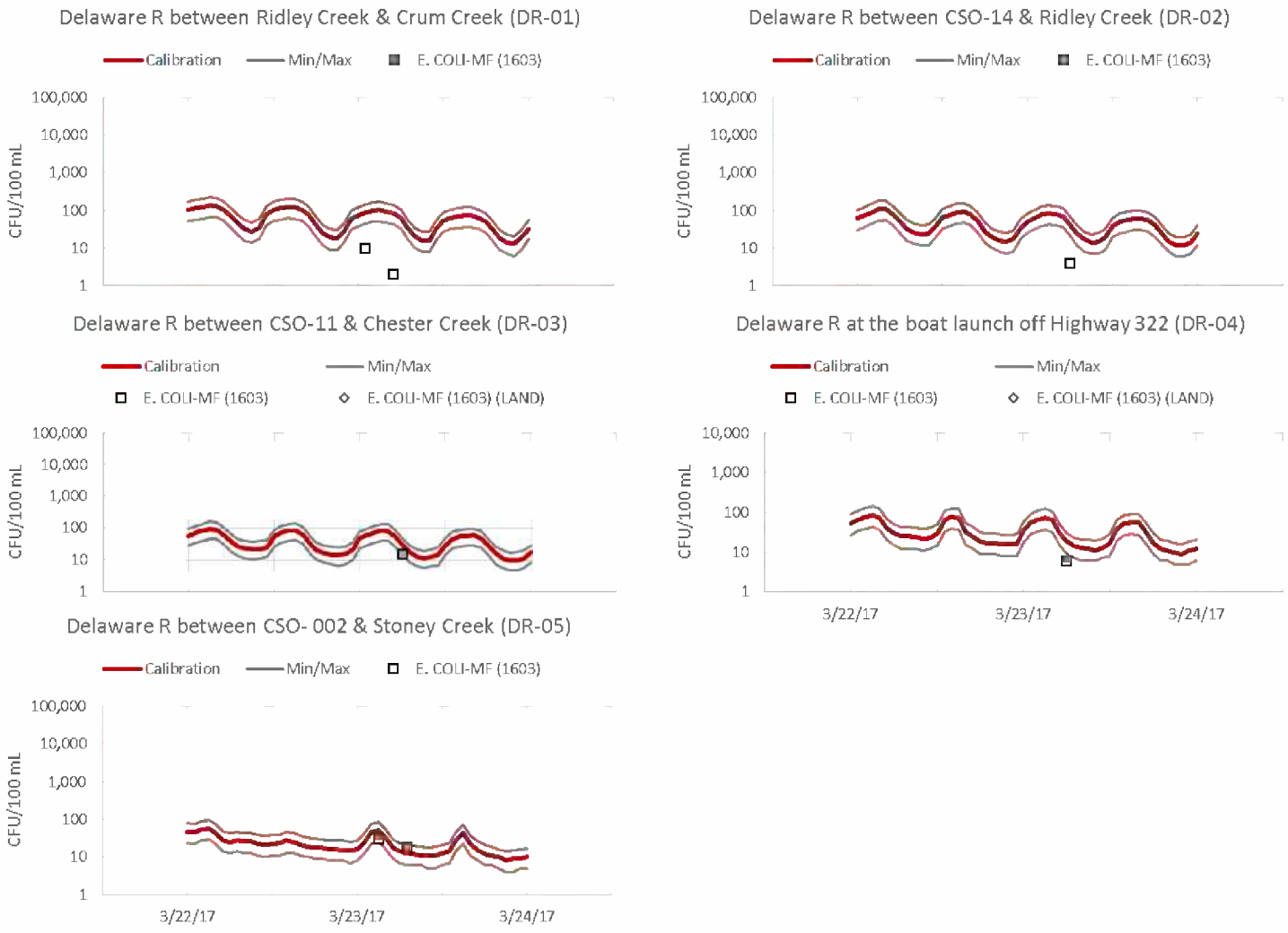


Figure 19. E. coli Calibration at Delaware River Stations (Dry Weather Event #1, 3/23/17)

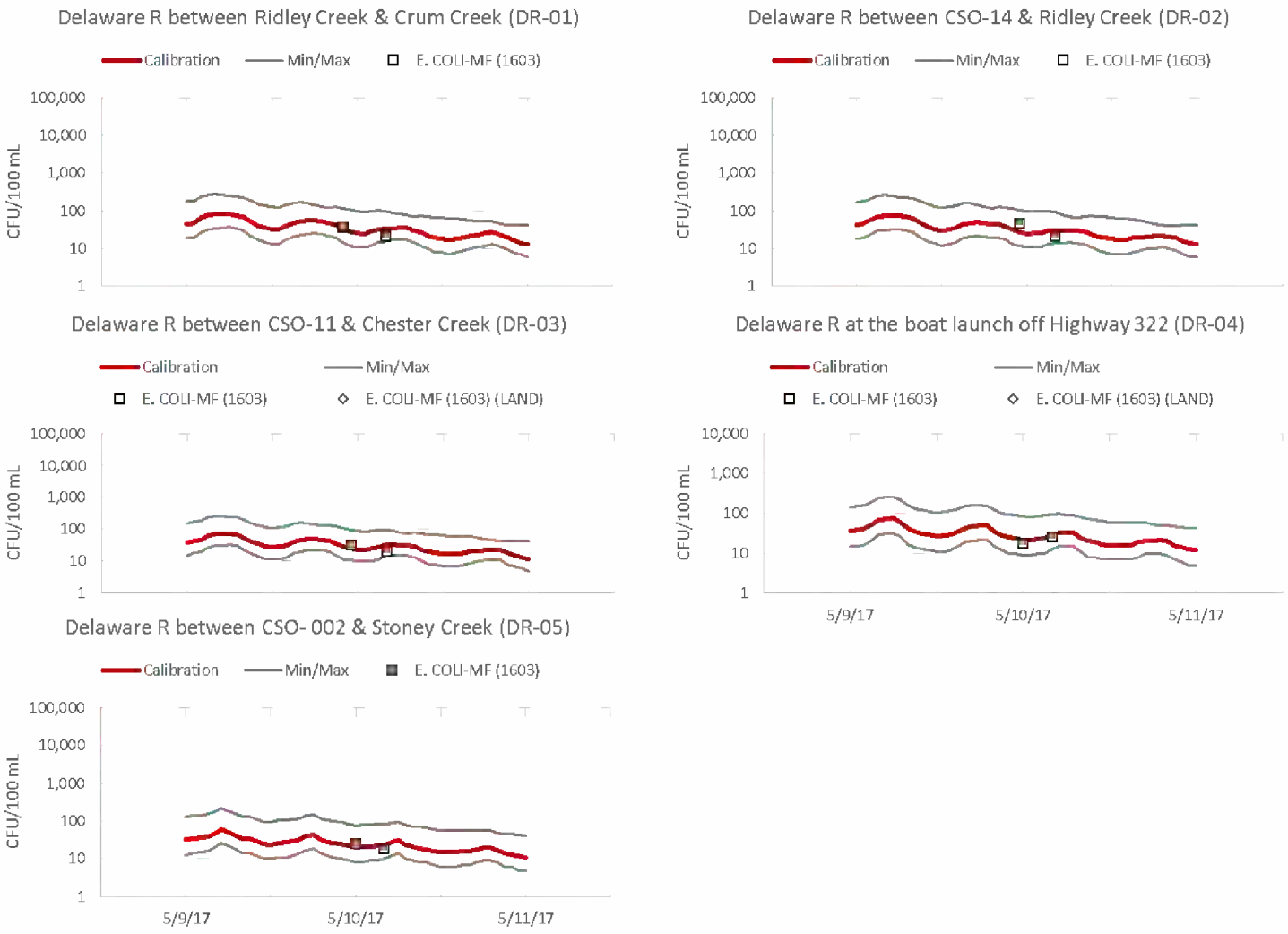


Figure 20. E. coli Calibration at Delaware River Stations (Dry Weather Event #2, 5/10/17)

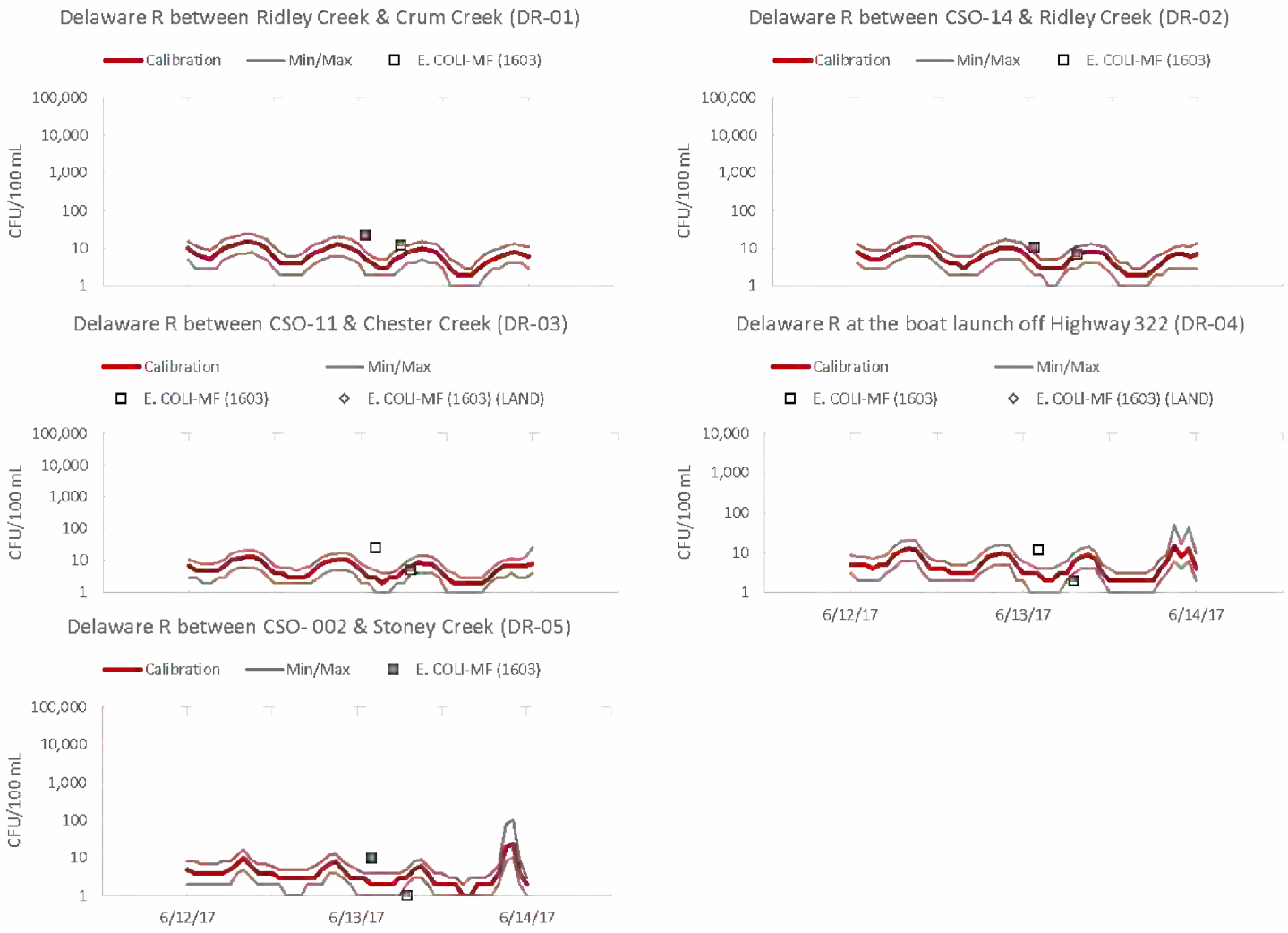


Figure 21. E. coli Calibration at Delaware River Stations (Dry Weather Event #3, 6/13/17)

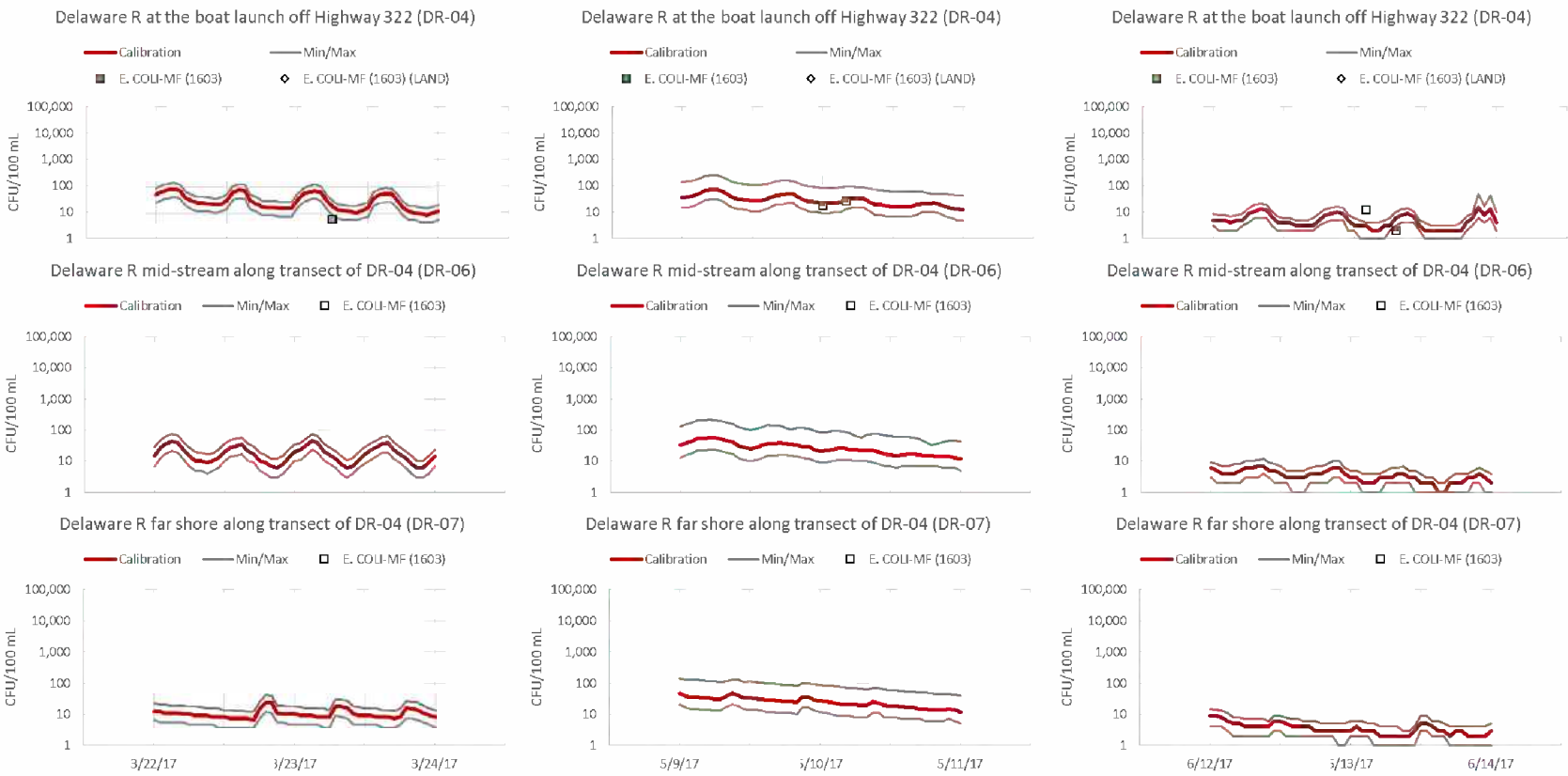


Figure 22. E. coli Calibration at Delaware River Cross Section (Dry Weather Events #1-3)

E. coli—2017 Wet Weather Calibration

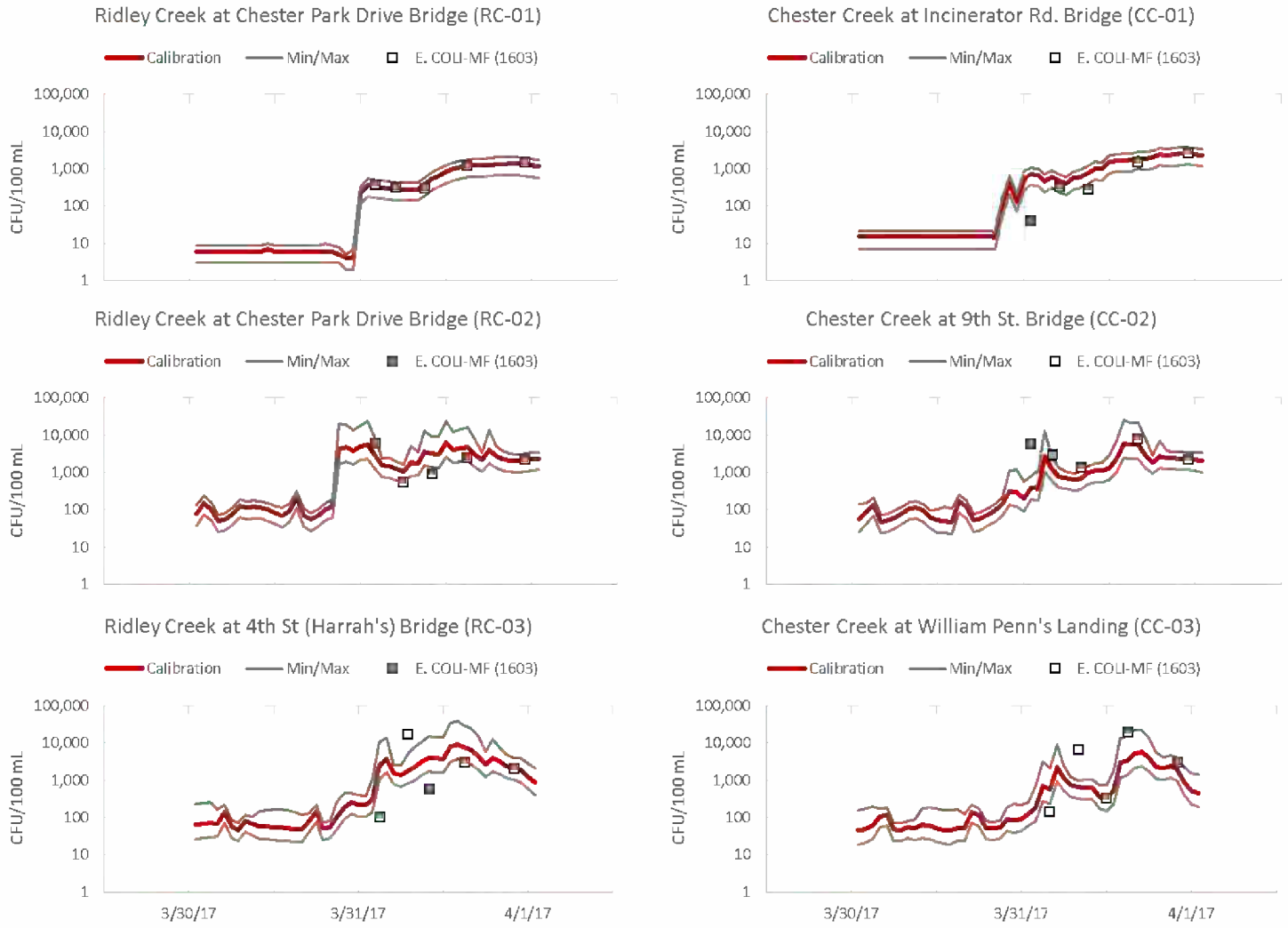


Figure 23. E. coli Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #1, 3/30/17-4/1/17)

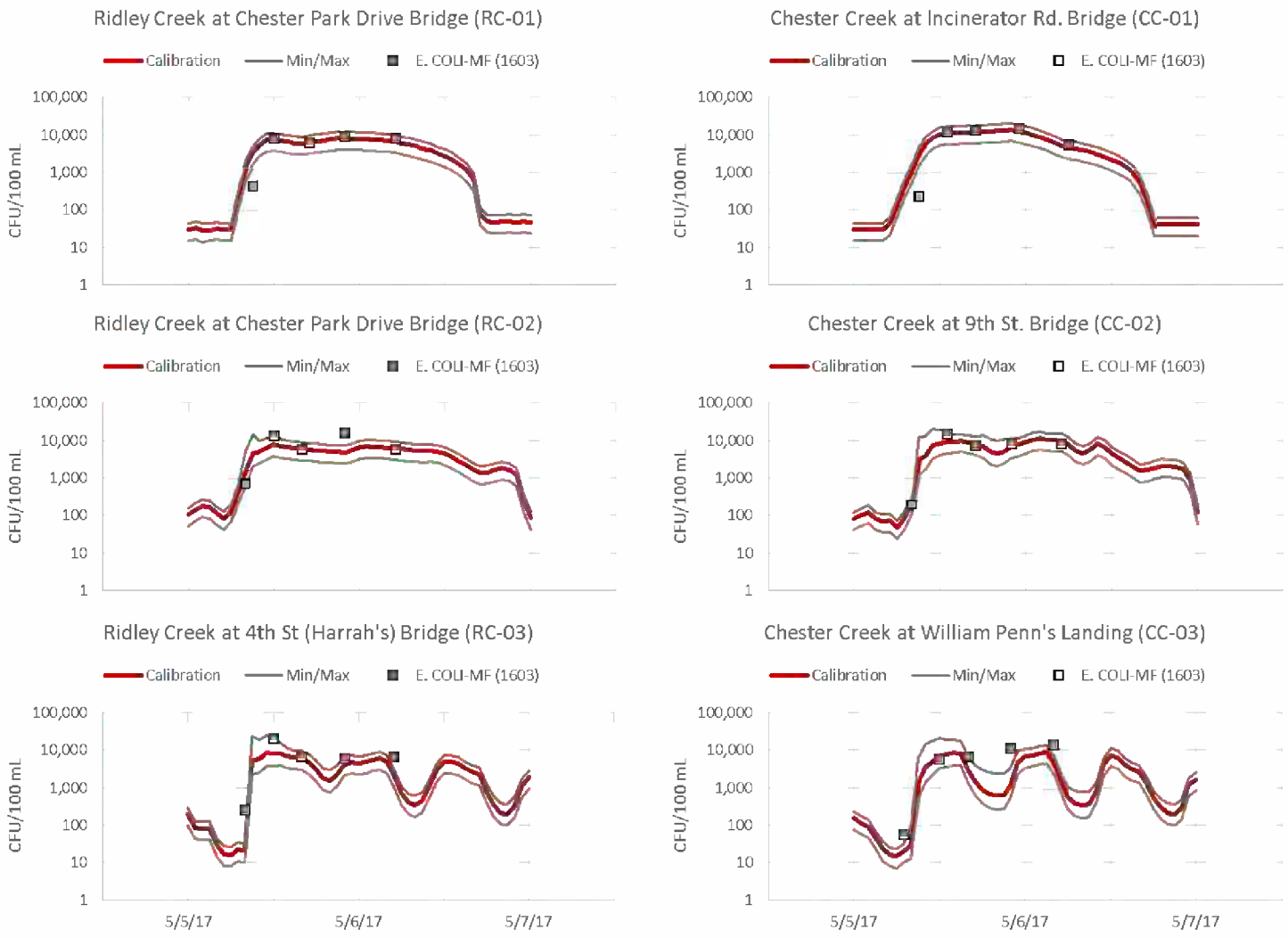


Figure 24. E. coli Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #2, 5/5/17-5/6/17)

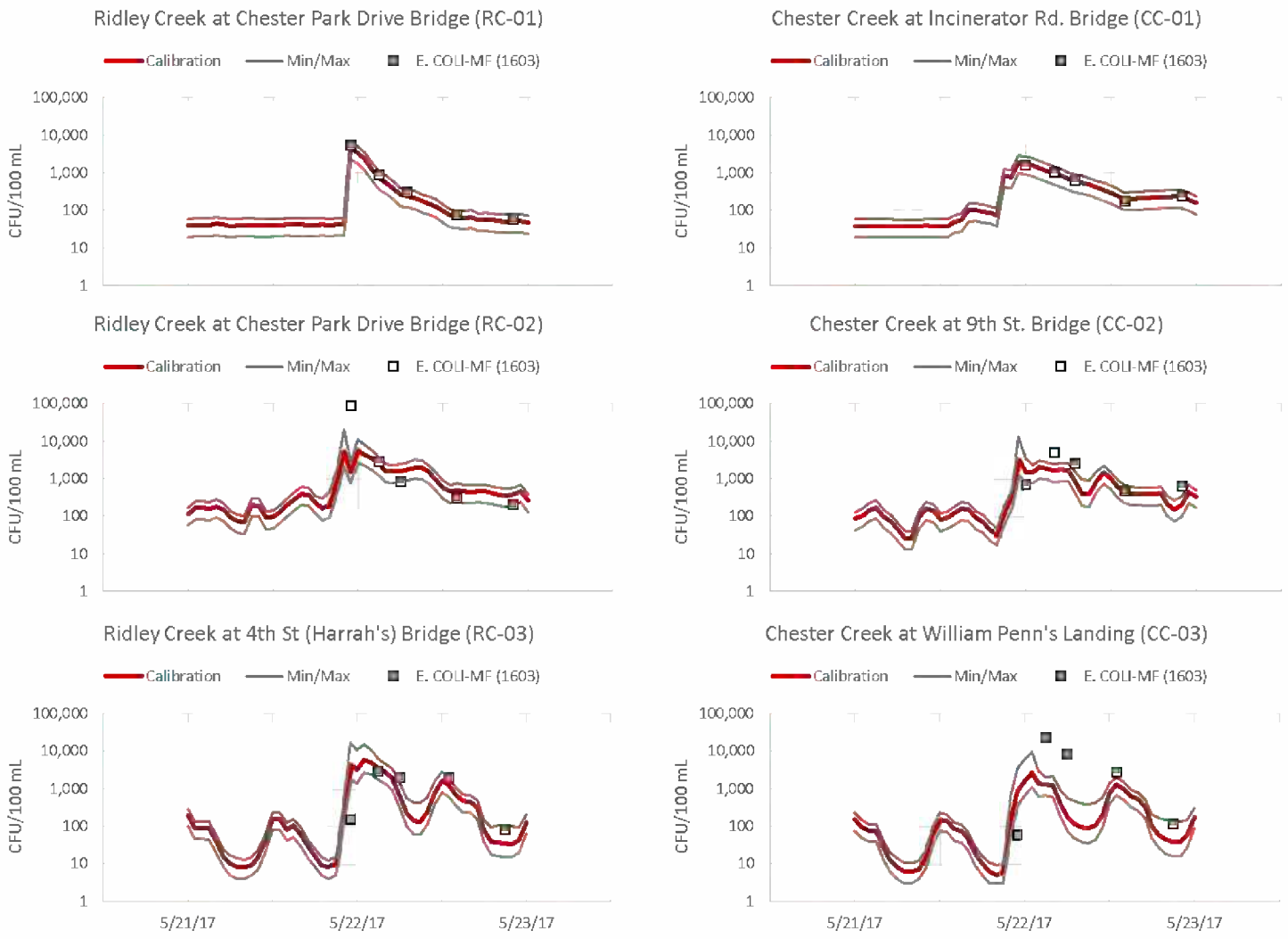


Figure 25. E. coli Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #3, 5/22/17-5/23/17)

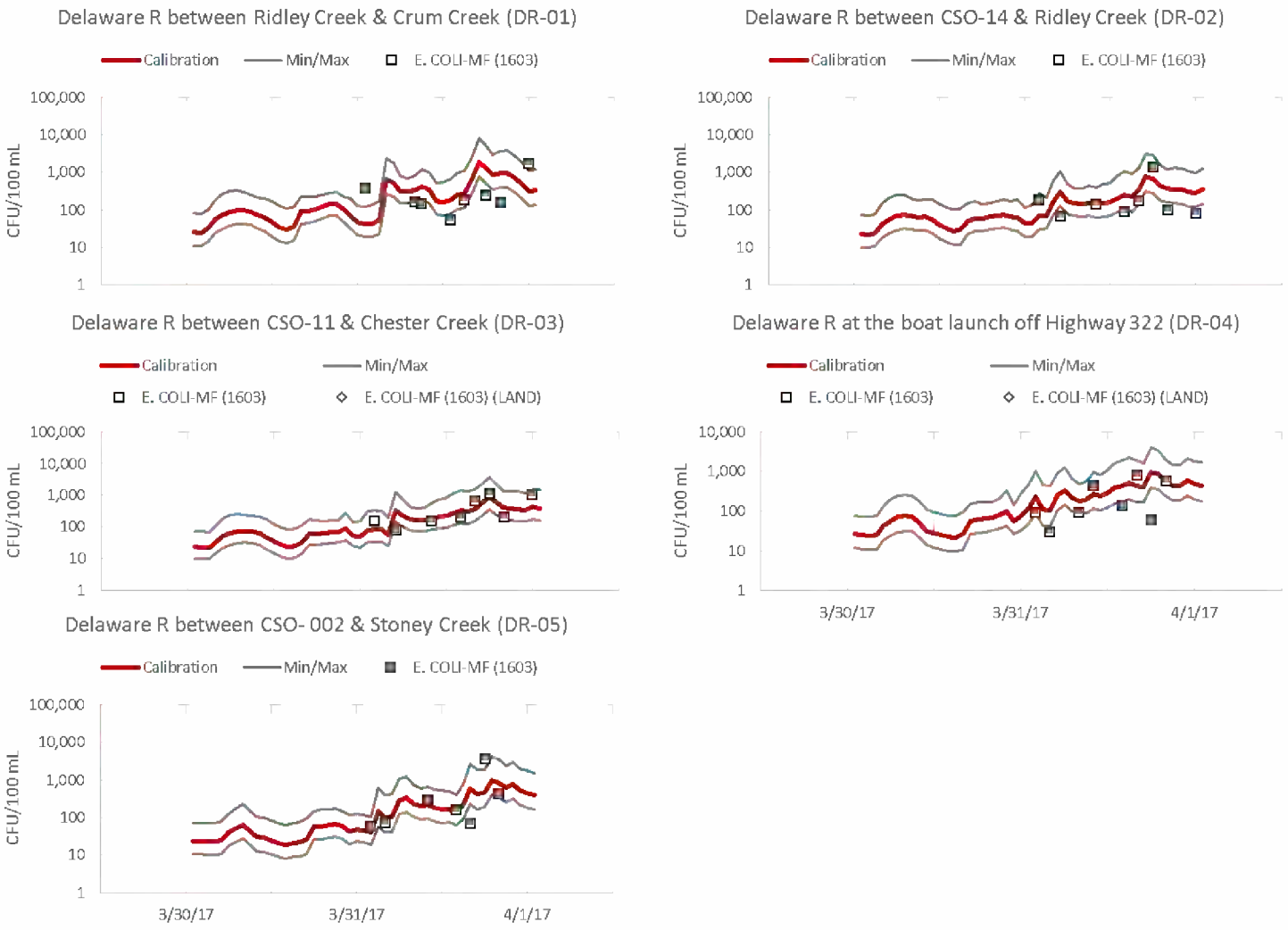


Figure 26. E. coli Calibration at Delaware River Stations (Wet Weather Event #1, 3/30/17-4/1/17)

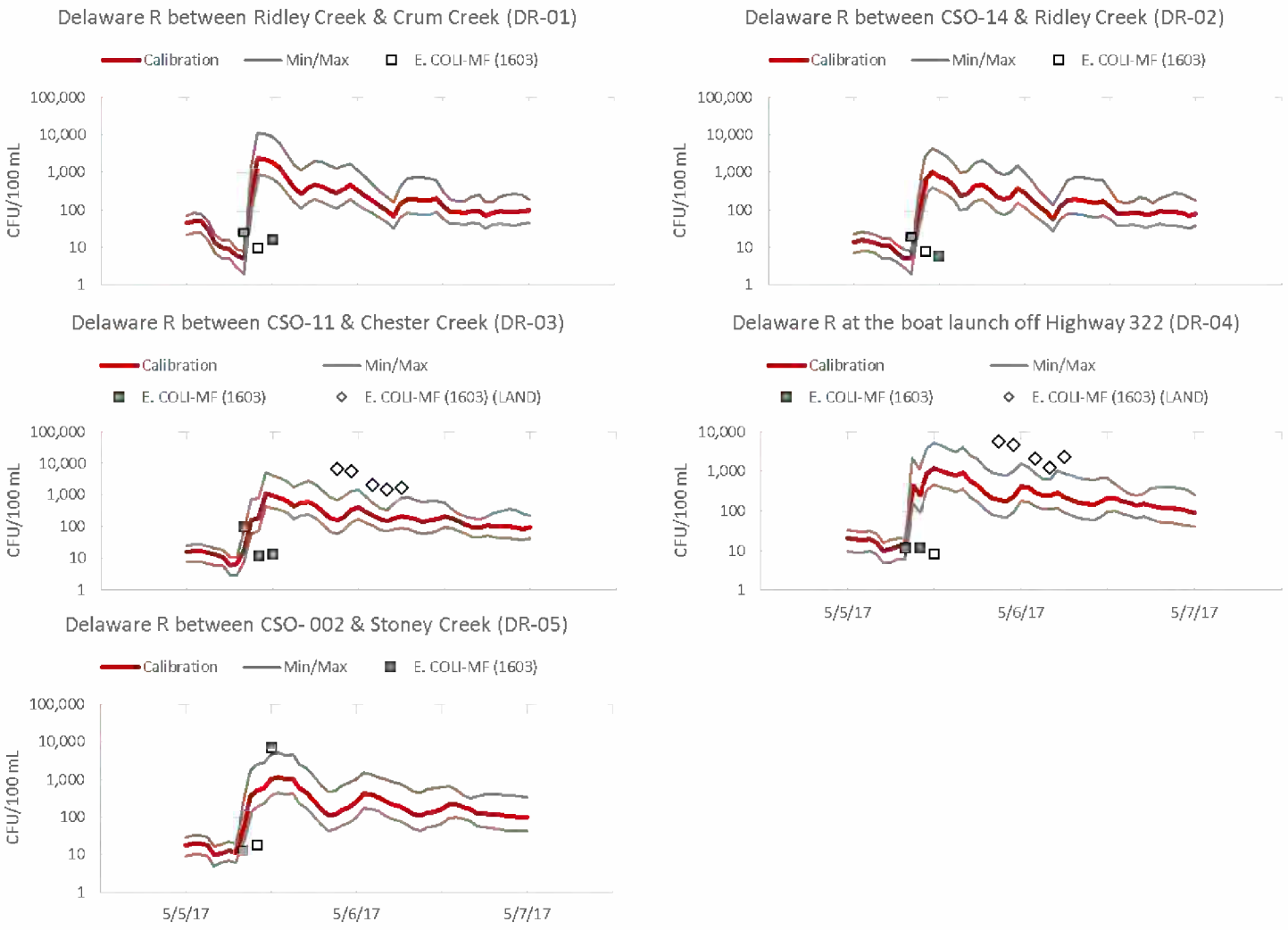


Figure 27. E. coli Calibration at Delaware River Stations (Wet Weather Event #2, 5/5/17-5/6/17)

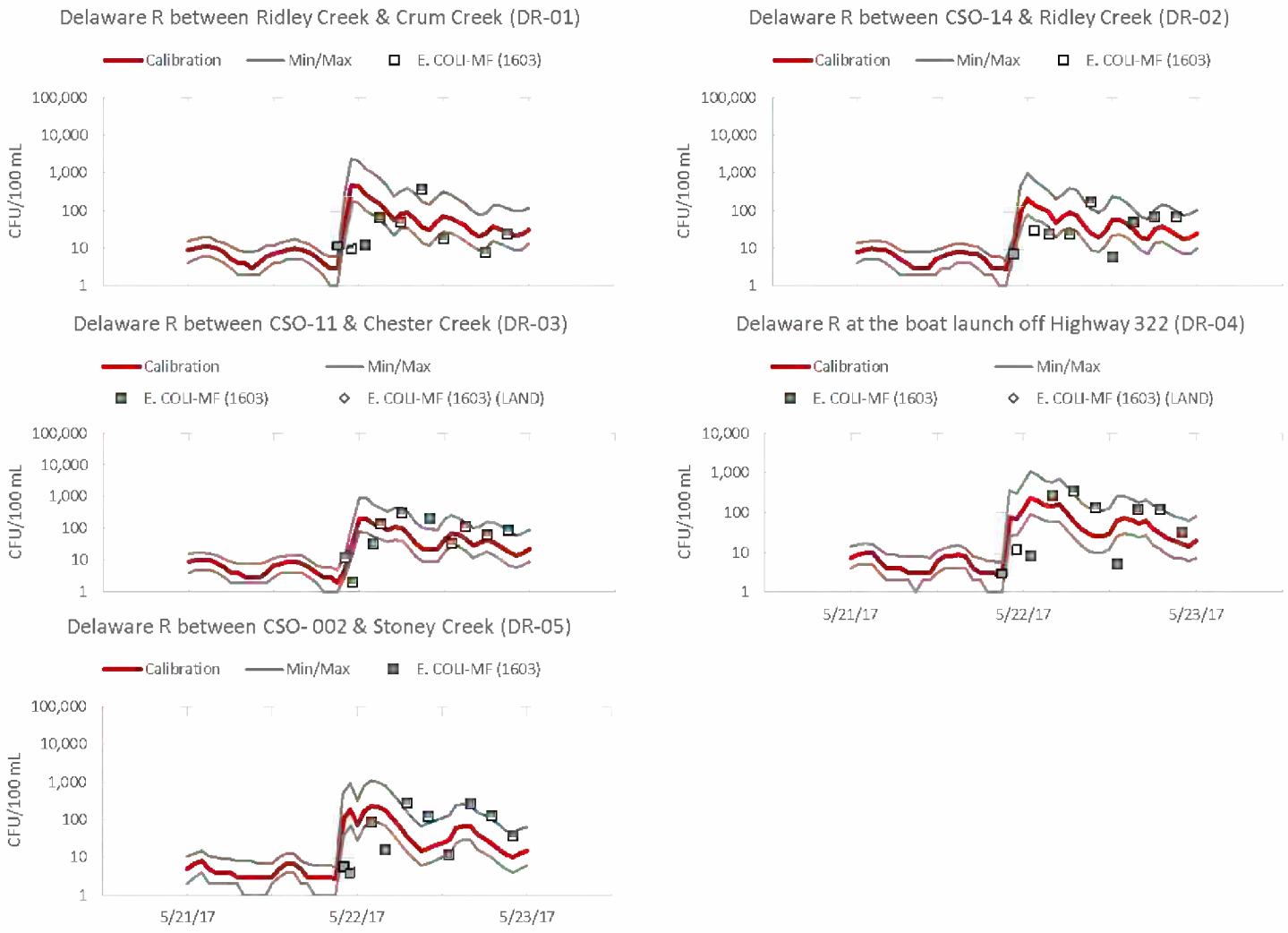


Figure 28. E. coli Calibration at Delaware River Stations (Wet Weather Event #3, 5/22/17-5/23/17)

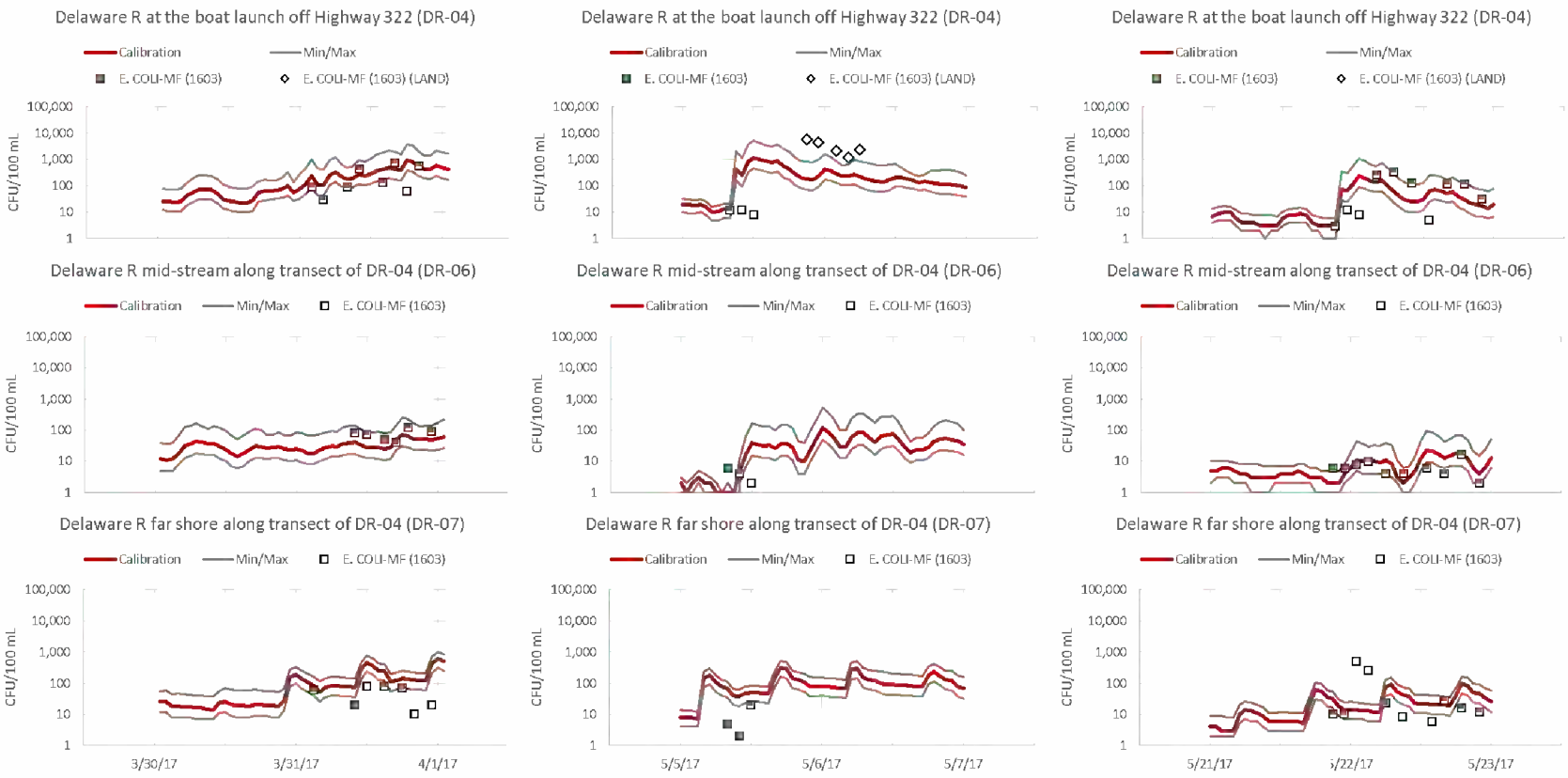


Figure 29. E. coli Calibration at Delaware River Cross Section (Wet Weather Events #1-3)

E. coli—2012 Model Validation

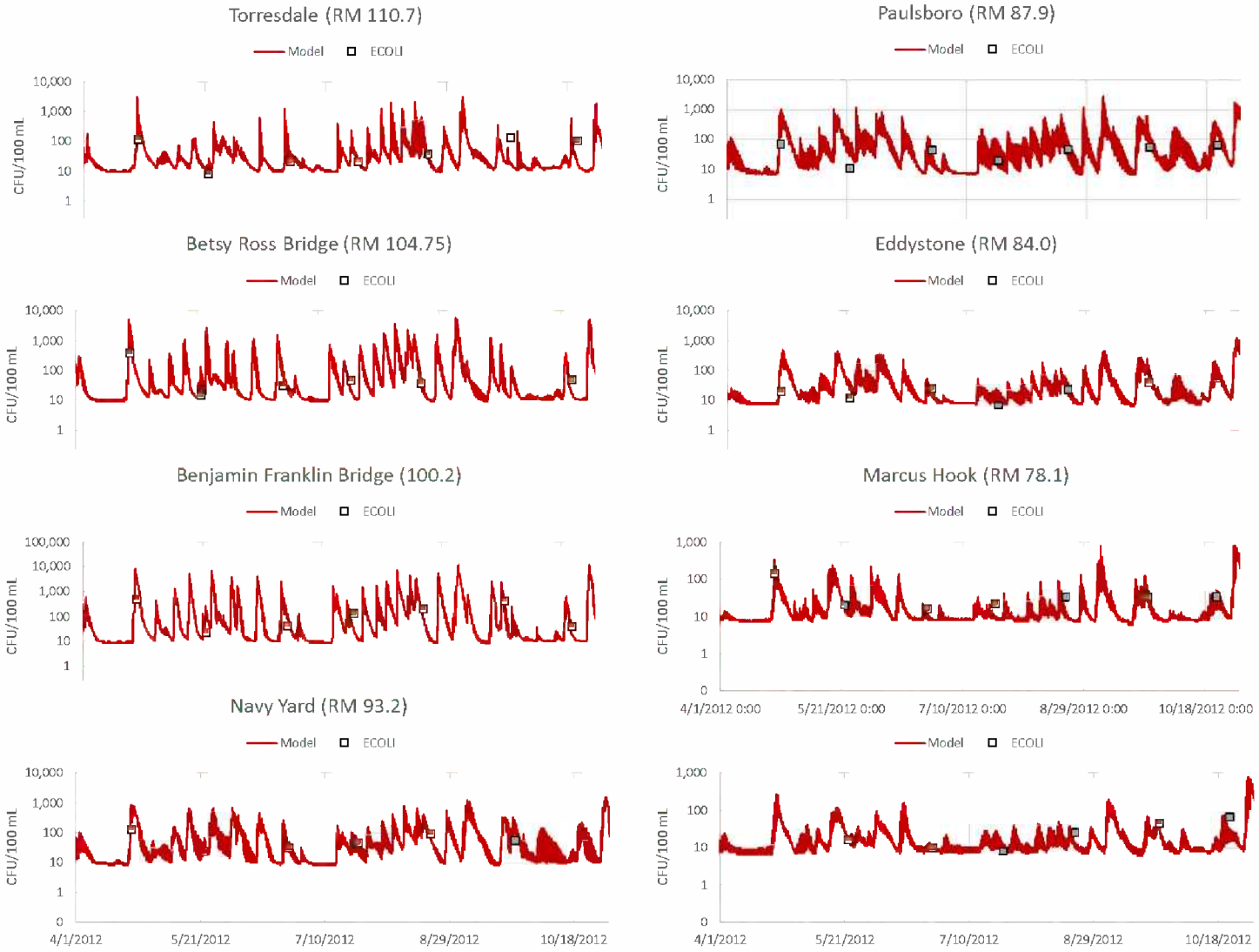


Figure 30. E. coli Model Validation at DRBC Delaware River Sampling Stations (2012)

Enterococcus

Enterococcus—2017 Dry Weather Calibration

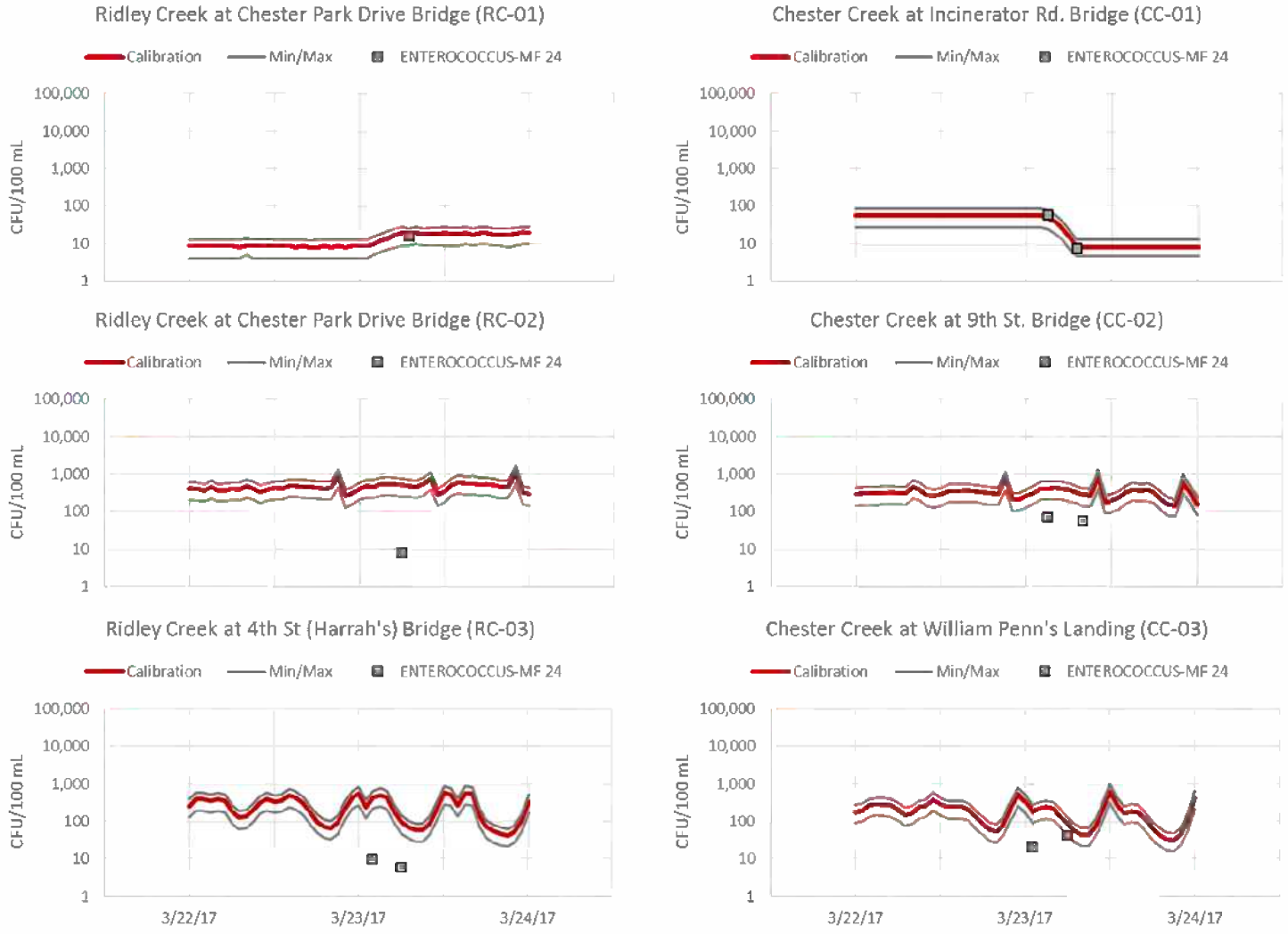


Figure 31. Enterococcus Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #1, 3/23/17)

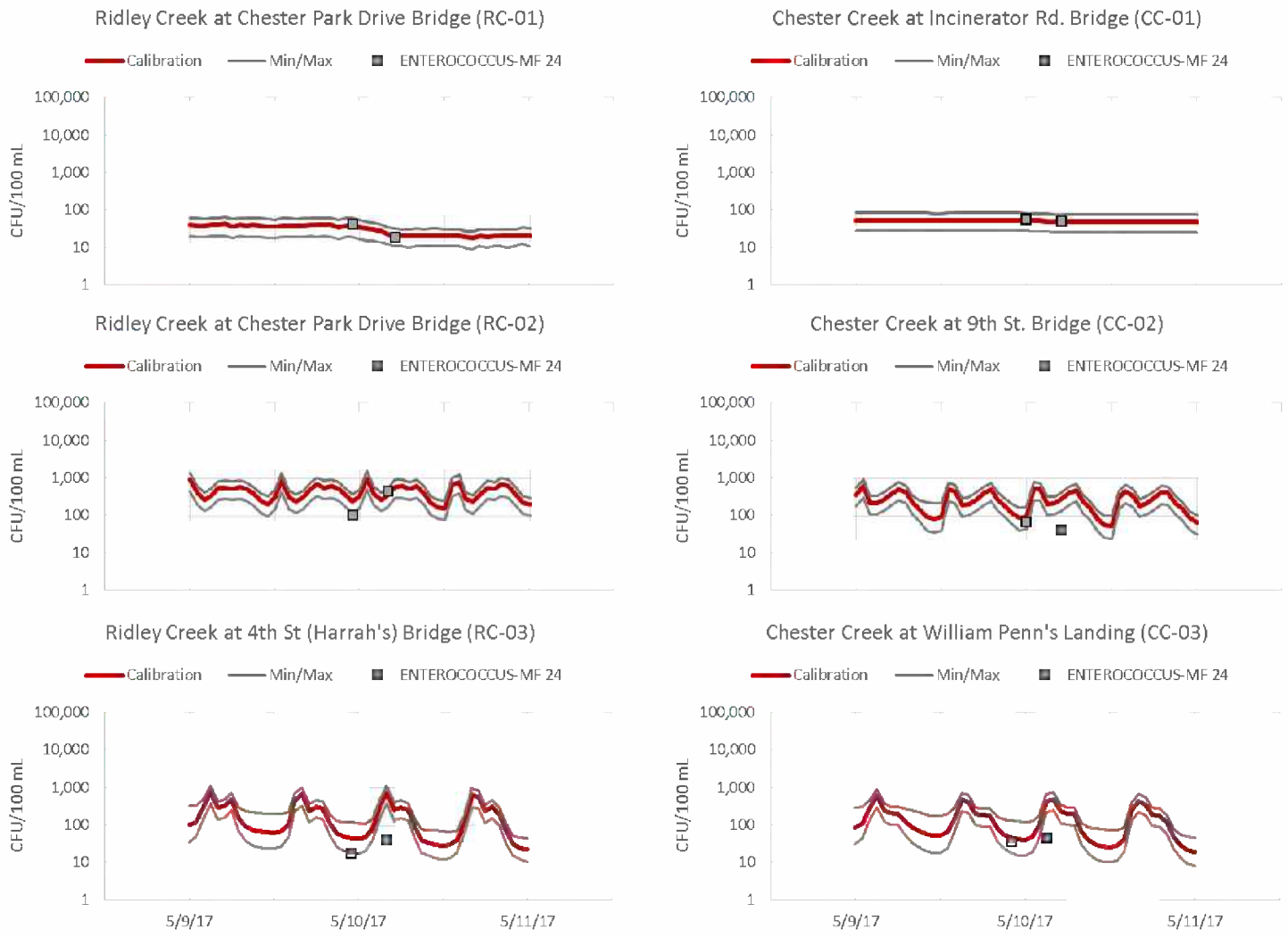


Figure 32. Enterococcus Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #2, 5/10/17)

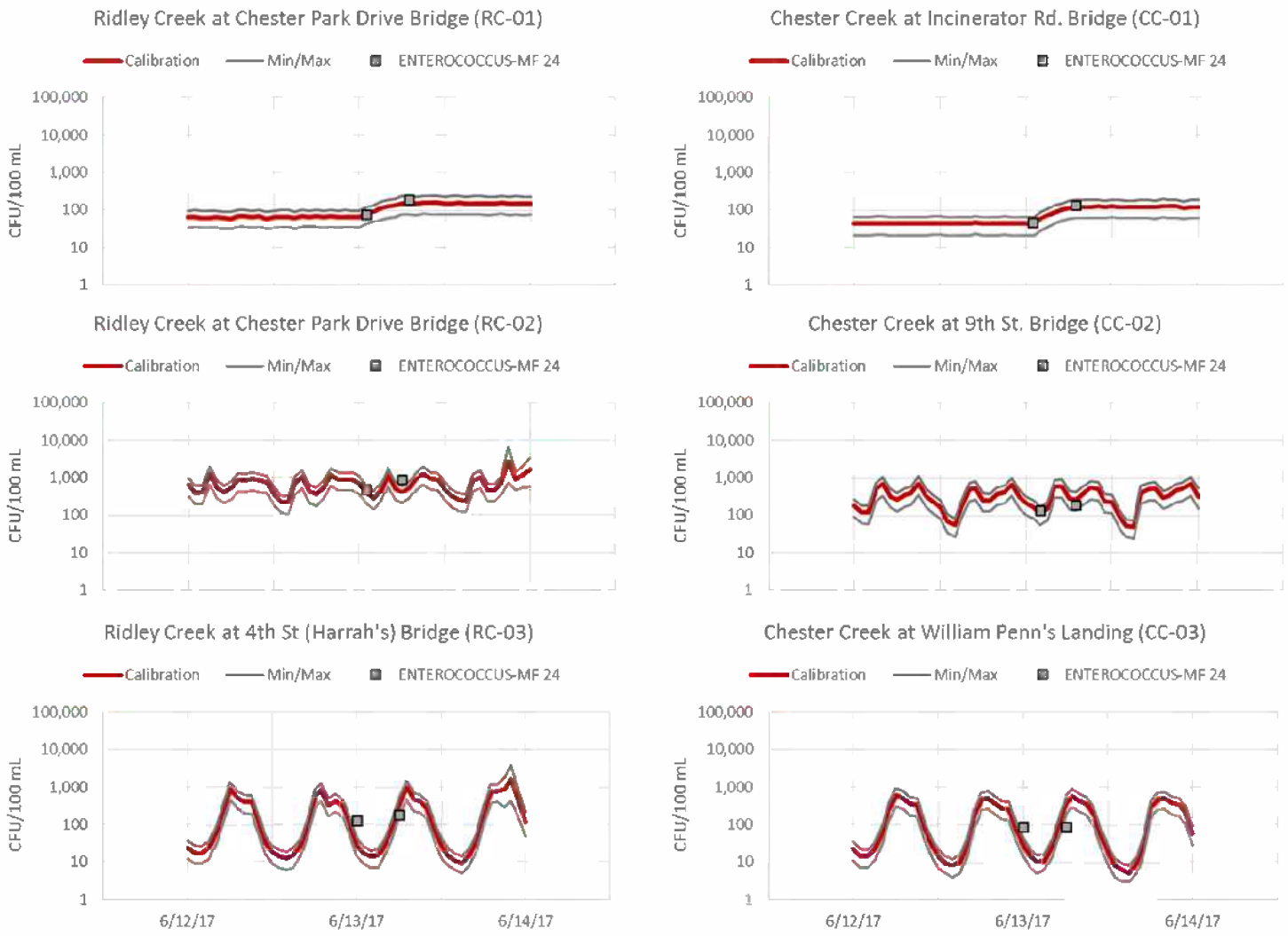


Figure 33. Enterococcus Calibration at Ridley Creek and Chester Creek Stations (Dry Weather Event #3, 6/13/17)

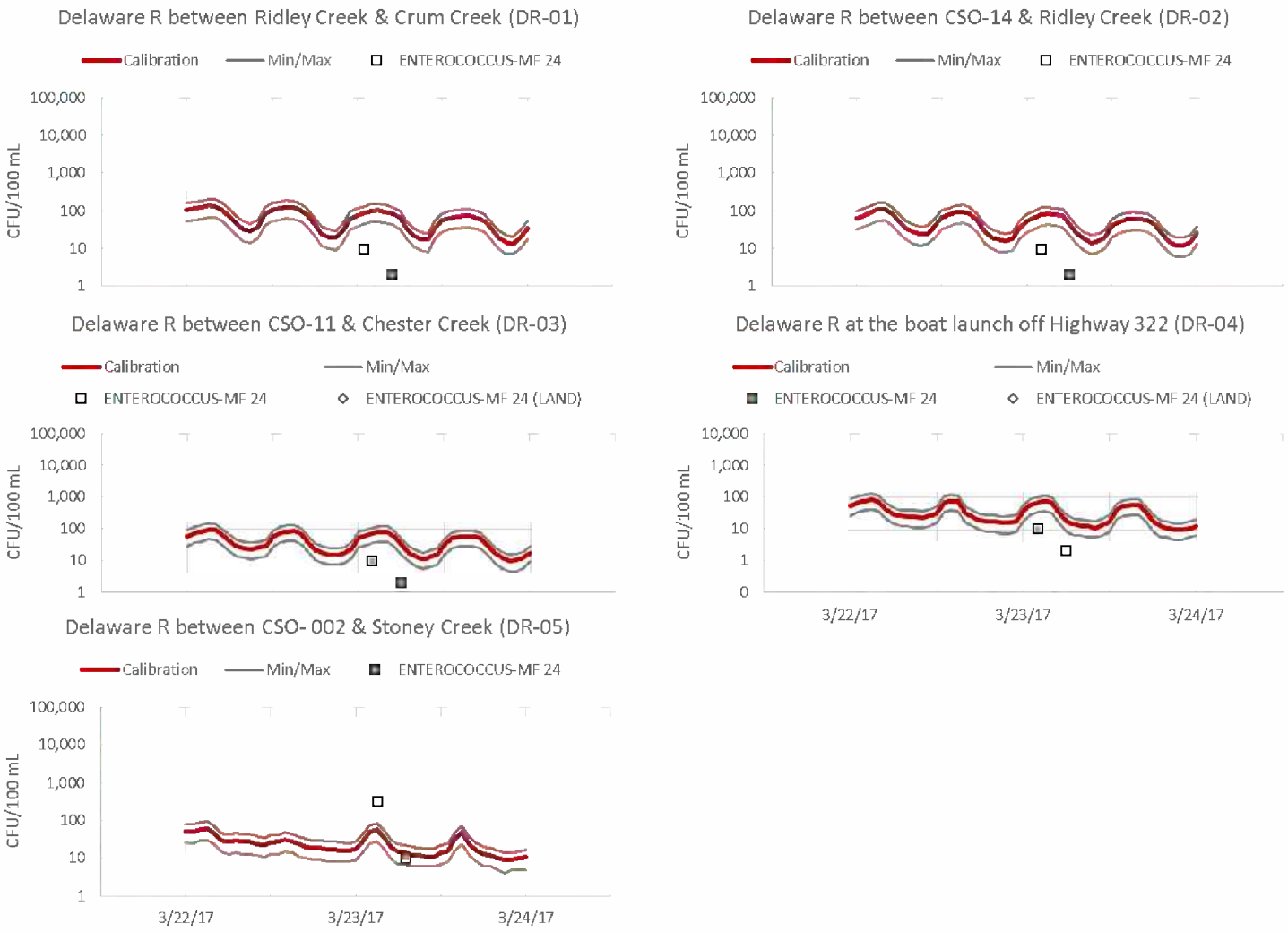


Figure 34. Enterococcus Calibration at Delaware River Stations (Dry Weather Event #1, 3/23/17)

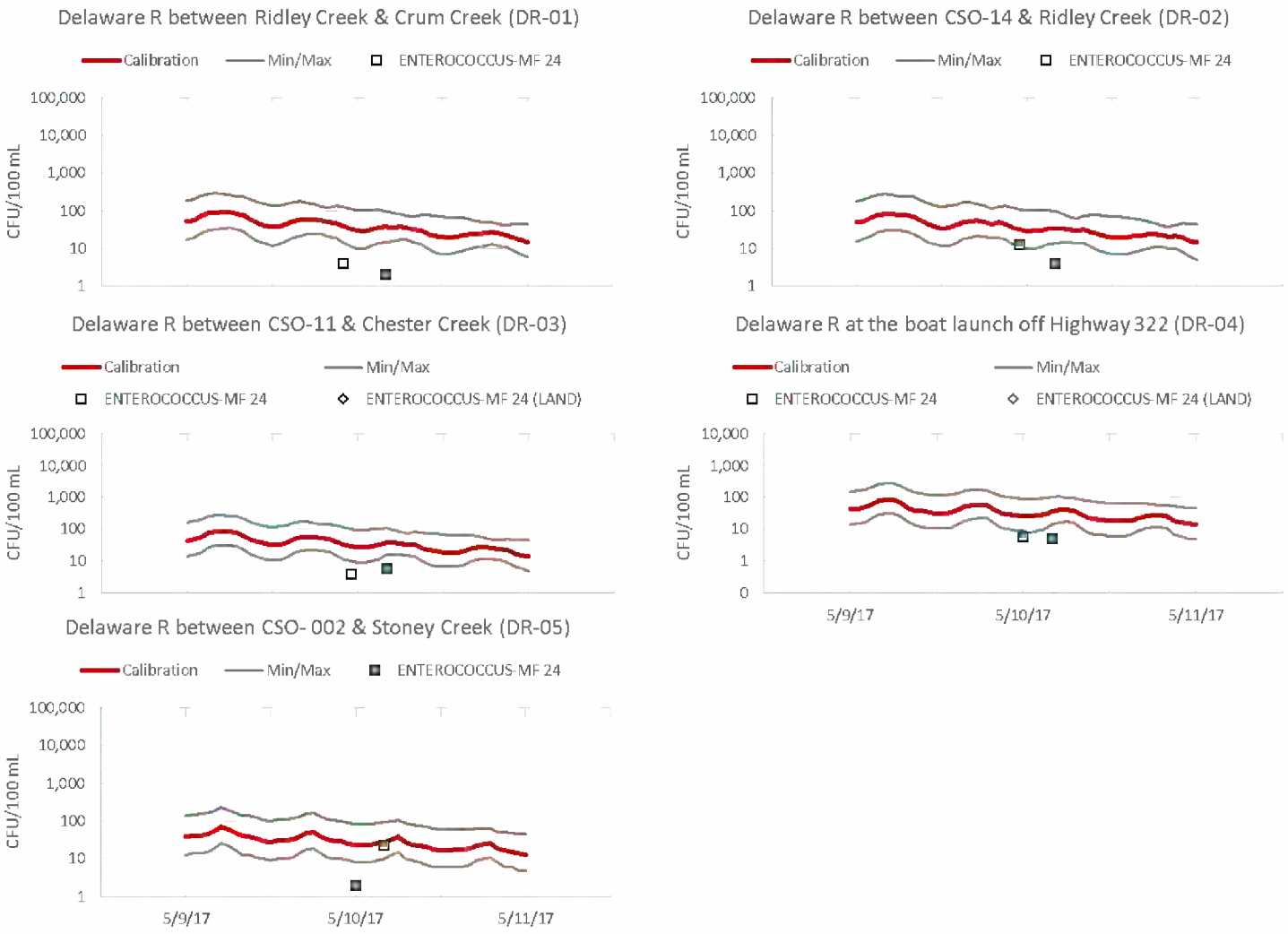


Figure 35. Enterococcus Calibration at Delaware River Stations (Dry Weather Event #2, 5/10/17)

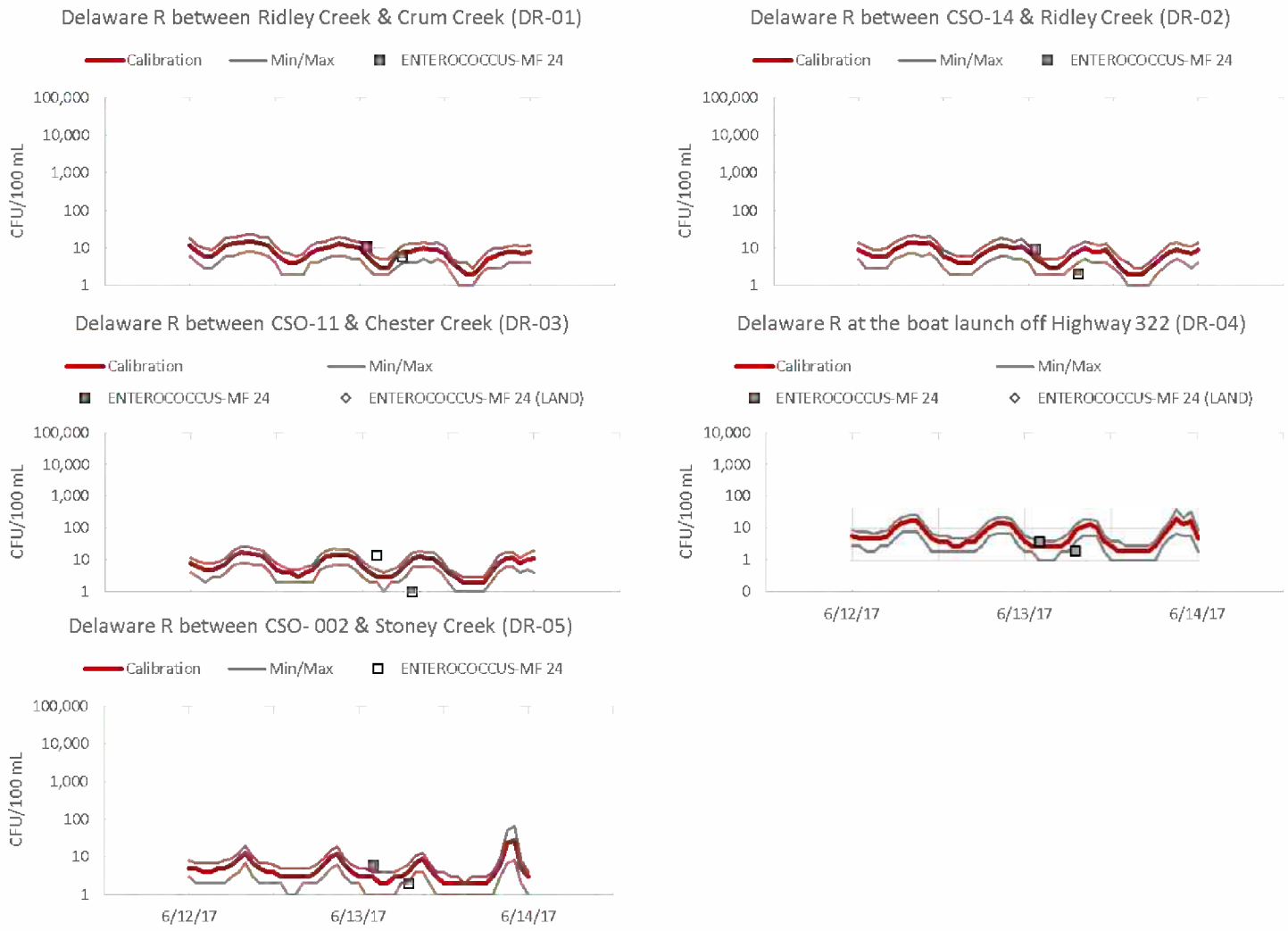


Figure 36. Enterococcus Calibration at Delaware River Stations (Dry Weather Event #3, 6/13/17)

Figure 37. Enterococcus Calibration at Delaware River Cross Section (Dry Weather Events #1-3)

Enterococcus—2017 Wet Weather Calibration

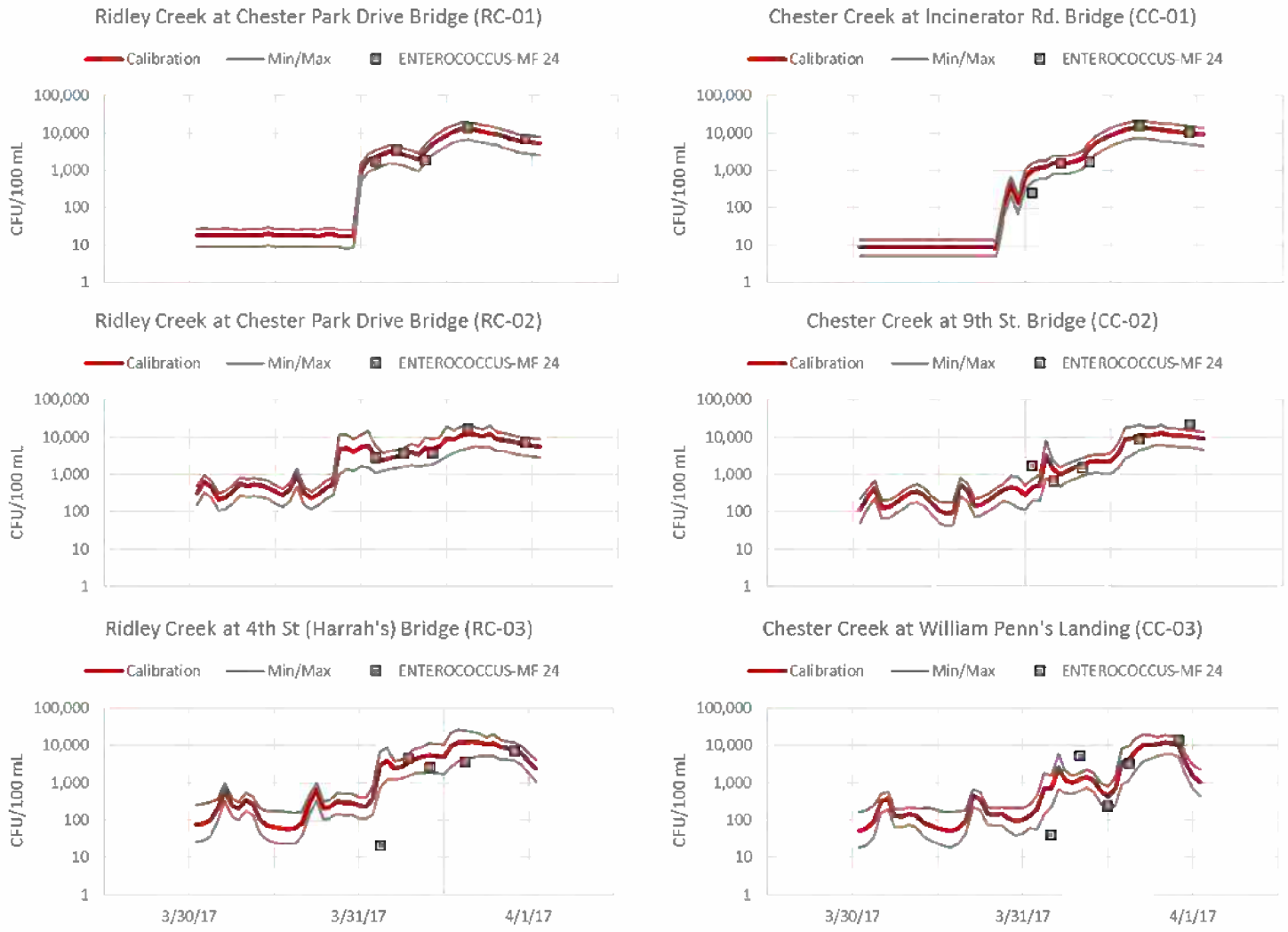
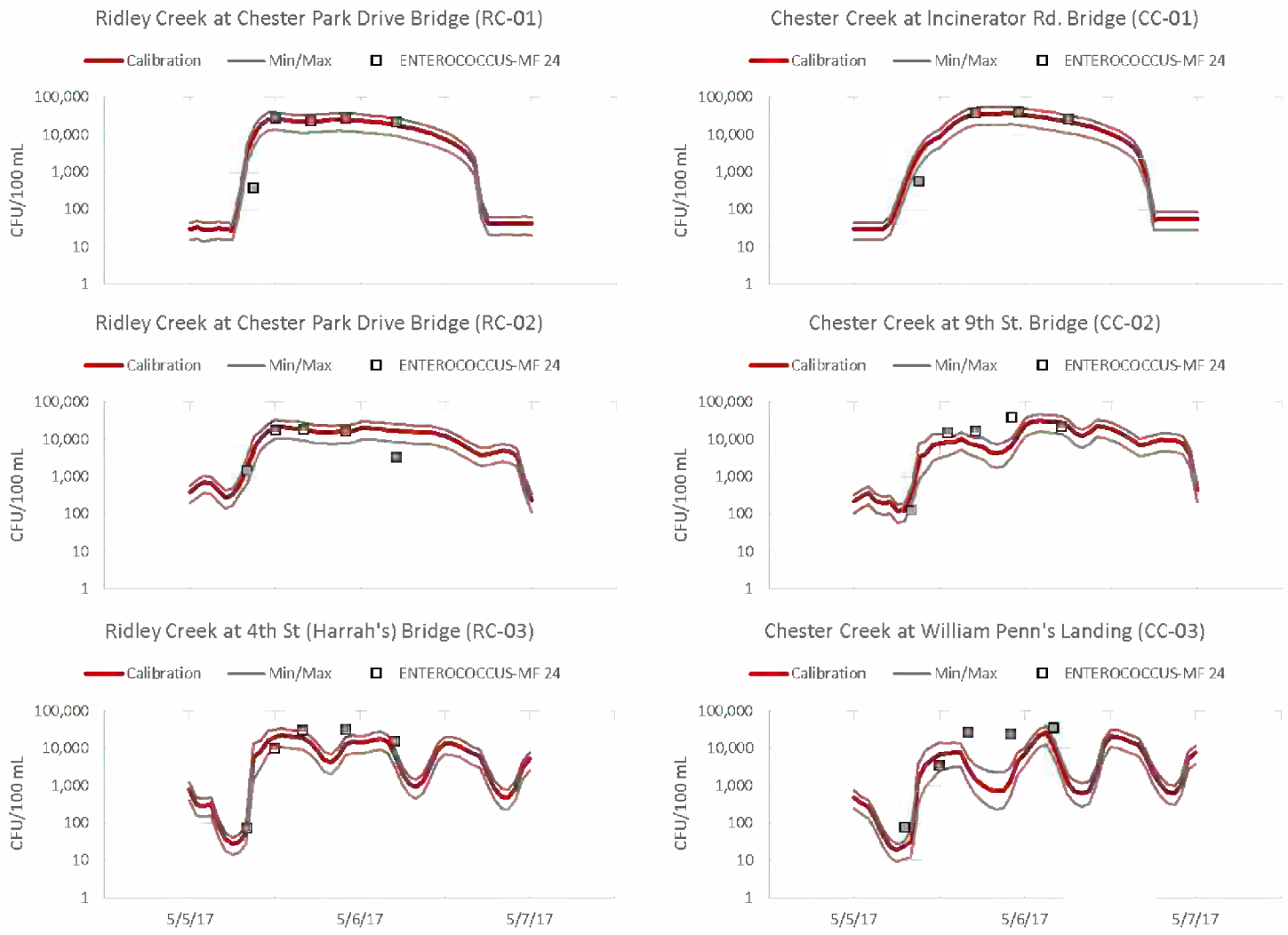


Figure 38. Enterococcus Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #1, 3/30/17-4/1/17)



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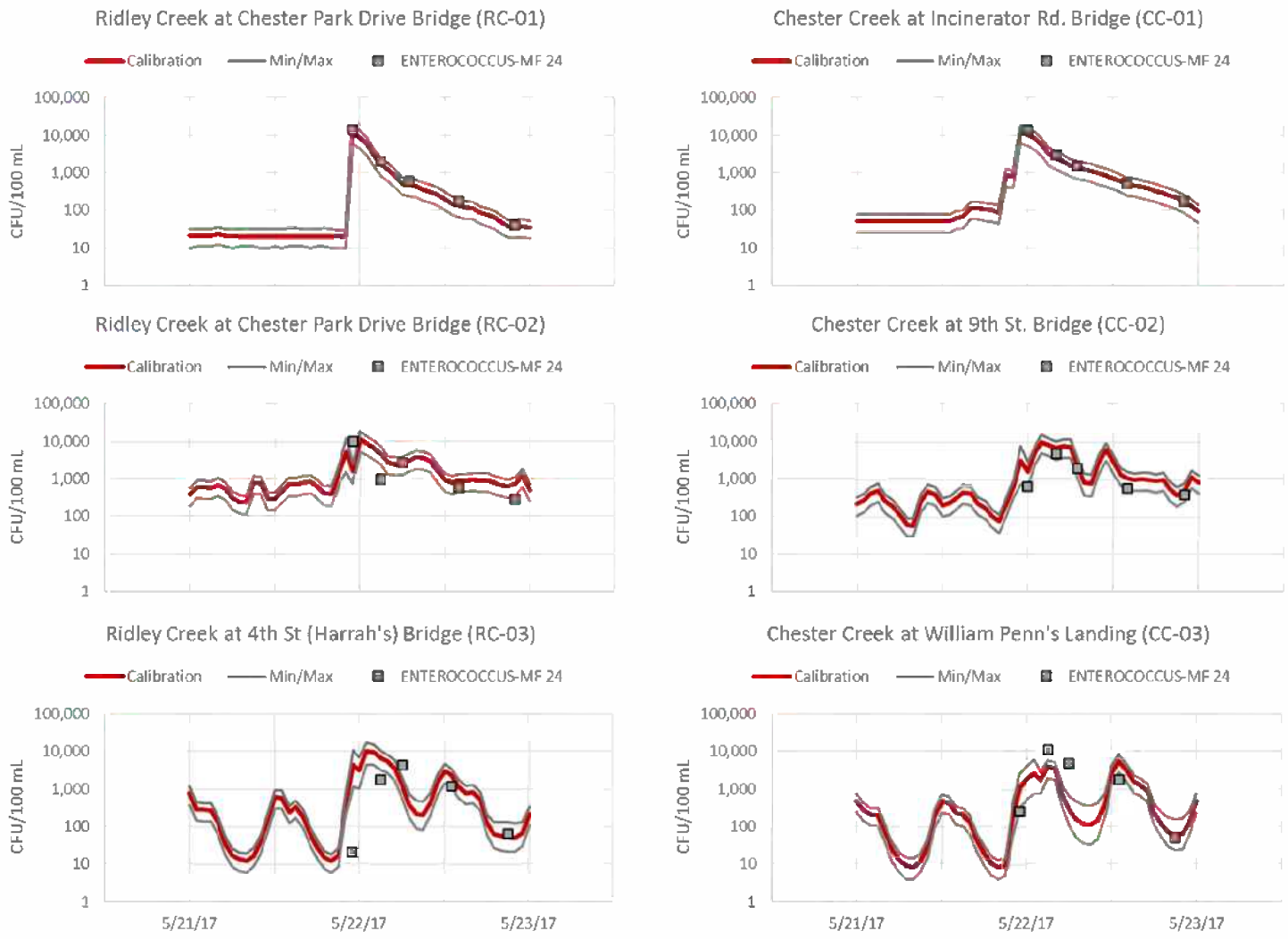


Figure 40. Enterococcus Calibration at Ridley Creek and Chester Creek Stations (Wet Weather Event #3, 5/22/17-5/23/17)

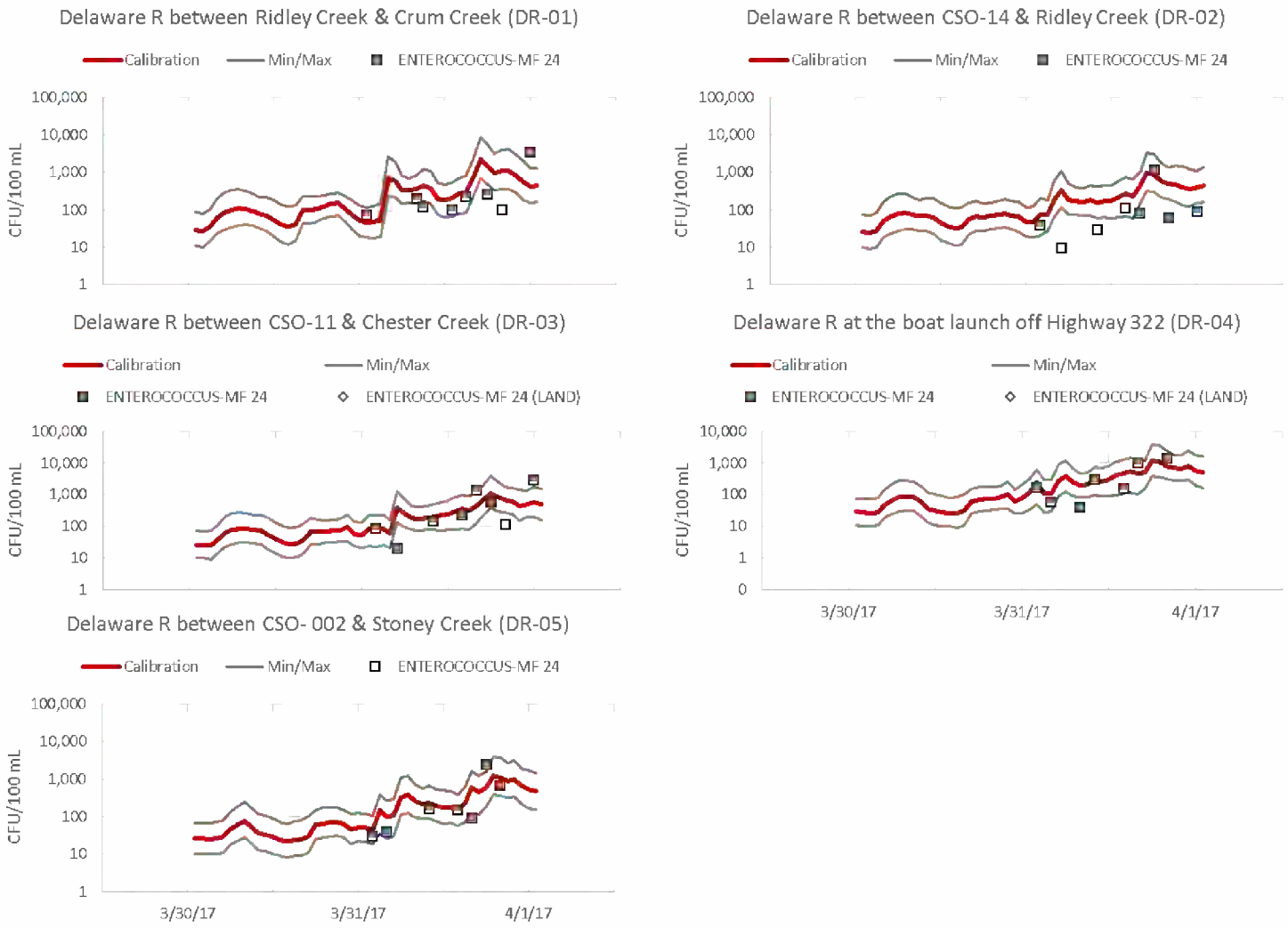


Figure 41. Enterococcus Calibration at Delaware River Stations (Wet Weather Event #1, 3/30/17-4/1/17)

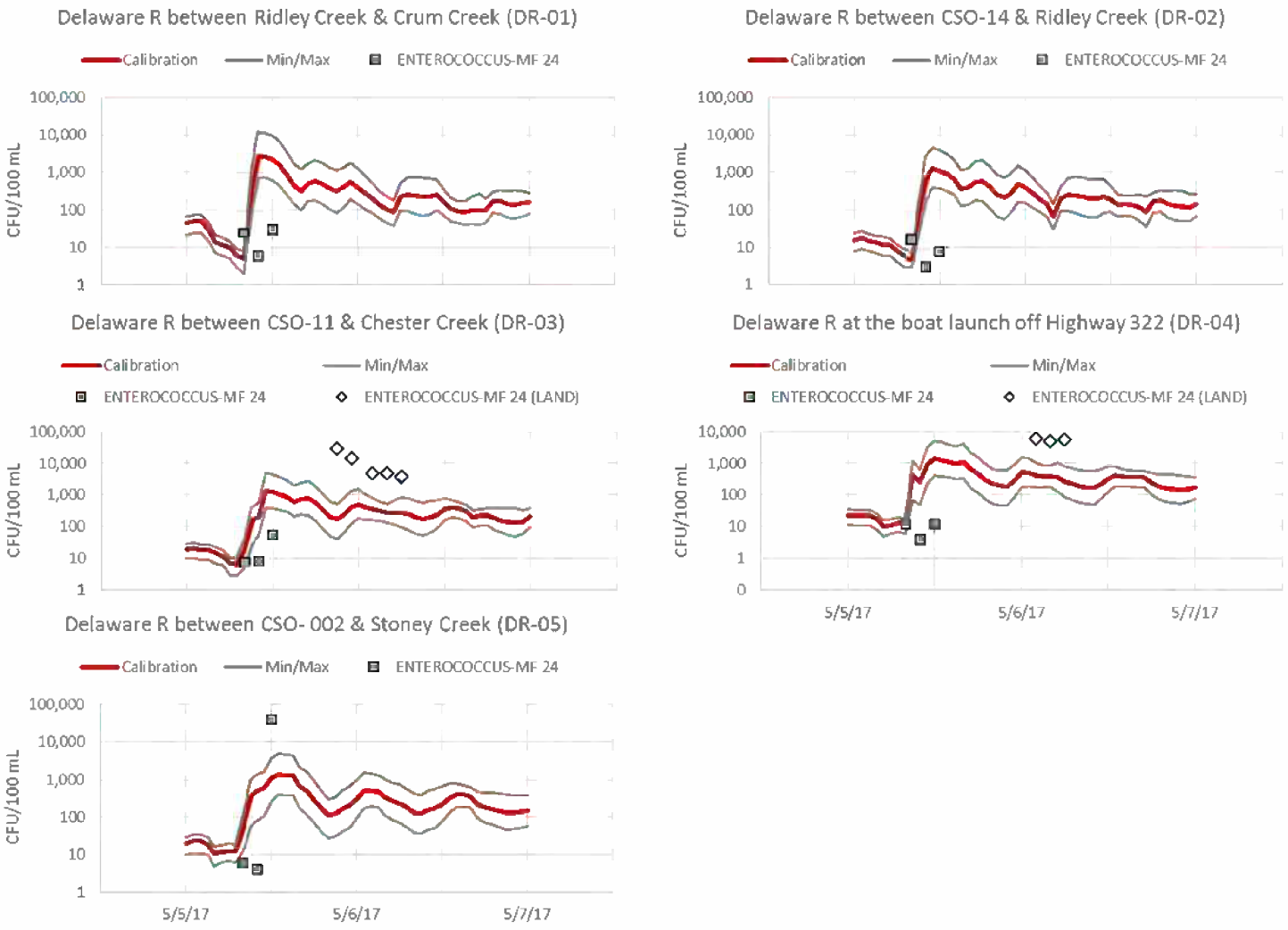


Figure 42. Enterococcus Calibration at Delaware River Stations (Wet Weather Event #2, 5/5/17-5/6/17)

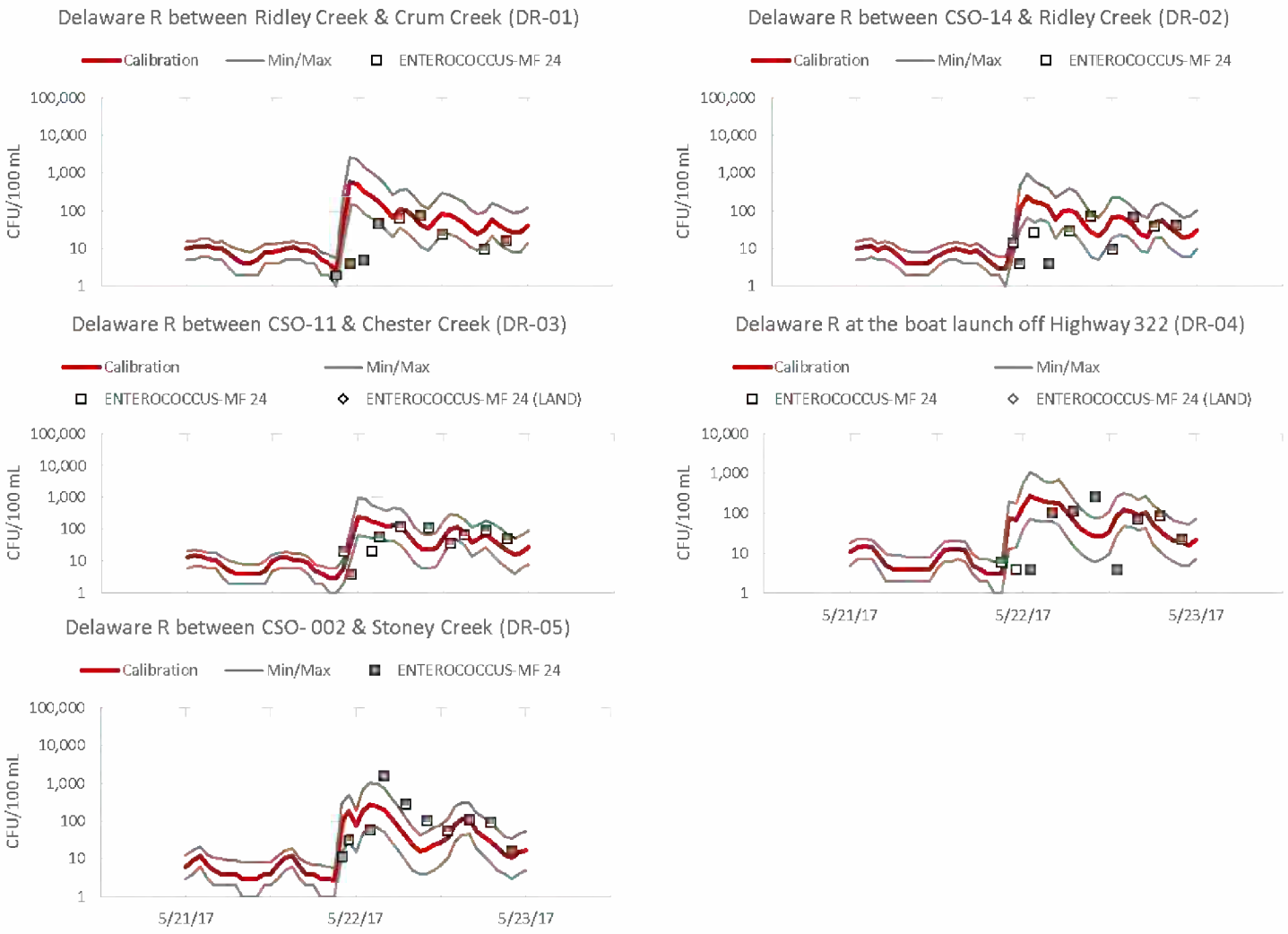
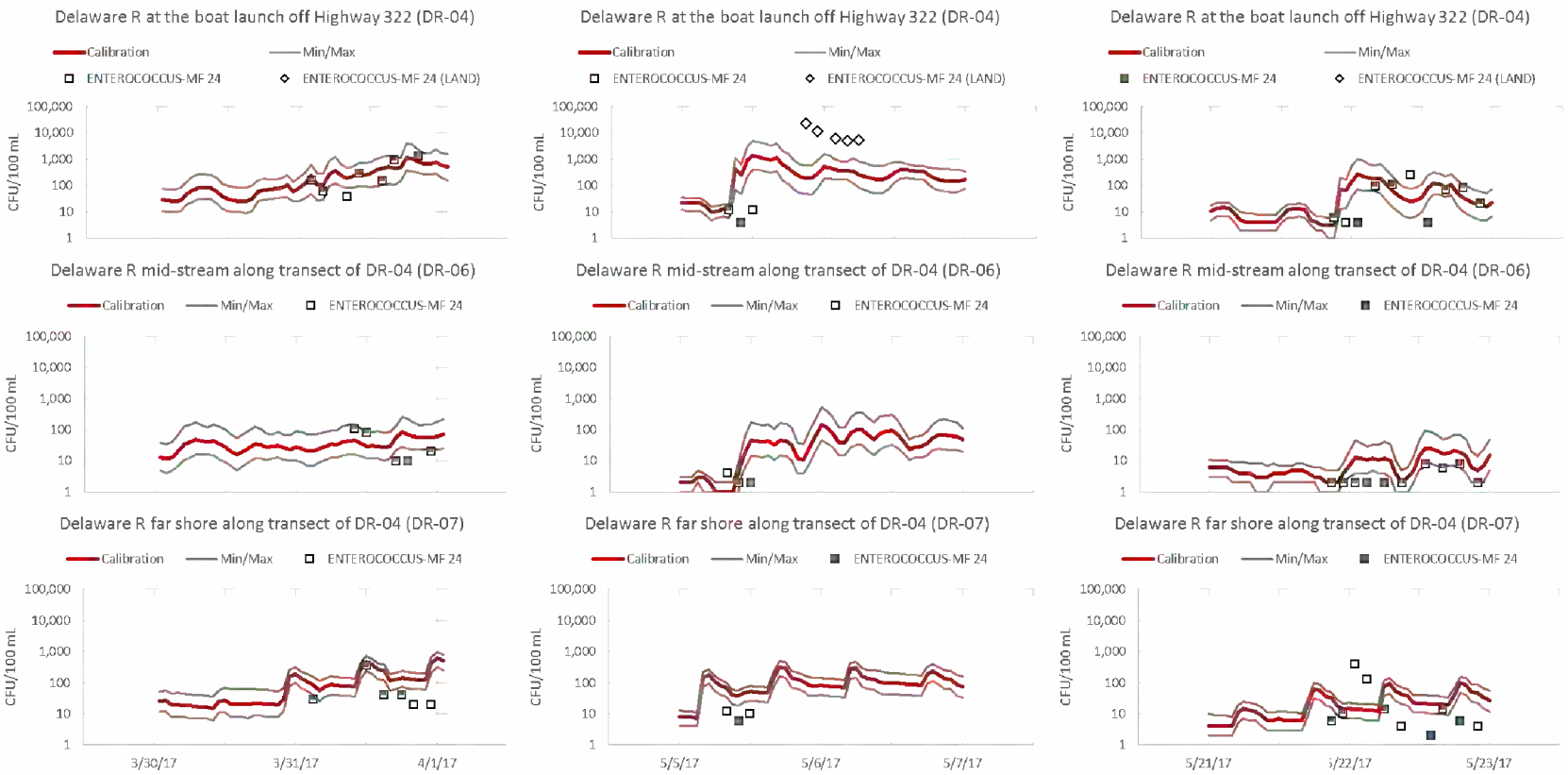


Figure 43. Enterococcus Calibration at Delaware River Stations (Wet Weather Event #3, 5/22/17-5/23/17)



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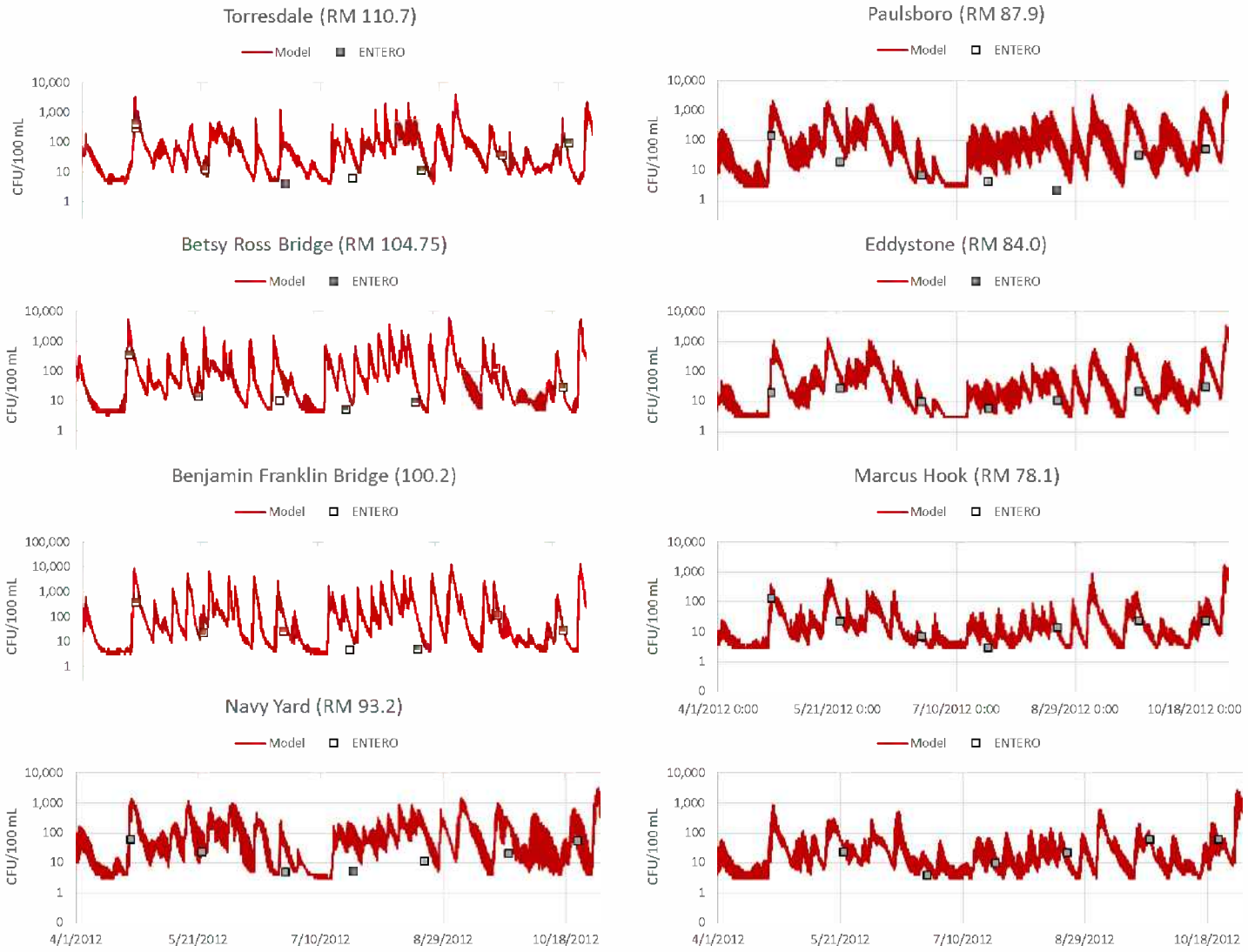

Figure 45. Enterococcus Model Validation at DRBC Delaware River Sampling Stations (2012)

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Orig: M. DiSantis

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4/17/2018

Mr. Michael DiSantis, Director of Operations & Maintenance
Delaware County Regional Water Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. DeSantis:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Regional Water Quality Control Authority (DELCORA) Water Quality Model Report dated February 27, 2018. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA accepts and approves the subject report.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: P. Yeany, EPA
Tom Magee, PaDEP, SERO
C. Hurst, DELCORA

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APPENDIX K

Existing Service Area Characterization Report

- DELCORA Existing Service Area Characterization Report (Final) dated August 2017
- USEPA Approval of the Existing Service Area Characterization Report dated April 16, 2018

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Existing Service Area Characterization Report (Final)

August 2017

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Existing Service Area Characterization Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	8/8/17 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	8/8/17 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	8/8/2017 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

1.1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal wastewater authority that owns, operates and maintains collection systems that serve approximately a half-million people in southeastern Pennsylvania, including 45 municipalities in Delaware and Chester Counties, and is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA operates a Combined Sewer System (CSS) that is comprised of sewer sections that accept both stormwater and sanitary wastewater, which is treated at DELCORA's Western Regional Treatment Plant (WRTP).

Under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall 001), four stormwater outfalls at the WRTP (028-031) and from twenty-six (26) combined sewer overflow (CSO) regulators that discharge to twenty-five (25) CSO outfalls (002-027, 032, 033), and then discharge to the Delaware River, Chester Creek and/or Ridley Creek. CSOs are point source discharges that must be provided control measures in accordance with the Federal Clean Water Act and the 1994 National CSO Policy. CSO are allowed to discharge only when flows in the CSS exceed the conveyance or treatment capacities of the system during wet weather periods, and dry weather overflows are prohibited.

DELCORA is in the process of developing a Long Term Control Plan (LTCP) Update for the Combined Sewer System as part of a Consent Decree entered with the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP). Paragraph V.A.16 of the Consent Decree requires DELCORA to submit an Existing Service Area Characterization Report to the USEPA and PADEP for review and approval.

This Existing Service Area Characterization Report has been prepared to fulfill the requirements of Paragraph V.A.16 of the Consent Decree, and of the federal CSO Control Policy Section II.C.1 – Characterization, Monitoring and Modeling of the Combined Sewer System. This Service Area Characterization Report presents the results to characterize, monitor and model DELCORA's combined sewer system, and incorporates the conclusions about Sensitive Areas that were previously determined in DELCORA's report *Identification of Sensitive Areas and Pollutants of Concerns* (Greeley and Hansen, 2016c).

1.2 Regulatory Requirements

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP) for review and approval. Consent Decree Paragraph V.A.16 (Existing Service Area Characterization) requires that within two years after the Date of Lodging of the Consent Decree, DELCORA shall submit to the USEPA and PADEP a System Characterization Report for review and

approval. Details of the Consent Decree requirements and the associated regulatory requirements for the Existing Service Area Characterization are respectively found below in Sections 1.2.1.
Requirements from the Consent Decree

The primary requirements for the Existing Service Area Characterization Report are established in the Consent Decree. Paragraph V.A.16 of the Consent Decree, Existing Service Area Characterization, states that:

> *"Not later than two years (24) months after the Date of Lodging of the Consent Decree, DELCORA shall submit a characterization of the Model Area that includes all of the information required by CSO Control Policy Section II.C.1 and associated guidance to Plaintiffs for review and approval in accordance with the requirements of Section VI (Review and Approval of Submittals). The characterization shall include, but not be limited to, the following:*
>
> *DELCORA shall use the updated, calibrated, and validated H&H Model to characterize the expected volume, frequency, and duration of CSO discharge events from each CSO during the Typical Year, based on an inter-event period of twelve (12) hours;*
>
> *DELCORA shall incorporate the results of its investigation of Sensitive Areas;*
>
> *DELCORA shall provide a characterization of current water quality in its Receiving waters, based upon all available sampling data, and its efforts to identify POCs.*
>
> *The characterization submitted pursuant to this paragraph shall include the entire model Area, including the hydrology (i.e., runoff) from and within the entire Model Area."*

Additionally, the Consent Decree requires Rainfall and Flow Monitoring in Paragraph V.A.14.d. that:

> *"Rainfall and flow monitoring that shall be carried out in accordance with current good industry practice for a period of at least twelve (12) months, in accordance with the schedule included in the approved plan. Rainfall data shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per square kilometer, for the entire Model Area. Flow monitoring shall be carried out using sufficient monitors to allow the accurate characterization of dry and wet weather flows for the entire Model Area, and the response of each CSO to wet weather flows."*

1.2.1 Requirements from the USEPA's CSO Control Policy

Additional requirements for the Existing Service Area Characterization Report are established in the USEPA's CSO Control Policy (USEPA, 1994). Section II.C.1 of the CSO Control Policy "Characterization, Monitoring and Modeling of the Combined Sewer System" states:

> *"In order to design a CSO control plan to adequately meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring,*

modelling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses."

The CSO Control Policy states that the major elements of a sewer system characterization include:
Rainfall Records

"The permittee should examine the complete rainfall record for the geographic area of its existing CSS using sound statistical procedures and best available data. The permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water conditions."

Combined Sewer System Characterization

"The permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities necessary to understand the number, location and frequency of overflows and their location relative to sensitive areas and to pollution sources in the collection system, such as indirect significant industrial users."

CSO Monitoring

"The permittee should develop a comprehensive, representative monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters."

Modeling

"Modeling of a sewer system is recognized as a valuable tool for predicting sewer system response to various wet weather events and assessing water quality impacts when evaluating different control strategies and alternatives. EPA supports the proper and effective use of models, where appropriate, in the evaluation of the nine minimum controls and the development of the long-term CSO control plan."

1.3 Contents of this Report

To satisfy the requirements of DELCORA's Consent Decree and of the CSO Control Policy, this Existing Service Area Characterization Report provides a comprehensive characterization of DELCORA's combined sewer system and of the CSS monitoring and modeling that DELCORA has completed. In addition to describing the characteristics of the wastewater collection system, this report presents the results of DELCORA's rainfall and flow monitoring programs, its receiving water monitoring program, and the results from the H&H model from the typical year for the Combined Sewer System.

Table 1-1 lists the individual sections of the Report and contents.

Table 1-1 DELCORA Existing Service Area Characterization Report

Section	Description
Section 1 Introduction	This section introduces DELCORA's system, the Consent Decree requirements, requirements from the USEPA's CSO Control Policy, as well as individual sections of the Plan.
Section 2 Overview of DELCORA's Facilities and Service Areas	This section provides an overview of DELCORA's facilities, a description of DELCORA's Service Areas, an overview of DELCORA's treatment facilities, and an overview of DELCORA's combined sewer system within the City of Chester.
Section 3 Characteristics of the Model Area Sewer System	This section describes the details of the combined sewer system and includes the physical characteristics and attributes of DELCORA's Sewer System. These include system configuration, regulator, manhole; pump stations and force main characteristics.
Section 4 Collection of Precipitation and Sewer Flow Data	This section presents the results of DELCORA's efforts to collect precipitation monitoring data for locations throughout the areas served by DELCORA's Sewer System. It also presents the results of DELCORA's efforts to collect flow monitoring data in the combined sewer system and in the receiving waters. It presents the dry weather and wet weather flow data for DELCORA's Sewer System.
Section 5 Characteristics of the Receiving Waters and Watersheds	This section provides an overview of the location, physical characteristics, waterbody classifications and analysis of the current water quality of DELCORA's receiving waters. This section also incorporates the results of DELCORA's investigation of Sensitive Areas, and their relative location to the CSOs.
Section 6 Collection of Water Quality Data	This section presents the results of DELCORA's investigation into the current water quality in the receiving waters. This section also presents the CSO water quality data resulting from DELCORA's CSO Monitoring Program.
Section 7 Typical Hydrologic Period	This section summarizes the typical hydrologic period to be used for modeling based on previously submitted *Typical Hydrologic Period Report*.
Section 8 Hydrologic and Hydraulic Modeling	This section provides an overview of the Hydrologic and Hydraulic Model of the combined sewer system that DELCORA has developed. It also presents the results from the modeling of DELCORA's sewer system and the expected volume, frequency, and duration of CSO discharge events from each CSO during the Typical Hydrologic Period.

Section 2 Overview of DELCORA's Facilities and Service Areas

2.1 Overview of DELCORA's Facilities

DELCORA owns and operates an extensive conveyance system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 2-1. The total service area served by DELCORA, as shown on Figure 2-2, is approximately 82,977 acres and illustrates that DELCORA serves a significant and widespread portion of Delaware County. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers and over 14 miles of large-diameter (>24-inch) force mains. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-six (26) combined sewer regulators that discharge to twenty-five (25) combined sewer outfalls, as CSO Regulators #009 and #010 both discharge to CSO Outfall #009. The combined sewer area simulated in DELCORA's Hydrologic and Hydraulic (H&H) model is located within the City of Chester and consists of a drainage area of approximately 1,506 acres. It comprises approximately half of Chester City's serviced area. The location of Chester City's service area is illustrated on Figure 2-2.

DELCORA has characterized its service areas as "Eastern" and "Western." Historically, the Eastern service area discharged to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PSWPCP) while the Western Service Area discharged to DELCORA's Western Regional Treatment Plant (WRTP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area now discharges to the WRTP while only those CDPS flows above 20 MGD are to be directed to the PWD-SWPCP. Figure 2-1 shows the interconnections in DELCORA's system. The left side of the figure indicates the Western Service Area and the right side indicates the Eastern Service Area. This interconnectivity coupled with the legal agreements DELCORA maintains with the municipalities and conveyance authorities in Delaware County creates the complicated legal/financial framework under which DELCORA operates.

Under its National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the PADEP, DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall #001), four storm water outfalls at the WRTP (028-031) and from the 26 CSO regulators (#002-#005, #007-#026, #032 and #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek. There are a total of 26 combined sewer overflow (CSO) regulators listed with 25 discharge points (Regulators 009 and 010 both discharge at Outfall 009) in DELCORA's existing NPDES Permit.

Figure 2-1: DELCORA Conveyance System

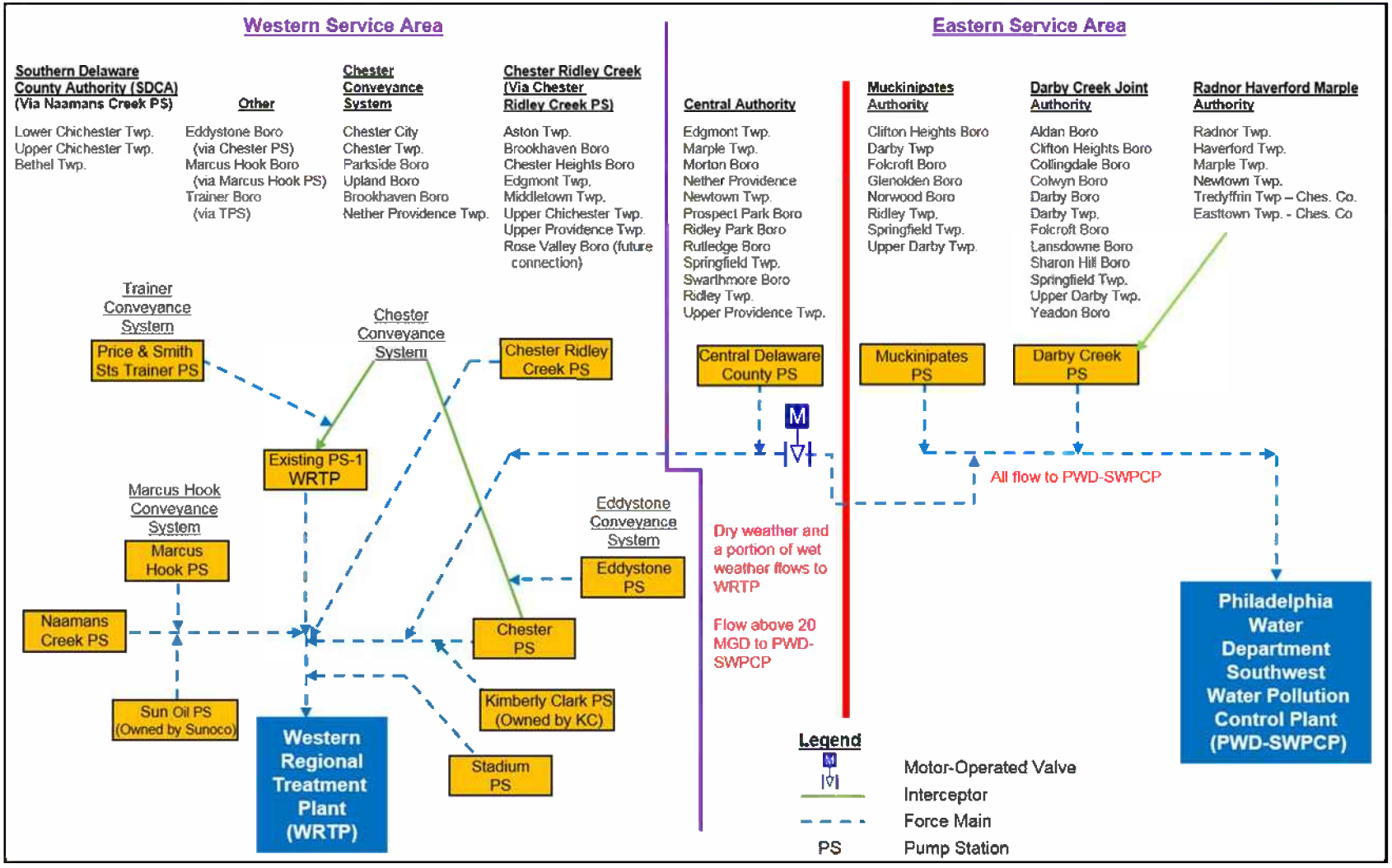
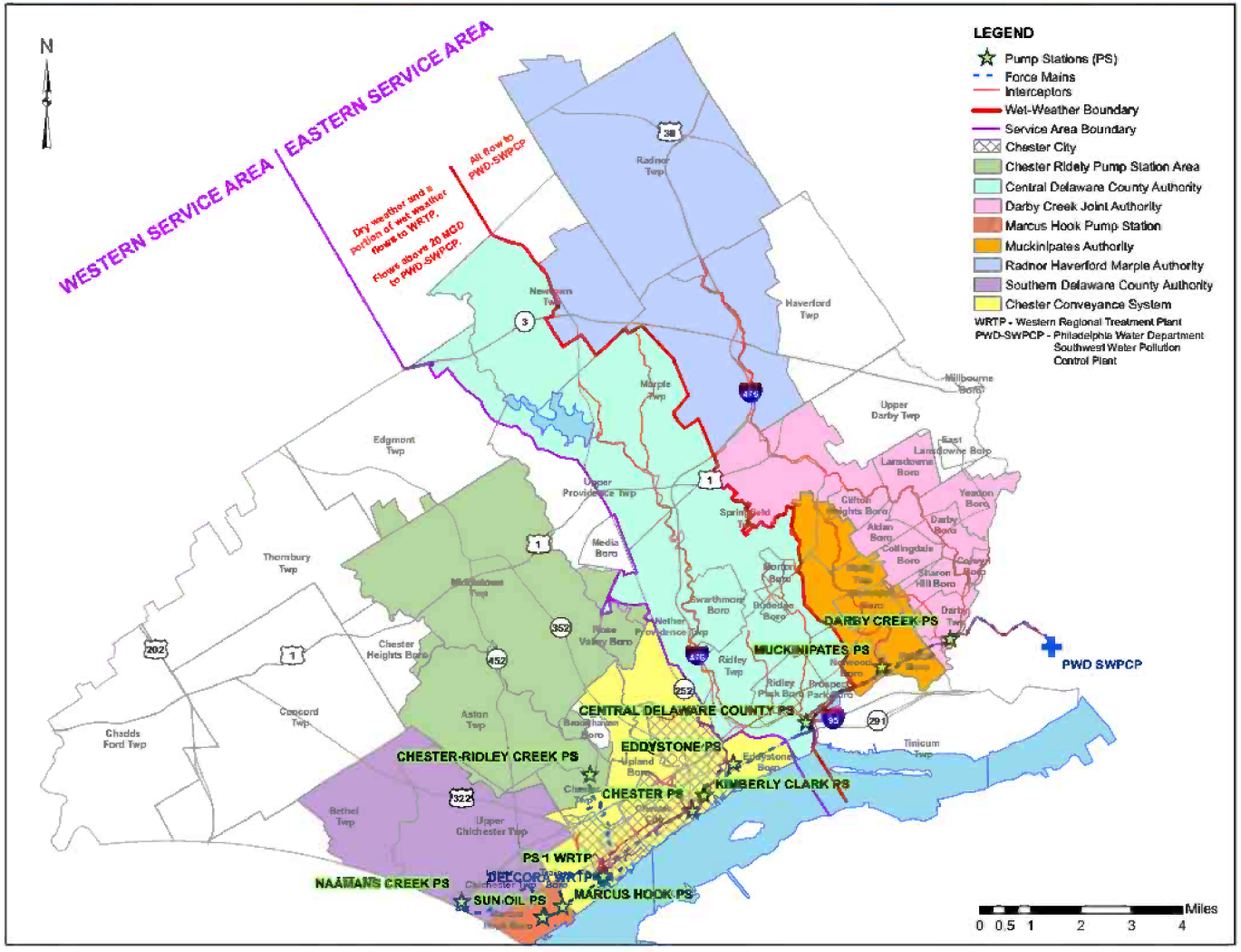


Figure 2-2: DELCORA Service Area



2.2 DELCORA's Service Areas

As mentioned previously and depicted in Figure 2-2, DELCORA serves a significant and widespread portion of Delaware County. To support this service area, DELCORA owns and operates over 137 miles of gravity sewers and over 14 miles of large-diameter (>24-inch) force mains. Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western Service Area discharges to the Western Regional Treatment Plant. The Eastern Service Area discharges to the Philadelphia Southwest Water Pollution Control Plant (PSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are to be directed to the PWD-SWPCP. As such, dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

2.2.1 Eastern Service Area

The Eastern Service Area is composed of four subareas that are served by conveyance authorities. These areas are the Radnor Haverford Marple (RHM) Authority, Darby Creek Joint Authority (DCJA), Muckinipates Authority (MA), and Central Delaware County Authority (CDCA) and are delineated in Figure 2-2. Each of these authorities has a legal agreement with their member municipalities to dispose of their wastewater. In turn, DELCORA has legal agreements with each of the authorities, except RHM, to receive and dispose of the collected wastewater. RHM discharges to the DCJA.

DELCORA owns and operates three large pump stations that serve DELCORA's Eastern Service Area; they are the Central Delaware County Pump Station, the Muckinipates Pump Station, and the Darby Creek Pump Station. These pump stations are designed to pump the wastewater from DELCORA's Eastern Service Area to the Philadelphia Southwest Water Pollution Control Plant for treatment. Originally constructed in the 1970s, the Central Delaware Pump Station (serving CDCA) is rated for 40 MGD. As originally designed, the Central Delaware pump station discharges though a 1.9-mile, 36-inch-diameter prestressed concrete cylinder pipe (PCCP) force main that runs northeast toward the Muckinipates Pump Station. The next pump station is the 24-MGD Muckinipates Pump Station (serving MA). Here the force main increases to 48 inches in diameter and continues approximately 1.65 miles northeast to the Darby Creek Pump Station. Upon reaching the 60-MGD Darby Creek Pump Station (serving DCJA and RHM), the force main increases in diameter to 66 inches and continues approximately 2.5 miles on to PSWPCP.

The operation of the Central Delaware Pump Station (CDPS) had been modified in 2002 to allow for flow from the CDPS to be discharged to the WRTP. Currently, wastewater flows up to 20 MGD are discharged to WRTP and the wastewater flows in excess of 20 MGD are conveyed to PWD-SWPCP.

2.2.2 Western Service Area

DELCORA's Western Service Area is also shown in Figure 2-2. DELCORA owns and operates the collection system in the following communities in the Western service area:

Chester City
Chester Township[1]
Marcus Hook Borough
Parkside Borough
Rose Valley Borough[2]
Upland Borough
Trainer Borough

DELCORA does not own or operate the collection system in the following communities in the Western Service Area:

Brookhaven Borough
Lower Chichester Township
Nether Providence Township
Eddystone Borough

2.3 Model Area

As described in the Consent Decree, the characterization report will evaluate the Model Area comprising those areas hydraulically connected to the WRTP. Section V.A.14.b of the Consent Decree describes the Model Area as follows:

> *"… all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area")."*

As shown in the schematic of DELCORA's conveyance system (see Figure 2-1), the conveyance system is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to, and thus is hydraulically connected to, DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are

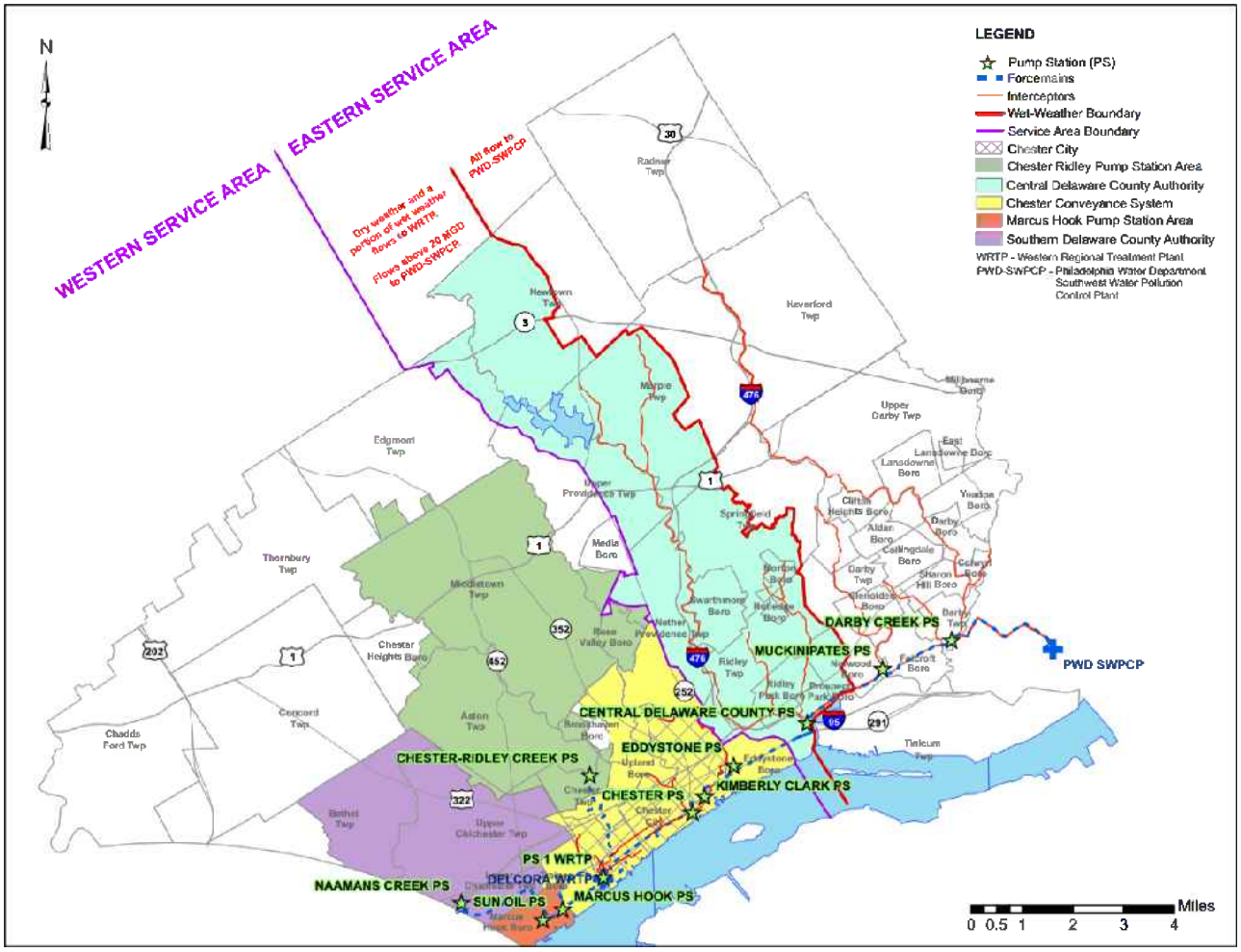
[1] DELCORA owns only a portion of the collection system in Chester Township.
[2] Rose Valley Borough collection system discharges to its own treatment plant and a portion is discharged to the WRTP via Nether Providence's collection system.

considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows to the PWD-SWPCP rather than to the WRTP. Therefore, municipalities connected to these pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area. In summary, the Model Area includes the municipalities in the Western Service Area plus those municipalities in the Eastern Service Area that are connected to the Central Delaware Pump Station, as described in Table 2-1. The Model Area is illustrated in Figure 2-3.

Table 2-1: Model Area

Municipality	Service Area
Aston Township	Western
Bethel Township*	Western (SDCA)
Brookhaven Borough*	Western
Chester City	Western
Chester Township	Western
Eddystone Borough	Western
Edgmont Township*	Eastern (CDCA)
Lower Chichester Township	Western
Marcus Hook Borough	Western
Marple Township*	Eastern (CDCA)
Middletown Township	Western
Morton Borough	Eastern (CDCA)
Nether Providence Township	Eastern (CDCA) and Western
Newtown Township*	Eastern (CDCA)
Parkside Borough	Western
Prospect Park Borough	Eastern (CDCA)
Ridley Park Borough	Eastern (CDCA)
Ridley Township*	Eastern (CDCA)
Rose Valley Borough	Western
Rutledge Borough	Eastern
Springfield Township*	Eastern (CDCA)
Swarthmore Borough	Eastern (CDCA)
Trainer Borough	Western
Upland Borough	Western
Upper Chichester Township	Western (SDCA)
Upper Providence Township*	Eastern (CDCA) and Western
*Indicates that only a portion of the municipality contributes flow to WRTP CDCA: Central Delaware County Authority SDCA: Southern Delaware County Authority	

Figure 2-3: DELCORA LTCP Model Area



2.4 Watersheds

The watersheds of concern for the Model Area include portions of the Delaware River, Chester Creek and Ridley Creek watersheds. Figure 2-4 illustrates the watershed boundaries along with the boundaries of the Model Area.

2.5 DELCORA's Treatment Facilities

DELCORA's primary treatment facility is the WRTP located at 3201 W. front Street in Chester, PA. The WRTP is a permitted 44 MGD activated sludge treatment plant, shown schematically in Figure 2-5. The PADEP and the Delaware River Basin Commission (DRBC) have approved the re-rate of the WRTP to 50 MGD. DELCORA will need to extend the WRTP discharge outfall approximately 455 feet into the Delaware River to meet DRBC regulatory requirements for a re-rate to 50 MGD. Peak capacity at the WRTP is approximately 110 MGD. Based on data obtained for the period 18 March 2016 to 1 May 2017, the annual average dry weather flow to the WRTP is approximately 28 MGD. This facility treats all wastewater from the Model Area, including all flows from the Western Service Area as well as up to 20 MGD from the Central Delaware County Authority.

All wastewater from the Muckinipates Authority, Darby Creek Joint Authority, and the Radnor Haverford Marple Authority are transported to the PSWPCP for treatment and disposal. The Central Delaware Pump Station can direct flow to the WRTP via the Central Diversion Force Main or to the PSWPCP. DELCORA has an agreement with the City of Philadelphia for the disposal of wastewater. This agreement specifies DELCORA's flow thresholds to the PSWPCP to be an annual average of 50 MGD, a daily maximum of 75 MGD, and an instantaneous peak flow of 100 MGD. Flows above these thresholds are subject to exceedance charges.

DELCORA also purchased the Rose Valley Treatment Plant in 2009. The Rose Valley Treatment Plant is permitted at 0.13 MGD and is located in Delaware County. On March 1, 2010, DELCORA purchased the Riverside Treatment Plant in Pocopson Township, Chester County. It is permitted at 0.045 MGD.

Figure 2-4: Watershed Boundaries

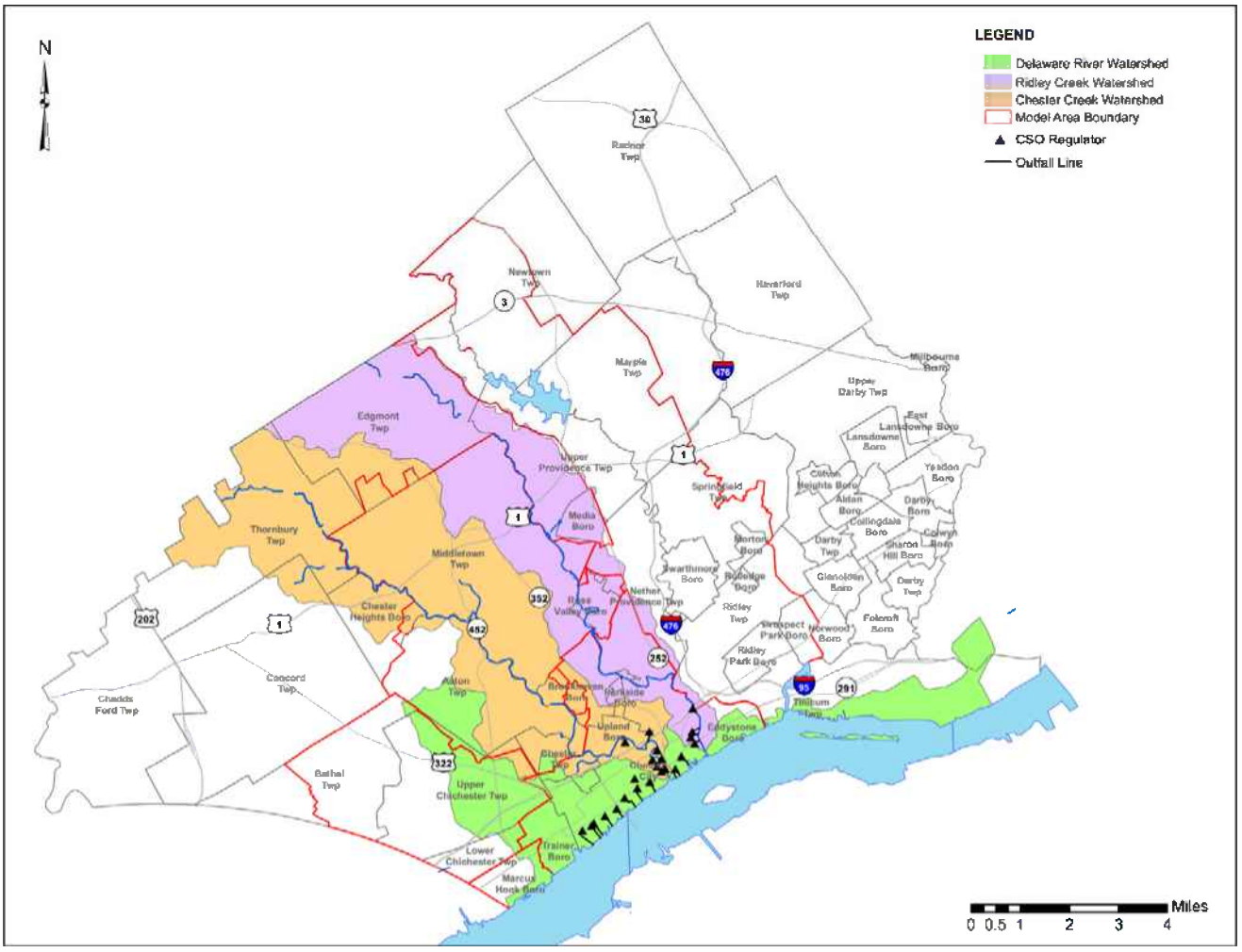
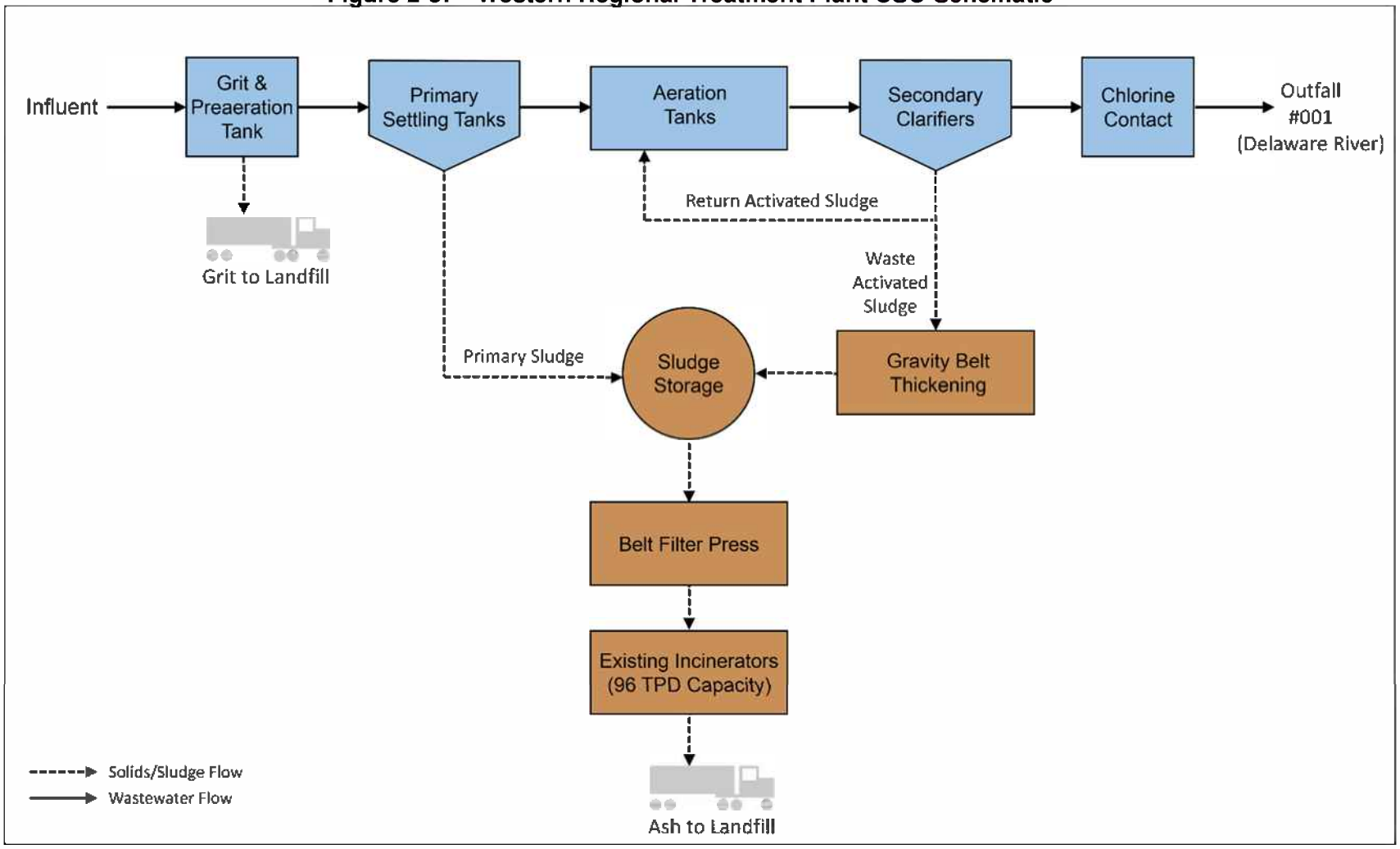


Figure 2-5: Western Regional Treatment Plant CSO Schematic



Section 3 Characteristics of the Model Area Sewer System

3.1 Introduction

This section presents an investigation of the collection system to meet the requirements of Section II.C.1.b, Combined Sewer System Characterization, of the USEPA's CSO Control Policy. Section II.C.1.b requires DELCORA to evaluate the nature and extent of the sewer system through evaluation of available sewer records and inspections necessary to understand the number, location and frequency of overflows, and their locations relative to Sensitive Areas and to pollution sources in the collection system.

3.2 Sources of Collection System Data

The characteristics and attributes of DELCORA's collection system were determined through the collection, assessment, and evaluation of existing data and information, as part of the implementation of the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015).

Data and information on the collection system were obtained from several sources including DELCORA's input, DELCORA's Geographic Information System (GIS), as-built record drawings, design drawings and field surveys.

3.3 Overview of Sewer System Characteristics

The wastewater collection system within the Model Area consists of separated storm and sanitary sewer piping in some areas and combined sewer system piping in other areas. The Model Area covers approximately 50,000 acres, with approximately 48,540 acres served by separated storm and sanitary systems while only 1,463 acres are served by a combined sewer system. The combined sewer system is located entirely within the City of Chester. However, the City of Chester also has areas that are served by separated storm and sanitary piping or are direct drainage. The remaining areas of the Model Area outside of the City of Chester are all served by separated storm and sanitary sewer piping.

In separated areas, the sanitary sewers convey wastewater to the WRTP for treatment and stormwater runoff is collected through storm sewers and discharged directly to the receiving waters.

Within the City of Chester's combined sewer areas, however, sanitary and storm sewers are combined into the same pipe. During dry weather, the sanitary wastewater is conveyed to the WRTP. During large storms, the stormwater runoff causes the carrying capacity of these combined sewers to be exceeded, and part of this combined flow may discharge directly to the receiving waters without undergoing any treatment.

Sewersheds (subcatchments) are delineated based on the drainage network and area characteristics. Each sewershed has a dry weather and a wet weather flow input to the model network. The model network comprises 114 sewersheds (subcatchments), including 53 combined and 61 separated subcatchments.

3.4 Characteristics of Separated Sewer Areas

Sanitary sewers within the separated areas deliver flow to the WRTP through connections to DELCORA's sewers and through connections to DELCORA's pump station. In many cases, DELCORA does not own or operate the sanitary sewers in separated areas. Consequently, detailed information regarding the characteristics of sanitary sewers from the separated areas is not included in this Report. For modeling purposes, the separated areas will be treated as node inputs to the H&H Model. Flow inputs at the nodes will be derived as described in Sections 4 and 8. Key characteristics necessary for developing flow inputs include delineation of subcatchment boundaries (see Figures 3-1 and 3-2) and areas (see Table 3-1).

3.5 Characteristics of Combined Sewer System

As noted in Section 2.1, the combined portion of DELCORA's sewer system is located within the City of Chester (City), and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, and CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The CSS system in the City of Chester has several key components that all impact how the system operates. These key components are the local street sewers, combined collector sewers, CSO regulators, interceptors, and outfalls. The system starts with local street sewers that take flow from houses and businesses as well as the stormwater inlets that drain the streets. These local street sewers typically range in size from 12" to 24" in diameter. The local street sewers discharge to combined collector sewers (shown in Figure 2-1) which flow to the CSO regulators. The combined collector sewers are larger pipes typically range in size from 18" to 72" in diameter and connect directly to the CSO regulator.

Generally, in the CSO drainage areas, flows from the separate sanitary sewers flow into the combined sewers. Flows from the combined sewers in the collection system flow to the regulator structures where dry weather flow and a portion of wet weather flow are diverted into the interceptors. The remainder of the wet weather flow that exceeds the capacity of the interceptors is discharged directly to the closest receiving water (Delaware River, Chester Creek or Ridley Creek) through the CSO outfalls.

3.5.1 Overall Configuration

A schematic of the CSS was developed to facilitate the development, calibration, and validation of the H&H Model. The schematic illustrates the relationship between all major regulators, interceptors, outfalls, pump stations, force mains and other major appurtenances. The schematic also includes the location of the flow meters, and provides and good understanding of the relationship between the flow meters. The schematic of the collection system components is shown on Figure 3-3.

Figure 3-1: DELCORA Model Area Subcatchments

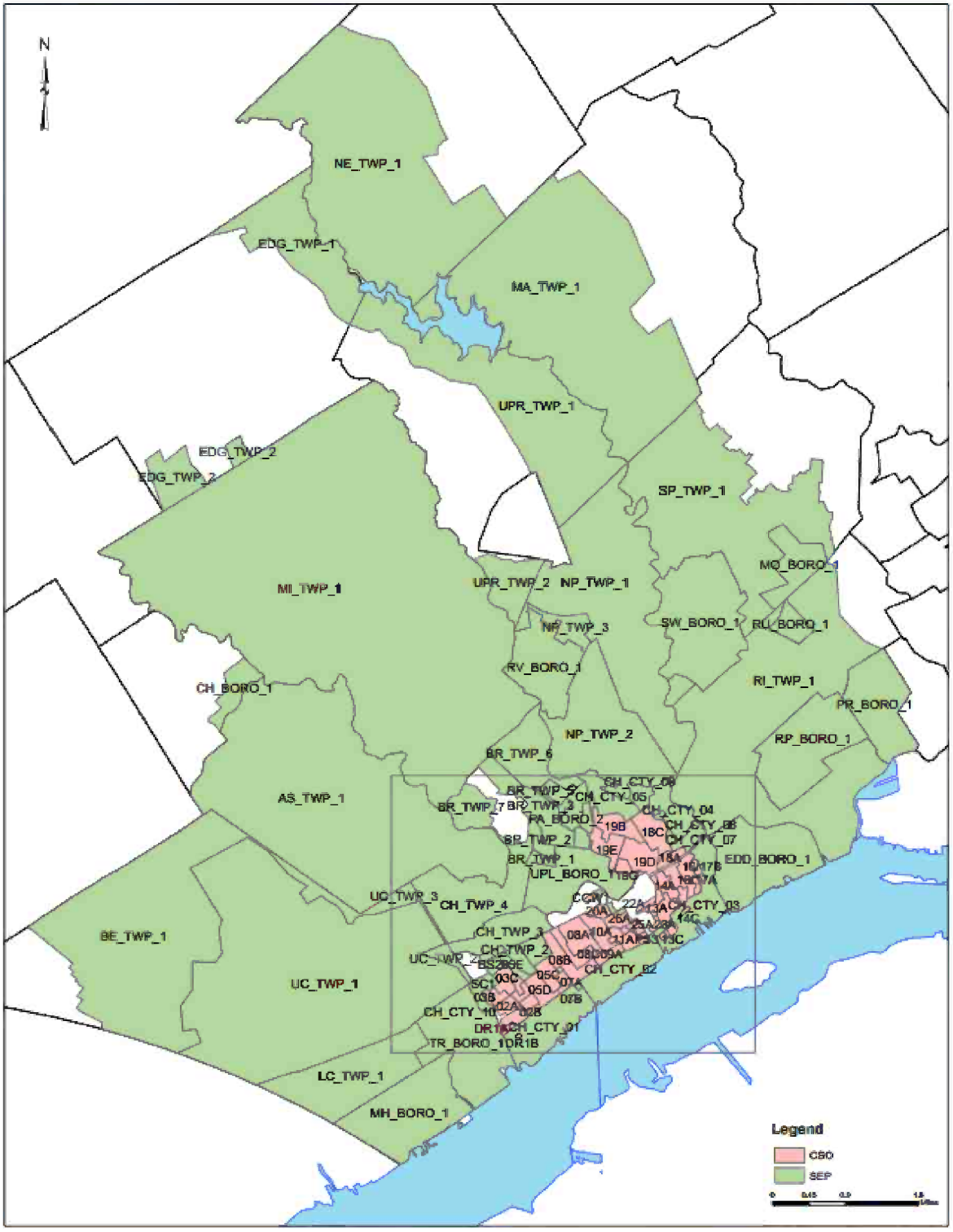


Figure 3-2: DELCORA CSS Area Subcatchments (Enlarged)

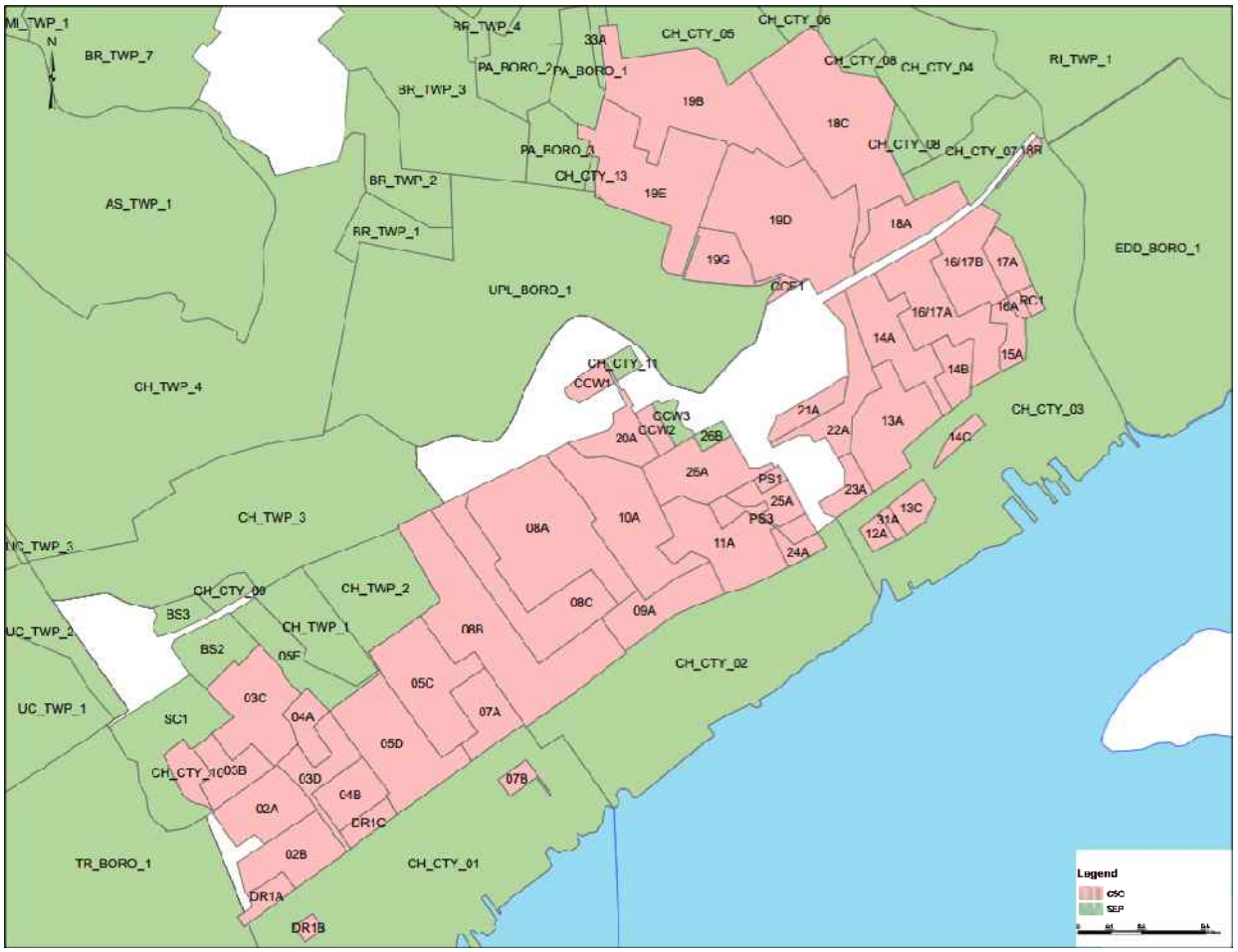


Figure 3-3: Schematic of Chester CSO System

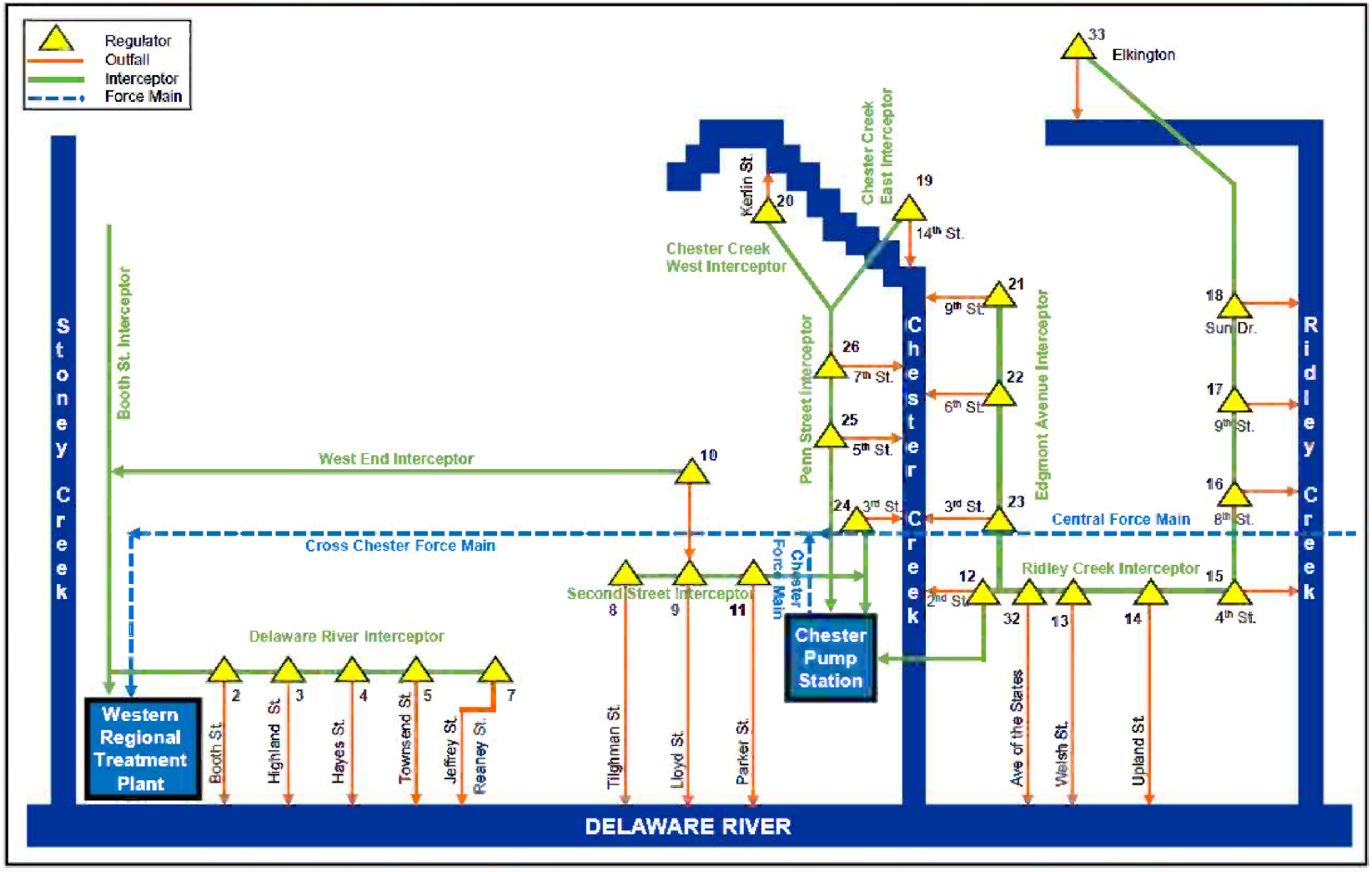


Figure 3-4 depicts the locations of DELCORA's CSO regulators and outfalls. Figure 3-4 also depicts the various drainage subcatchments that flow to each of the CSO regulators. Information about the 26 CSO drainage areas including their subcatchments, total acreage and combined sewer acreage are shown depicted in Table 3-1. Together Figure 3-4 and Table 3-1 also provide a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers.

3.5.2 Sewer Mains

Sewer data was collected from DELCORA's GIS in support of the work to develop and update and calibrate the H&H model. Most of the pipe input characteristics, including upstream and downstream nodes, dimension, shape, number of barrels, and flap gate information, were found or estimated from record drawings, design drawings and sewer gravity main GIS shapefiles. If sewer main information was not available, sewer length was estimated in GIS geometry measurement; sewer size were assumed based on upstream and downstream sewers; sewer upstream and downstream offsets were estimated based on sewer connectivity assuming constant slope. Conduit ID was inherited from the 2012 H&H Model and new IDs were provided for the pipes not in the 2012 H&H Model.

Manhole information, including invert and rim elevations, were found or estimated from record drawings, design drawings, and the sewer manhole shape file. For water tight manholes or manholes with bolted down covers, a surcharge depth of 50-ft will be applied. Manhole ID was inherited from the name of the manhole in the sewer GIS. The naming convention is "MH_XXXX". Manhole input information was updated based on the latest available GIS information.

3.5.3 Flow Diversion Structures and CSO Regulators

The Chester CSO system contains 26 permitted CSO regulators as listed in Table 3-2. The CSO regulators and outfalls serve as combined sewer reliefs necessitated by stormwater entering the sewer system and exceeding the hydraulic capacity of the sewers and/or treatment plant. Wet weather flows in excess of the collection system's capacity are discharged to the Delaware River, Chester Creek or Ridley Creek. Although there are 26 regulators, there are only 25 CSO discharge locations, as CSO #010 discharges to the Delaware River through CSO #009. Table 3-2 shows that eleven of the outfalls, CSO Outfalls #002, 003, 004, 005, 007, 008, 009, 011, 013, 014, and 032, discharge excess wet weather flows into the Delaware River. Nine of the outfalls, CSO Outfalls #012, 019, 020, 021, 022, 023, 024, 025 and 026, discharge excess wet weather flows into the Chester Creek. The remaining five designated outfalls, Outfall #015, 016, 017, 018 and 033[3] , discharge excess wet weather flows into the Ridley Creek.

Since the approval of the first LTCP in 1999, DELCORA has under-taken a program to replace and/or rehabilitate CSO regulators and tide gates in the City of Chester CSO system. In some cases, regulators have been eliminated. The modifications DELCORA committed to in the 1999 LTCP include a complete

[3] DELCORA's NPDES permit includes 26 regulators. After the NPDES permit was issued, CSO regulator 033 was disconnected from the CSS.

Figure 3-4: CSS Area Delineation

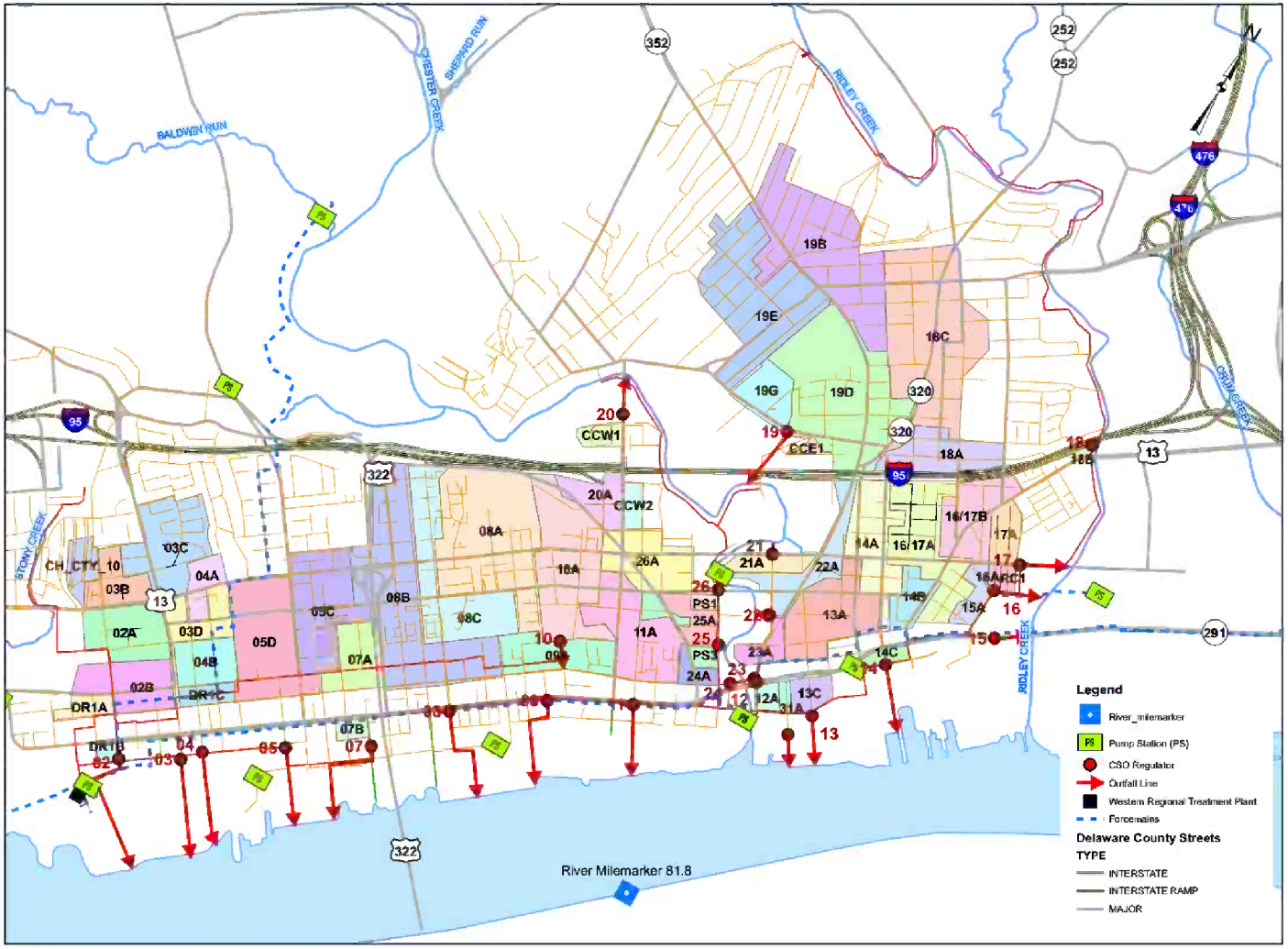


Table 3-1: Subcatchments in the Model Area Sewer System

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
Regulator 2	02A	CSS	29	58	Chester City
	02B	CSS	29		Chester City
Regulator 3	03B	CSS	19	87	Chester City
	03C	CSS	43		Chester City
	03D	CSS	20		Chester City
Regulator 4	04A	CSS	12	31	Chester City
	04B	CSS	19		Chester City
Regulator 5	05C	CSS	49	233	Chester City
	05D	CSS	53		Chester City
	05E	Separate	27		Chester City
	CH_TWP_2	Separate	59		Chester Twp
	CH_CTY_9	Separate	7		Chester City
	CH_TWP_1	Separate	38		Chester Twp
Regulator 7	07A	CSS	21	26	Chester City
	07B	CSS	5		Chester City
Regulator 8	08A	CSS	89	237	Chester City
	08B	CSS	96		Chester City
	08C	CSS	52		Chester City
Regulator 9	09A	CSS	27	27	Chester City
Regulator 10	10A	CSS	60	60	Chester City
Regulator 11	11A	CSS	44	44	Chester City
Regulator 12	12A	CSS	5	5	Chester City
Regulator 13	13A	CSS	41	50	Chester City
	13C	CSS	9		Chester City
Regulator 14	14A	CSS	35	53	Chester City
	14B	CSS	13		Chester City
	14C	CSS	5		Chester City
Regulator 15	15A	CSS	10	10	Chester City
Regulator 16/17	16/17A	CSS	46	77	Chester City
	16/17B	CSS	31		Chester City
Regulator 16	16A	CSS	2	2	Chester City
Regulator 17	17A	CSS	12	12	Chester City
Regulator 18	18A	CSS	28	130	Chester City
	18B	CSS	2		Chester City
	18C	CSS	100		Chester City
Regulator 19	18C	Separate	100	421	Chester City
	19B	CSS	88		Chester City
	19D	CSS	94		Chester City
	19E	CSS	76		Chester City
	19G	CSS	18		Chester City
	PA_BORO_1	Separate	28		Parkside Boro
	CH_CTY_08	Separate	17		Chester City
Regulator 20	20A	CSS	18	18	Chester City
Regulator 21	21A	CSS	11	11	Chester City
Regulator 22	22A	CSS	27	27	Chester City
Regulator 23	23A	CSS	10	10	Chester City
Regulator 24	24A	CSS	6	6	Chester City
Regulator 25	25A	CSS	12	12	Chester City

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
Regulator 26	26A	CSS	33	37	Chester City
	26B	Separate	4		Chester City
Regulator 32	31A	CSS	3	3	Chester City
Chester Creek Interceptor East	CCE1	CSS	3	3	Chester City
Chester Creek Interceptor West	CCW1	CSS	7	552	Chester City
	CCW2	CSS	6		Chester City
	CCW3	Separate	5		
	CH_CTY_11	Separate	5		Chester City
	PA_BORO_3	Separate	27		Parkside Boro
	BR_TWP_1	Separate	27		Brookhaven Boro
	BR_TWP_2	Separate	49		Brookhaven Boro
	CH_CTY_13	Separate	2		Parkside Boro
	UPL_BORO_1	Separate	424		Upland Boro
2nd Street Interceptor	CH_CTY_02	Separate	238	238	Chester City
Penn Street Interceptor	PS1	CSS	3	13	Chester City
	PS3	CSS	10		Chester City
Ridley Creek Interceptor	RC1	CSS	3	2,327	Chester City
	CH_CTY_03	Separate	276		Chester City
	33A	Separate	9		Chester City
	CH_CTY_04	Separate	137		Chester City
	CH_CTY_05	Separate	124		Chester City
	CH_CTY_06	Separate	44		Chester City
	CH_CTY_07	Separate	44		Chester City
	BR_TWP_6	Separate	327		Brookhaven Boro
	NP_TWP_2	Separate	991		Nether Providence Twp
	PA_BORO_2	Separate	71		Parkside Boro
	BR_TWP_3	Separate	236		Brookhaven Boro
	BR_TWP_4	Separate	21		Brookhaven Boro
	BR_TWP_5	Separate	44		Brookhaven Boro
Stony Creek Interceptor	SC1	CSS	54	54	Chester City
West End Interceptor	DR1A	CSS	8	1,023	Chester City
	DR1C	CSS	7		Chester City
	CH_CTY_10	CSS	11		Chester City
	TR_BORO_1	Separate	669		Trainer Boro
	CH_TWP_3	Separate	245		Chester Twp
	UC_TWP_2	Separate	51		Upper Chichester Twp
	BS2	CSS	22		Chester City
	BS3	CSS	10		Chester City
Delaware River Interceptor	DR1B	CSS	3	332	Chester City
	CH_CTY_01	Separate	329		Chester City
Eddystone Pump Station	EDD_BORO_1	Separate	664	664	Eddystone Boro
Central Delaware Pump Station	RI_TWP_1	Separate	2,806	18,806	Ridley Twp
	RP_BORO_1	Separate	679		Ridley Park Boro
	RU_BORO_1	Separate	90		Rutledge Boro
	SP_TWP_1	Separate	2,208		Springfield Twp
	SW_BORO_1	Separate	898		Swarthmore Boro
	UPR_TWP_1	Separate	1,722		Upper Providence Twp
	PR_BORO_1	Separate	477		Prospect Park Boro
	MO_BORO_1	Separate	238		Morton Boro

CSO Regulator/Interceptor/ Pump Station	Subarea	Collection System Type	Area/Subarea (ac)	Total Area (ac)	Municipality
	NE_TWP_1	Separate	3,422		Newtown Twp
	NP_TWP_1	Separate	1,927		Nether Providence Twp
	EDG_TWP_1	Separate	735		Edgmont Twp
	MA_TWP_1	Separate	3,604		Marple Twp
Chester Ridley Creek Pump Station	UC_TWP_3	Separate	192	14,513	Upper Chichester Twp
	UPR_TWP_2	Separate	248		Upper Providence Twp
	RV_BORO_1	Separate	471		Rose Valley Boro
	NP_TWP_3	Separate	110		Nether Providence Twp
	AS_TWP_1	Separate	3,732		Aston Twp
	CH_TWP_4	Separate	593		Chester Twp
	EDG_TWP_2	Separate	258		Edgmont Twp
	MI_TWP_1	Separate	8,612		Middletown Twp
	BR_TWP_7	Separate	156		Brookhaven Boro
	CH_BORO_1	Separate	141		Chester Heights Boro
Marcus Hook Pump Station	LC_TWP_1	Separate	700	1,401	Lower Chichester Twp
	MH_BORO_1	Separate	701		Marcus Hook Boro
Naamans Creek Pump Station	BE_TWP_1	Separate	2,500	6,528	Bethel Twp
	UC_TWP_1	Separate	4,028		Upper Chichester Twp

Table 3-2: CSO Regulator Information

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	Latitude	Longitude	CSO Regulator Type	Regulator Replacement Status
002	Front & Booth	Delaware River	39°49'30"N	75°23'31"W	Brown & Brown	Replaced 2010
003	Front & Highland	Delaware River	39°49'34"N	75°23'11"W	Brown & Brown	Replaced 2010
004	Front & Hayes	Delaware River	39°50'36"N	75°23'07"W	McNulty	In Progress; Anticipated Completion Fall 2017
005	Front & Townsend	Delaware River	39°49'46"N	75°22'53"W	Brown & Brown	Replaced
007	Delaware & Reaney	Delaware River	39°49'51"N	75°22'45"W	Brown & Brown	Replaced
008	2nd & Tilghman	Delaware River	39°50'05"N	75°22'22"W	Brown & Brown	Replaced
009	2nd & Lloyd	Delaware River	39°50'14"N	75°22'10"W	Brown & Brown	Replaced
010*	5th & Pusey	Delaware River	39°50'26"N	75°22'19"W	Brown & Brown	Replaced
011	2nd & Parker	Delaware River	39°50'26"N	75°21'54"W	Brown & Brown	Replaced
012	2nd & Edgmont	Chester Creek	39°50'42"N	75°21'38"W	Brown & Brown	Replaced
013	2nd & Welsh	Delaware River	39°50'37"N	75°21'17"W	Brown & Brown	Replaced
014	3rd & Upland	Delaware River	39°50'50"N	75°21'05"W	Brown & Brown	Replaced
015	4th & Melrose	Ridley Creek	39°51'03"N	75°20'48"W	Brown & Brown	2022
016	8th & McDowell	Ridley Creek	39°51'15"N	75°20'53"W	Brown & Brown	Replaced
017	9th & Campbell	Ridley Creek	39°51'16"N	75°20'51"W	Brown & Brown	2021
018	Sun Dr. & Hancock	Ridley Creek	39°51'47"N	75°20'57"W	Brown & Brown	Scheduled for 2017
019	14th & Crozer Hospital	Chester Creek	39°51'24"N	75°21'54"W	Brown & Brown	2024
020	Kerlin & Finland	Chester Creek	39°51'24"N	75°22'27"W	Brown & Brown	Replaced
021	9th & Sproul	Chester Creek	39°51'08"N	75°21'49"W	Brown & Brown	Replaced
022	6th & Sproul	Chester Creek	39°50'56"N	75°21'47"W	Brown & Brown	Replaced
023	3rd & Edgmont	Chester Creek	39°50'45"N	75°21'42"W	Brown & Brown	Replaced
024	3rd & Dock	Chester Creek	39°50'44"N	75°21'43"W	Brown & Brown	Replaced
025	5th & Penn	Chester Creek	39°50'49"N	75°21'50"W	Brown & Brown	Replaced

CSO Regulator No.	CSO Regulator Location	CSO Receiving Water	Latitude	Longitude	CSO Regulator Type	Regulator Replacement Status
026	7th & Penn	Chester Creek	39°50'58"N	75°21'55"W	Brown & Brown	Replaced
032	2nd & Avenue of the States	Delaware River	39°50'34"N	75°21'25"W	No CSO Regulator	Removed Mechanisms
033	Elkington Blvd. and Ridley Creek	Ridley Creek	39°52'22"N	75°22'29"W	No CSO Regulator	See Notes
Notes: - CSO Regulator 010 discharges at Outfall 009. - CSO Regulators 006 ad 007 have been disconnected from CSS and removed from NPDES permit - CSO Regulator 033 has been disconnected from the CSS but had not been removed from NPDES permit at the date of this Report						

replacement of the mechanism, installation of a monitoring system to determine if flow is passing over the CSO regulator diversion weir to the outfall, and conversion of the CSO regulators to Type A. After installation of the first CSO regulator monitoring systems, DELCORA determined that the monitoring system improves system operation and significantly reduces dry-weather overflows by notifying operators at the WRTP that flow is passing over the diversion weir. (If it is not raining, this notification is indication of a dry-weather overflow and DELCORA dispatches a maintenance crew to correct the situation.) After this determination, DELCORA installed the monitoring system on all CSO regulators even though it was not required until the CSO regulator was replaced. DELCORA continues to use this system and it provides critical information to maintain proper operation of the CSO regulators.

As indicated in Table 3-2, the majority of the City's CSO regulators are Brown & Brown type regulators. The original CSO regulators were Type B regulators in which the regulator gate position is controlled by the level in the trunk sewer entering the CSO regulator chamber. As part of its regulator replacement program DELCORA is replacing the regulators with Type A regulators in which the gate position is controlled by the level in the interceptor. This allows for the interceptor to operate at full capacity thus maximizing amount of flow being sent to the WRTP for treatment. Flow that cannot enter the interceptor because it is at capacity, passes over the CSO regulator diversion weir and into the outfall for release to the receiving water.

The updated model includes twenty-five[1] (25) CSO regulators, which were modeled as weirs and orifices. The configuration of CSO regulators was obtained from both record drawings and field surveys.

3.5.3.1 Flow Diversion Structure Components

The key components required for modeling these structures include float-operated gates, orifice plates and diversion weirs. Schematic representations of the flow diversion structures are shown in Figure 3-5. Table 3-2 lists basic information for each of DELCORA's 26 CSO regulators. Appendix A contains the data collected for each CSO regulator structure in the collection system that was utilized in the updated H&H Model. Appendix A, Table A-1, shows the invert elevation of the outfall pipe at the regulator and the invert elevation of the outfall pipe at the receiving stream.

Regulator Gates

Characteristics of the regulator gates were obtained from as-built drawings and field surveys. The gates are rectangular, covering rectangular openings except at Regulator #004, which is circular. The gates open and close based on their associated floats. Settings for opening and closing of the gates based on levels in the float chamber and regulator limit settings were obtained as part of the characterization survey. All regulator gates are modeled as side-type orifices and have been assigned a discharge coefficient of 0.65. For cases where the regulator float and gate have been removed, dry weather flow and some portion of the wet weather flow will pass through the opening previously covered by the now removed gate. Flow through this opening will be modeled as an orifice. When weather flow exceeds the capacity of the orifice, the level in the sewer will continue to rise until it is high enough for a portion of the flow to pass over the weir and discharge through the associated outfall. Regulator gate ID is named according to the CSO regulator points. For example, the regulator gate for CSO regulator 003 is named "REG_003_Gate." A summary of regulator gate characteristics is shown in Appendix A, Table A-2.

Orifices

Most of the regulators include an orifice between the regulator gate and the downstream interceptor. All orifices in the collection system are side orifice type, rectangular in shape and were assigned a discharge coefficient of 0.65. The dimensions are based on record drawings.

A summary of the orifice data used in the model is contained in Appendix A, Table A-3. The updated H&H model has 20 orifices. All orifices are side type and are rectangular in shape. Regulators 004, 015, 017 018 and 032 do not have an orifice plate. Regulators 006, 027 and 033 are no longer connected to the CSS and therefore do not have any orifices, weirs or outfalls included in the H&H model. The orifice ID used in the H&H model is named according to the CSO overflow points. For example, the orifice for CSO 03 is named "REG_03_Orifplate".

Weirs

Characteristics for the diversion weirs were obtained from record drawings and were field verified as necessary. All weirs were found to be of the transverse type with no end contractions. All weirs are assigned a discharge coefficient of 3.33. Weir ID will be named according to the CSO overflow points. For example, the weir for CSO 03 will be named "Weir_03". A summary of the weir data used in the model is contained in Appendix A, Table A-4.

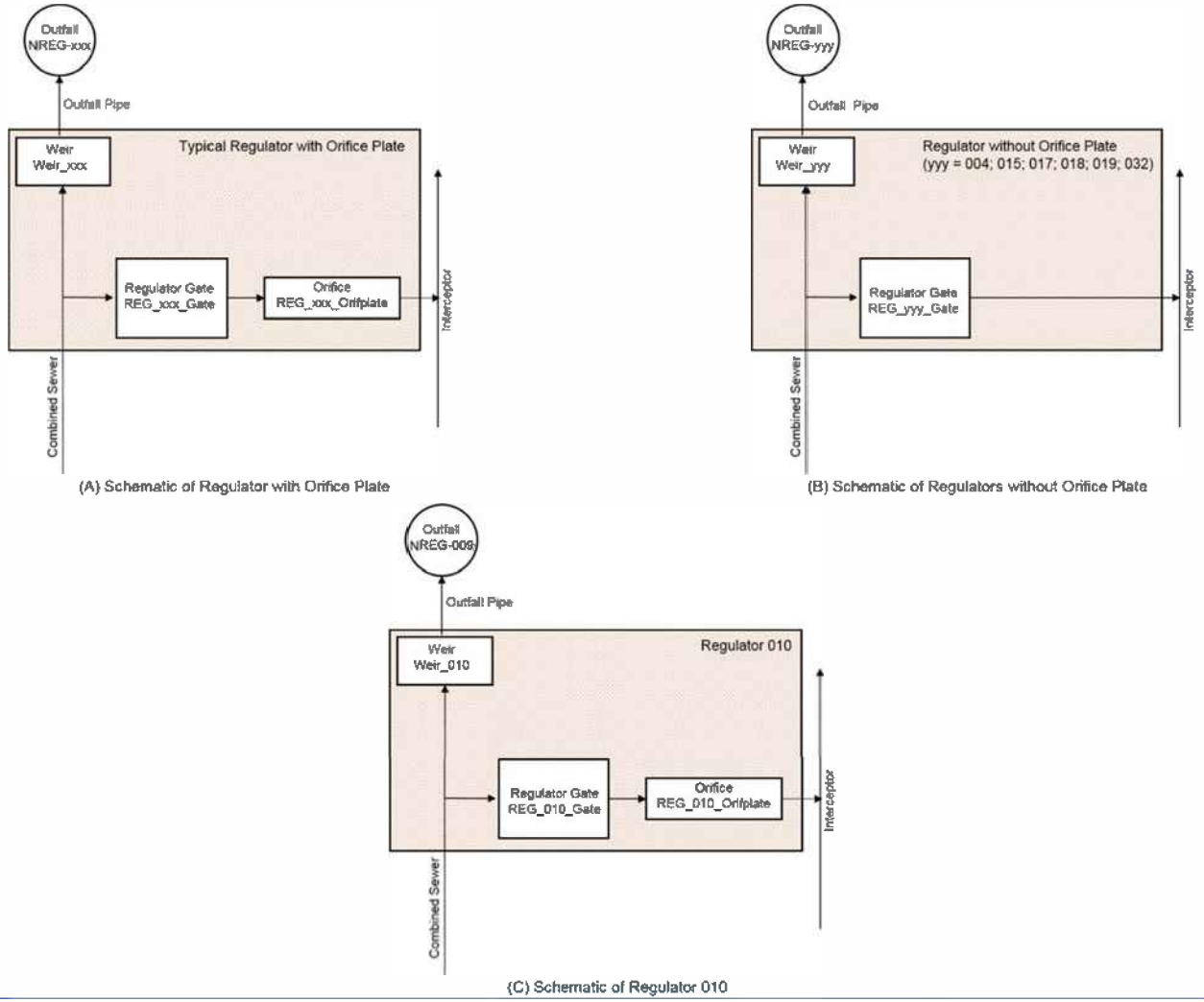
3.5.4 Interceptors

The interceptors convey flow from the CSO regulators to the WRTP or to the Chester Pump Station, which discharges directly to the WRTP. The interceptors shown on Figure 2-3 vary in size from 24" to 72" in diameter. Any flow entering the interceptor system will eventually reach the WRTP for treatment.

Figure 3-3 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO. Specifically as diagrammed in Figure 3-3, the relationship between DELCORA's interceptors and outfalls are as follows:

- The Delaware River Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 002, 003, 004, 005 and 007 into the Booth Street Interceptor that then leads to the WRTP.
- The Second Street Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 008, 009, 011 and 024 to the Chester Pump Station, which is then pumped to the WRTP.
- The West End Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Area 010 into the Booth Street Interceptor and then to the WRTP.
- The Ridley Creek Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 012, 013, 014, 015, 016, 017, 018 and 032 to the Chester Pump Station, which pumps the flow to the WRTP.

Figure 3-5: Flow Diversion Structure Schematic



- The Edgmont Avenue Interceptor conveys dry weather flow and a portion of wet weather flow from CSO Service Areas 021, 022 and 023 into the Ridley Creek Interceptor and from there to the Chester Pump Station and then to the WRTP.
- The Chester Creek East Interceptor and the Chester Creek West Interceptor respectively convey the dry weather flow and a portion of the wet weather flow from CSO Service Areas 019 and 020. These two interceptors then both flow into the Penn Street Interceptor that also conveys the dry weather flow and a portion of wet weather flow from CSO Service Areas 025 and 026 to the Chester Pump Station, which pumps the flow to the WRTP.

3.5.5 CSO Outfalls

Outfalls are the discharge points at the receiving streams. The outfalls can either be free outfalls without any boundary conditions or the outfalls can have a boundary condition that the head needs to overcome for outflow to occur. The outfalls in the DELCORA's collection system are mostly in the tidal river reach. Therefore, appropriate tidal stages from NOAA data were used to set boundary conditions. Outfalls can have a flap gate or other backflow device at the end to prevent backflow.

CSO outfalls will be simulated as outfall nodes in the model. Outfall ID will be named according to the CSO regulator overflow points. For example, the outfall for CSO regulator 002 will be named "NREG-002". The inverts of outfalls were estimated based on record drawings and design drawings.

A summary of the outfall data used in the model is contained in Appendix A, Table A-5. One regulator (Regulator 010) does not have its own outfall, but rather discharges through the same outfall (Outfall 009) as Regulator 009. Also, Regulator 033 has been disconnected from the CSS and, therefore, its outfall is not included in the updated H&H model. As a result, there are a total of 25 CSO outfalls in the updated H&H model.

3.5.6 Drainage Areas and Subcatchments

Each of the 25 CSO regulators has a unique drainage area associated with it. A CSO drainage area is defined as the entire surface area contributing overland wet weather flow to a specific CSO. Subcatchments are smaller drainage basins located within the overall CSO drainage area. Subcatchments are more useful when developing a model, because the area is smaller and it becomes more site-specific. Subcatchment boundaries were determined from sewer system maps and local topography. GIS software was then used to estimate the acreage within a subcatchment boundary. There are a total of 53 subcatchments within DELCORA's 25 drainage areas of the CSS. An overall configuration of the CSS drainage areas is presented in Figure 3-4. This figure shows the boundaries of each of the 25 CSO regulator drainage areas (subcatchments), as well the combined and separated portions of these service areas. Table 3-1 presented a listing of the subcatchment areas associated with each CSO regulator, and the type of collection system (CSS or separated) within the subcatchment.

3.5.7 Percent Imperviousness

Areas that are impervious to rainfall infiltration, like pavement and rooftops, generate the most runoff in urban settings. Percent imperviousness is the fraction or percentage of a particular subcatchment that is covered by impervious materials like parking lots, streets, and rooftops. The percent of directly

connected impervious area is the ratio of hydraulically connected impervious areas (parking lots, streets, etc.) to the total subcatchment area. Directly connected impervious areas are effectively connected to the sewer collection system. As a result, runoff from these areas is completely captured by the collection system. Runoff from the rest of the impervious area is deemed not to be captured by the system due to various potential reasons including, but not limited to, drains to pervious areas/creeks/streams, limited number and capacity of stormwater inlets, and bypassing. For model construction, the percent imperviousness was calculated using the high resolution land cover raster published by the Chesapeake Conservancy (Chesapeake Conservancy, 2017) as well as the land use shapefile published in 2015 by the Delaware Valley Regional Planning Commission as the initial inputs. Then, the impervious percentage values were adjusted during the model calibration process (see Section 7) to best simulate the observed hydrologic response over the selection of precipitation events.

For the separated areas within the City of Chester, the initial percent imperviousness was set at 0% because the impervious area in the separated area is not contributing runoff to the CSS, therefore it is not effectively connected. Subcatchment parameters mentioned hereafter were set at default values for the separated subcatchments.

3.5.8 Depression Storage

Depression storage is the rainfall abstraction volume that must be filled prior to the occurrence of runoff. It represents the loss (initial abstraction) caused by surface ponding, surface wetting, etc. The initial values of depression storage were set to 0.05 for impervious surfaces and 0.15 for pervious surfaces. Typical depression storage values are 0.05-0.10 for impervious surfaces and 0.10-0.30 for pervious surfaces. Depression storage is an empirical value and may be treated as a calibration parameter, especially to adjust runoff volumes.

In the model, the subcatchment was divided into three subareas: pervious area with depression storage, impervious area with depression storage, and impervious area without depression storage. The initial percent of the impervious area without depression storage was set to 0.10.

3.5.9 Soil Infiltration Parameters

Soil information is needed to estimate infiltration in the pervious areas of the CSS. The rate of infiltration is a function of soil properties and antecedent soil conditions. Infiltration parameters influence the runoff hydrograph from the combined sewer system subcatchments by absorbing rainfall into the soil. The infiltration capacity of the soil is exceeded when the soil becomes saturated during continuous simulation and heavy precipitation. When soil saturation is reached, most of the subsequent rainfall becomes runoff making the pervious areas behave as impervious areas.

Three infiltration methods are available in the software: the Horton method, Green-Ampt method, or Natural Resources Conservation Service (NRCS) Curve Number method. The Horton method has been extensively used for similar type of modeling work and it was used in this modeling effort to estimate infiltration. The required soil parameters for Horton method include:

- Maximum Infiltration rate (in/hr)
- Minimum Infiltration Rate (in/hr)

- Decay Constant (/hr)
- Drying time (d)
- Maximum Infiltration Volume Possible (inch)

To determine the Horton infiltration parameters, a soil map was first obtained from the NRCS (USDA, 2017). The soil types were then correlated to standard hydrologic soil groups.[4] A map of the hydrologic soil groups found in the CSS is presented in Figure 3-6. Hydrologic soil groups found in DELCORA's CSS are groups A, B, C, B/D and C/D. Horton's infiltration parameters for these soil groups were estimated based on typical values from literature and are shown in Table 3-3.

Table 3-3: Horton Infiltration Parameters

Horton Infiltration Parameter	Soil A	Soil B	Soil C	Soil B/D	Soil C/D
Max Infiltration Rate (in/hr)	5	3	2	2	1.5
Min Infiltration Rate (in/hr)	1.18	0.43	0.2	0.22	0.06
Decay Constant (1/hr)	4	4	4	4	4
Drying Time (d)	2	3	8	8	10.5
Max Volume (in)	14	13.2	12.5	9.8	7.0

3.6 Collection System Pump Stations and Force Mains

Major pump stations in the Western Service Area and the Central Delaware Pump Station in the Eastern Service Area were added to the updated model, as well as force mains connecting the pump stations to the WRTP. The list of the pump stations included in the H&H Model is as follows:

- Chester PS (CPS)
- Existing PS-1 (EPS-1)
- Marcus Hook PS (MHPS)
- Naamans Creek PS (NCPS)
- Eddystone PS (EDPS)
- Central Delaware PS (CDPS)
- Chester Ridley Creek PS (CRPS)
- Sun Oil PS (Owned by Sunoco) (SPS)
- Kimberly Clark PS (Owned by KC) (KCPS)

[4] Soil types can be categorized into standard hydrologic soil groups A, B, C and D, with group A having the lowest runoff potential and group D having the highest runoff potential. Dual rated groups are group D in their natural state, but can behave according to the first letter if the area is drained. Additional information regarding hydrologic soil group descriptions can be found in the Appendix.

The following pump stations were excluded from the H&H Model:

- Price & Smith Street Trainer PS
- Stadium PS

Flow from the Price & Smith Street Trainer PS discharges to the downstream existing PS-1 Pump Station (EPS-1) where it is re-pumped. The updated H&H model assumes that all flow from subcatchments associated with the Price and Smith Street Trainer PS can be treated as an input to EPS-1.
Flow from the Stadium PS is sanitary sewage with no wet weather flow. The Stadium PS discharges flow only during events held at the stadium. Due to the limited flow, its sporadic nature and the lack of wet weather flow, the Stadium PS is expected to have negligible effect on the wet weather capacity of the CSS. Therefore, the Stadium PS was not included in the H&H Model.

DELCORA owns or operates a number of lift stations that contribute to the Western Service Area and whose flows are handled by the above list of pumps stations. It was determined that the behavior of these lift stations would not require modeling and that inflow can be assumed to equal outflow to the downstream conduit.

Figure 3-7 presents a map of the pump stations that are included within the updated H&H model.

3.6.1 Force Mains

DELCORA's Model Area include several force mains to convey flow from various pump stations to the WRTP.

- Chester Force Main
- Central Force Main
- Chester-Ridley Creek Force Main
- Naaman's Creek Force Main
- Marcus Hook/Sun Oil Force Main
- Eddystone Force Main
- Kimberly Clark Force Main.
- Existing Pump Station Force Main

The 40-MGD Chester Pump Station discharges to the Chester Force Main which then runs to the WRTP as a 54-inch diameter ductile iron force main.

The Central Delaware Pump Station (CDPS) discharges through two force mains, one of which connects to the Model Area and the WRTP while the other delivers flow to PSWPCP. The force main to the Model Area is referred to as the Central Force Main and is a 3.4-mile, 24-inch ductile iron force main which subsequently connects to the Chester Force Main. This connection allows DELCORA to send up to 27 MGD of flow from the CDPS to the WRTP, however, DELCORA's operating policy limits this flow to 20 MGD, with flows above this point to be directed to PSWPCP. Only the force main connecting to the Model Area is included in the updated H&H model.

A schematic representation showing the force mains can be found in Figure 3-3. A map showing the location of the force mains is depicted in Figure 3-8.

Figure 3-6: Hydrologic Soil Groups for CSS Area

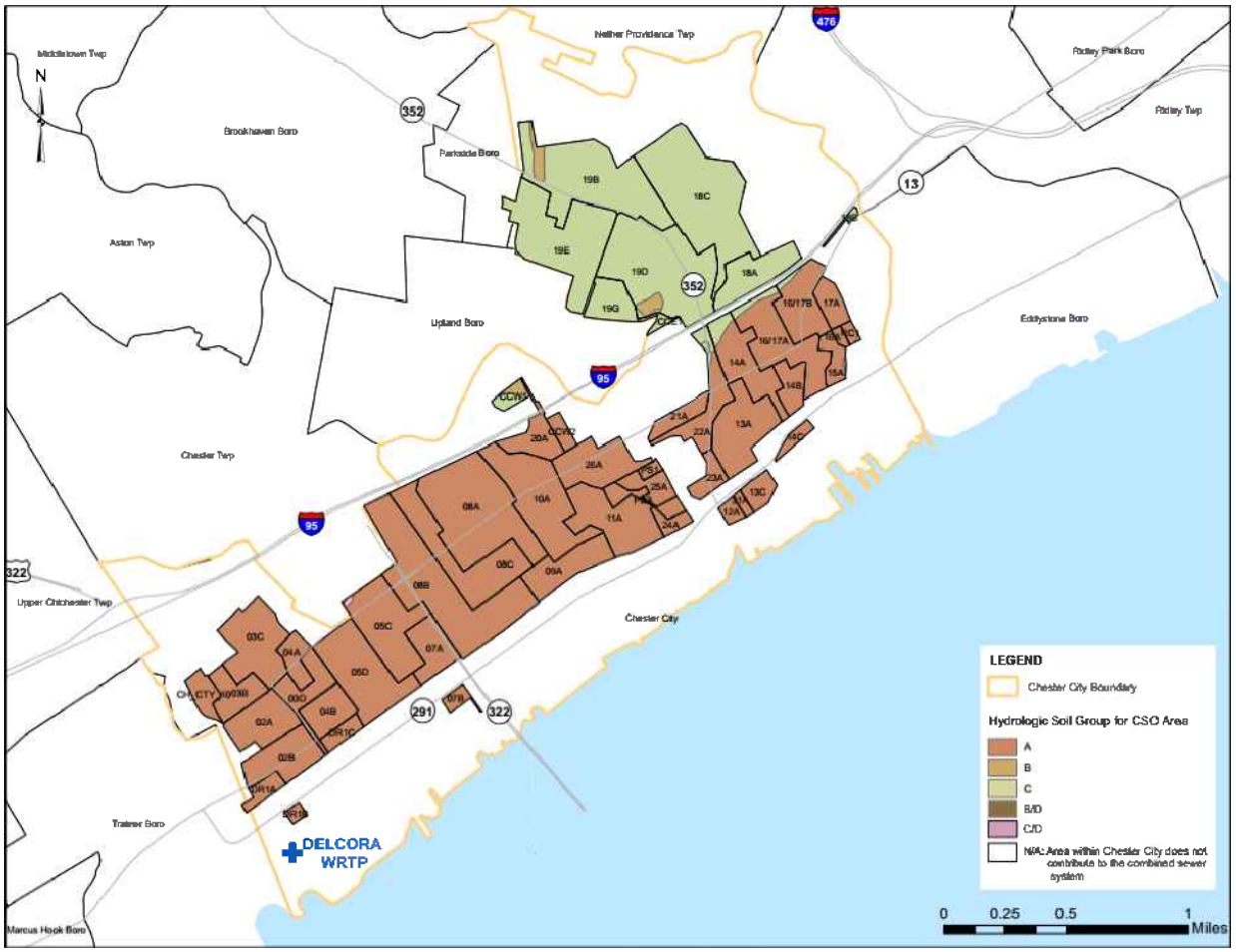


Figure 3-7: Pump Stations Included in the H&H Model

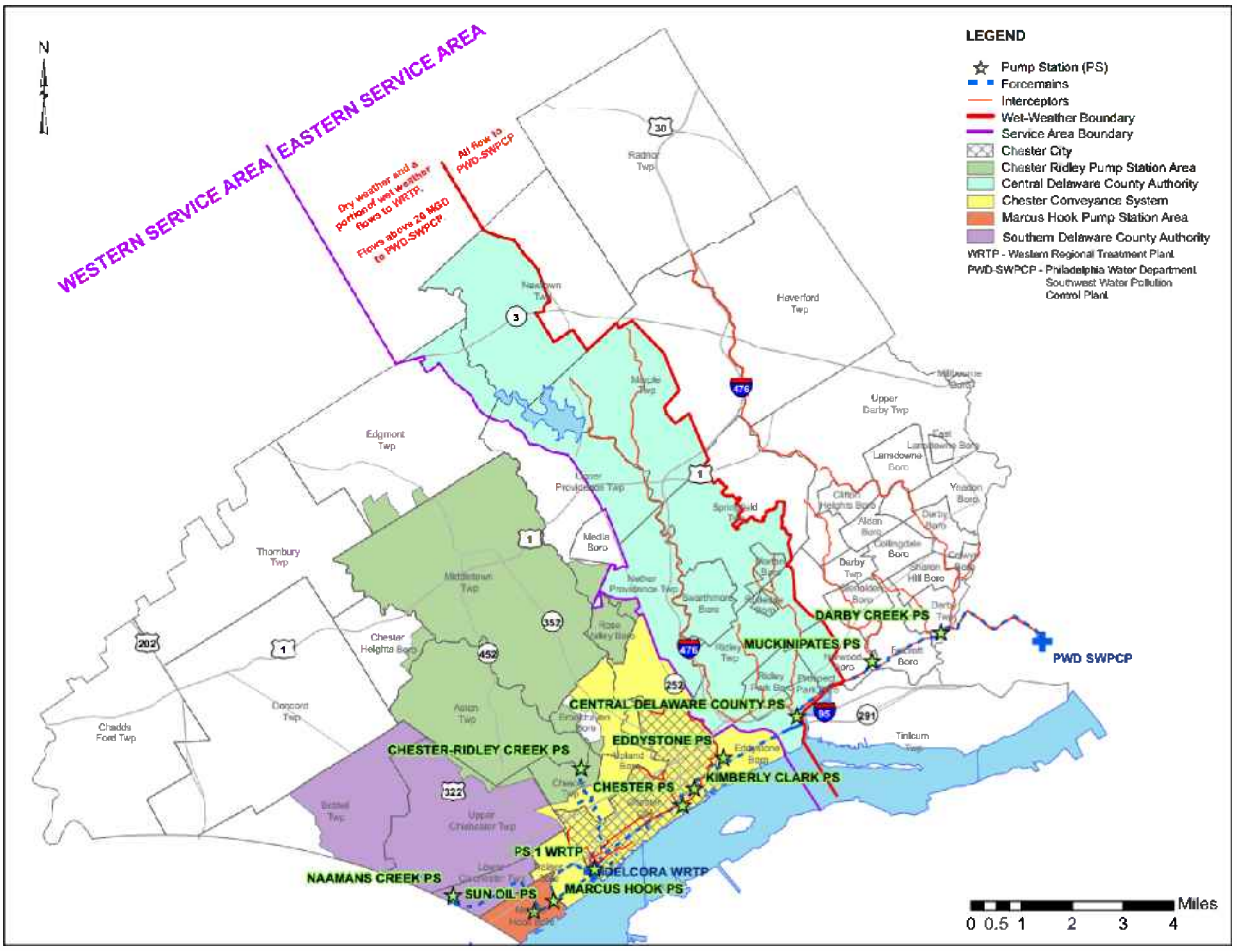
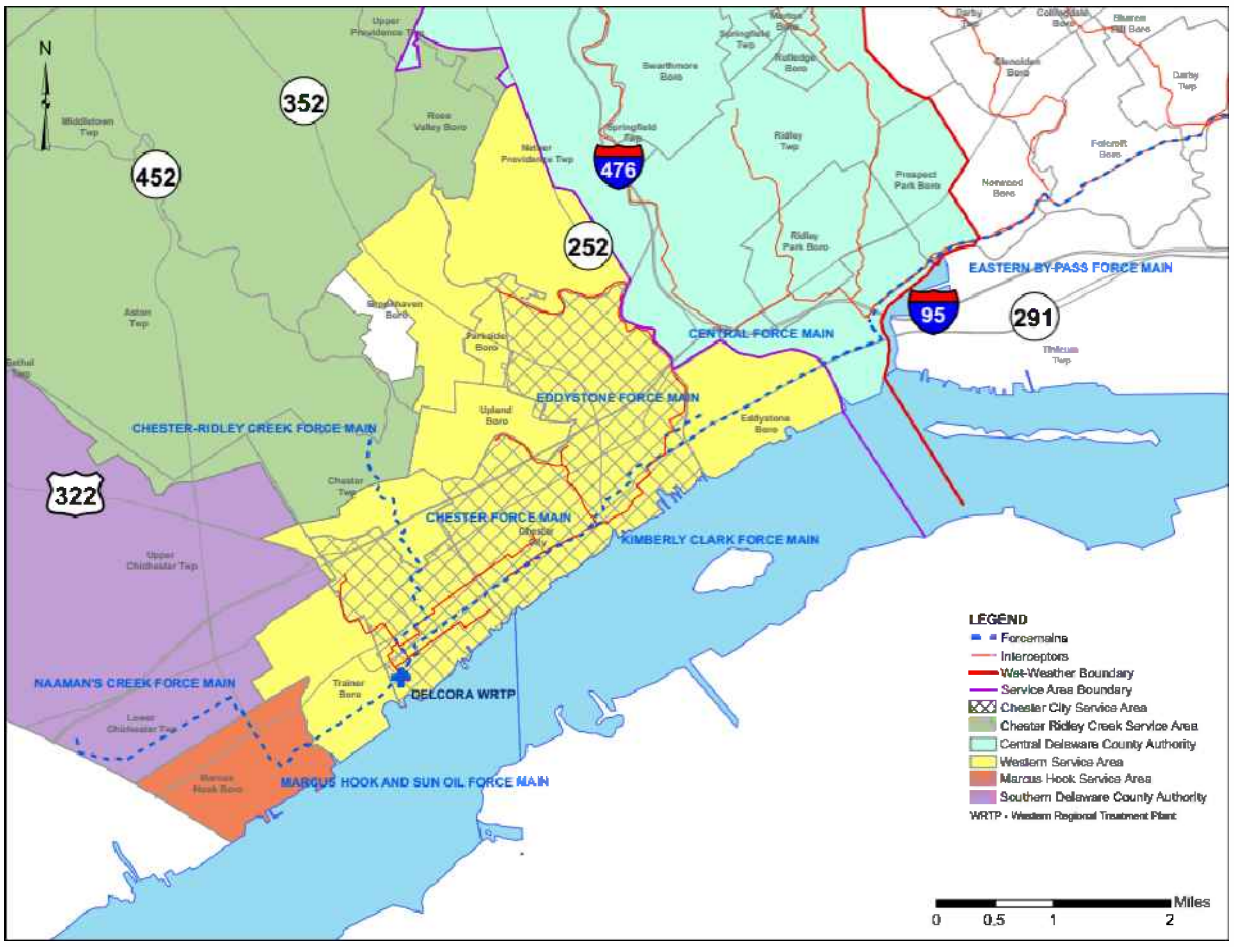


Figure 3-8: Force Mains



Section 4 Collection of Precipitation and Sewer Flow Data

4.1 Introduction

This section presents information on the collection of precipitation and sewer flow data to meet the requirements of Section V.A.14.d of the Consent Decree, and Paragraphs II.A.C.1.a and b of the USEPA's CSO Control Policy. Section V.A.14.d of the Consent Decree requires DELCORA to conduct rainfall monitoring in accordance with current good industry practice for a period of at least (12) months.

The rainfall and flow monitoring program was developed to provide adequate data for the development, calibration and validation of the H&H Model. The goals of this program were met by collecting rainfall and flow monitoring data for just over 12 months, from March 18, 2016 to April 4, 2017. Rainfall and flow monitoring data were collected on a monthly basis with quarterly reports were submitted to US EPA on August 28, 2016; November 1, 2016; February 1, 2017; and May 1, 2017. DELCORA considers Consent Decree requirements to be met due to no comments from US EPA and PA DEP.

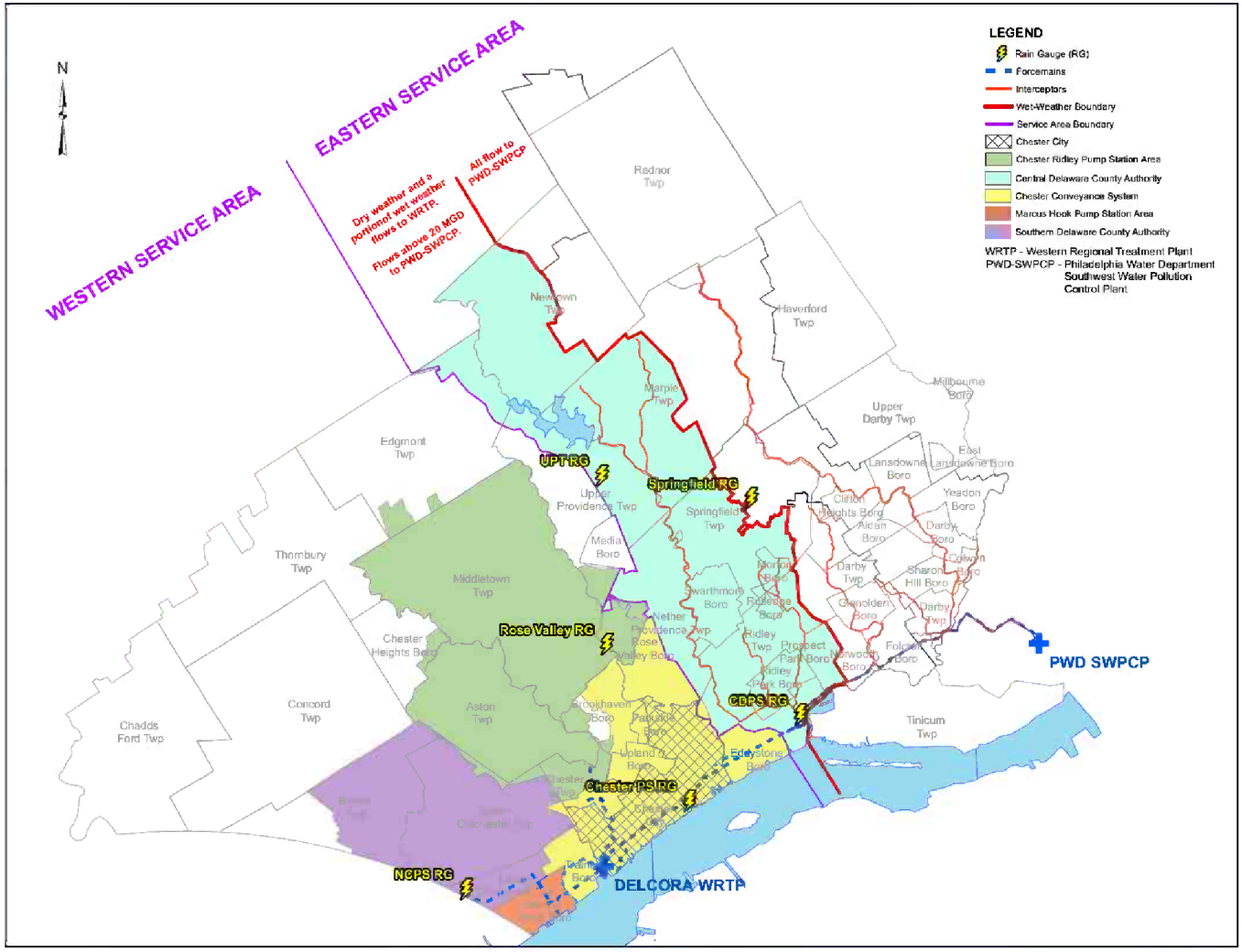
After it was carefully reviewed and analyzed, the data was deemed adequate to facilitate the development, calibration and validation of the H&H Model. This section contains a summary of the rainfall and flow monitoring program and discusses the network of rainfall and flow monitoring instrumentation, outlines the monitoring program, and describes how the data collected for the rainfall and flow monitoring program was analyzed for use in the H&H Model calibration and validation. Additional details can be found in the rainfall and flow monitoring quarterly reports, in the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015), and in the *Sewer System Hydrologic and Hydraulic Model Report* (Greeley and Hansen, 2017c).

4.2 Rainfall Monitoring and Analysis

A total of six (6) rain gauges were used for the monitoring program. As depicted in Figure 4-1, the gauges are stationed at the following locations:

- Rose Valley
- Chester Pump Station (CPS)
- Naaman's Creek Pump Station (NCPS)
- Springfield
- Upper Providence Township (UPT)
- Central Delaware County Pump Station (CDPS)

Figure 4-1: Rain Gauge Locations



Five out of six of the gauges provided data at 5 minute intervals. One rain gauge provided data on 15-minute intervals. The gauge rainfall data from the six rain gauges installed throughout the DELCORA service area was analyzed and used to:

- Document rainfall and flow monitoring locations,
- Overview flow monitoring data quality,
- Analyze rainfall data to identify dry weather and wet weather conditions and to characterize individual rainfall event for precipitation depth, duration, maximum intensity, and return frequency,
- Analyze flow data to determine dry weather flow and diurnal pattern, wet weather flow and peak factor, and system response to wet weather events, and
- Determine the wet weather events for H&H Model calibration and validation.

An inter-event time of 48 hours was used to identify individual rainfall events. The inter-event time specifies the minimum duration in which precipitation does not occur. Based on this criterion, a dry weather time period and the number of total rainfall events were identified. The rainfall events during the flow monitoring periods had a wide variation in terms of total depth, intensity, duration, and antecedent conditions to provide a large dataset for balanced model calibration and validation.

4.3 Rain Event Summary

The rainfall events were characterized by event start time, event end time, rainfall depth, duration, maximum intensity, and return frequency. As an initial screening criterion, rainfall events with a minimum of 0.9 inches of rainfall were identified. Further screening based on requiring at least two dry days prior to the event resulted in an initial list of ten (10) candidate events for calibration and validation as listed in Table 4-1 below.

Table 4-1: Top 10 Rainfall Events

Event	Event Start	Event End	Chester-PS Rainfall (in)	Duration (hr)	Max Intensity (in/hr)
E1	5/29/16 19:00	5/30/16 5:00	1.82	11.00	0.78
E2	9/28/16 12:00	9/30/16 10:00	2.36	47.00	0.37
E3	11/29/16 7:00	11/29/16 20:00	1.08	14.00	0.21
E4	3/30/17 21:00	4/1/17 3:00	1.83	31.00	0.25
E5	5/21/16 11:00	5/22/16 21:00	1.71	35.00	0.33
E6	7/28/16 15:00	7/29/16 9:00	1.26	19.00	0.74
E7	9/19/16 8:00	9/19/16 16:00	0.96	9.00	0.42
E8	3/13/16 18:00	3/14/16 14:00	1.08	21.00	0.25
E9	5/6/16 4:00	5/7/16 11:00	1.18	32.00	0.24
E10	10/8/16 14:00	10/9/16 11:00	1.00	22.00	0.15

4.4 Gauge-Adjusted, Radar Estimated Precipitation

According to the Consent Decree, rainfall data to be used for calibration and validation of the model *"…shall be obtained at a minimum effective density of 1 gauge/virtual radar-based gauge per kilometer"*. In order to achieve this density, Gauge-Adjusted Radar Rainfall (GARR) was employed. The rain gauges used to complete the flow monitoring program and choose the wet weather events used in calibration and validation were also used in the GARR analysis which provided effective spatial coverage of the entire Model Area. GARR data was provided for each of the subbasins in the Model Area. This rainfall data was input as a time series into the H&H Model for calibration and validation. An in-depth explanation of the use of GARR data in both the H&H Model and the Water Quality Model can be found in the *Sewer System Hydraulic and Hydrologic Report* and the *Water Quality Monitoring and Modeling Quality Assurance Project Plan*, respectively (Greeley and Hansen, 2017c), (Greeley and Hansen, 2017b).

4.5 Flow Monitoring

DELCORA owns and operates a flow monitoring network across the DELCORA Service Area. The monitoring network includes various types of flow meters located throughout DELCORA's Eastern Service Area and Western Service Area, at the WRTP, in each of the Pump Stations, and at the tie-in points where other municipal collection systems tie-into the collection system. Seven existing flow meters in the separated area (outside the CSO area), eight existing flow meters at pump stations and one existing flow meter at WRTP were used for the calibration and validation of the H&H Model. In addition, temporary flow meters were installed at 38 new locations to characterize surface runoff from the combined area and CSO discharges. The locations of flow meters installed specifically for the flow monitoring program and the H&H Model calibration and validation can be categorized into the following five categories:

1. Located on the influent pipe to CSO regulators, this is to measure the influent flow to CSO regulators and for combined area runoff calibration. Sixteen (16) meters were installed for this category.
2. Located on the effluent pipe and overflow pipe of CSO regulators, this is to measure the CSO overflows and calibrate CSO regulator parameters. Twelve (12) meters were installed for this category. They are on the effluent and overflow pipe of CSOs 02, 03, 05, 08, 14, & 19.
3. Located on the side-line from the combined areas (flows from the combined area tie into interceptor instead of CSO regulator). This is to measure flows from the combined area and to calibrate combined area runoff parameters. Two (2) meters were installed for this category.
4. Located upstream of the combined area, this is to measure flows from the upstream separated area for RDII characterization. Three (3) meters were installed for this category.
5. Located in the main interceptors to measure level and flows in the major interceptors. Five (5) meters were installed for this category.

Table 4-2 lists the flow meter locations and location categories of the meters. Figures 4-2 and 4-3 show the locations of the flow meters that were used for H&H Model calibration and validation. After initial installation of the new temporary flow meters, difficulties were encountered at Manhole MH3029. The site was severely surcharged during field investigation. Meanwhile it was found that at Manhole MH3002 (four manholes upstream of MH3029, approximately 800 feet upstream) another existing flow meter (Ridley Creek MH-28) was already installed for DELCORA. Instead of installing a new temporary flow meter around the site, the existing meter Ridley Creek MH-28 was used for the flow monitoring program.

Data was gathered from a total of 55 flow meters, 38 of which were newly installed as part of the flow monitoring program.

Table 4-2: Flow Monitoring Locations

Flow Meter	Approximate Location	Category
In-02	Influent pipe to CSO 02 Regulator	On the influent pipe to regulator
In-03	Influent pipe to CSO 03 Regulator	On the influent pipe to regulator
In-05	Influent pipe to CSO 05 Regulator	On the influent pipe to regulator
In-08	Influent pipe to CSO 08 Regulator	On the influent pipe to regulator
In-09	Influent pipe to CSO 09 Regulator	On the influent pipe to regulator
In-10	Influent pipe to CSO 10 Regulator	On the influent pipe to regulator
In-11	Influent pipe to CSO 11 Regulator	On the influent pipe to regulator
In-13	Influent pipe to CSO 13 Regulator	On the influent pipe to regulator
In-14	Influent pipe to CSO 14 Regulator	On the influent pipe to regulator
In-16	Influent pipe to CSO 16 Regulator	On the influent pipe to regulator
In-17	Influent pipe to CSO 17 Regulator	On the influent pipe to regulator
In-18	Influent pipe to CSO 18 Regulator	On the influent pipe to regulator
In-19-1	Influent pipe to CSO 19 Regulator (from East)	On the influent pipe to regulator
In-19-2	Influent pipe to CSO 19 Regulator (from West)	On the influent pipe to regulator
In-25	Influent pipe to CSO 25 Regulator	On the influent pipe to regulator
In-26	Influent pipe to CSO 26 Regulator	On the influent pipe to regulator
INT- 2nd St	2nd Street Interceptor	On the interceptor pipe
INT-DRI	Delaware River Interceptor	On the interceptor pipe
INT-Ridley 2	Ridley Creek Interceptor	On the interceptor pipe
INT-Ridley 3	Ridley Creek Interceptor	On the interceptor pipe
INT-West End	West End Interceptor	On the interceptor pipe
Side-1	Side line on Penn St. to 2nd St. Interceptor	On the side-line from the combined area
Side-2	Side line on Highland Ave. to West End Interceptor	On the side-line from the combined area
Sep-1	Upstream of the CSO 02 Drainage	On the separated area
Sep-2	Upstream of the CSO 05 Drainage	On the separated area
Sep-3	Upstream from Upland Borough	On the separated area
Sep-4 (Existing MH-28 after first quarterly report)	Upstream from Eastern Chester	On the separated area
CSO-02	Outfall pipe from CSO 02 Regulator	On the outfall pipe

Flow Meter	Approximate Location	Category
CSO-03	Outfall pipe from CSO 03 Regulator	On the outfall pipe
CSO-05	Outfall pipe from CSO 05 Regulator	On the outfall pipe
CSO-08	Outfall pipe from CSO 08 Regulator	On the outfall pipe
CSO-14	Outfall pipe from CSO 14 Regulator	On the outfall pipe
CSO-19	Outfall pipe from CSO 19 Regulator	On the outfall pipe
Eff-02	Effluent pipe for CSO-02 Regulator	On the effluent pipe
Eff-03	Effluent pipe for CSO-03 Regulator	On the effluent pipe
Eff-05	Effluent pipe for CSO-05 Regulator	On the effluent pipe
Eff-08	Effluent pipe for CSO-08 Regulator	On the effluent pipe
Eff-14	Effluent pipe for CSO-14 Regulator	On the effluent pipe
Eff-19	Effluent pipe for CSO-19 Regulator	On the effluent pipe
BR MH-1 (Existing)	Upstream from Brookhaven MH-1	On the separated area
BR MH-3 (Existing)	Downstream from Brookhaven MH-3	On the separated area
BR MH-5 (Existing)	Downstream from Brookhaven MH-5	On the separated area
BR MH-6 (Existing)	Downstream from Brookhaven MH-6	On the separated area
RC MH-26 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
RC MH-30 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
RC MH-32 (Existing)	Ridley Creek Interceptor	On the interceptor pipe
WRTP (Existing)	At WRTP	At WRTP

Figure 4-2: DELCORA Flow Meters

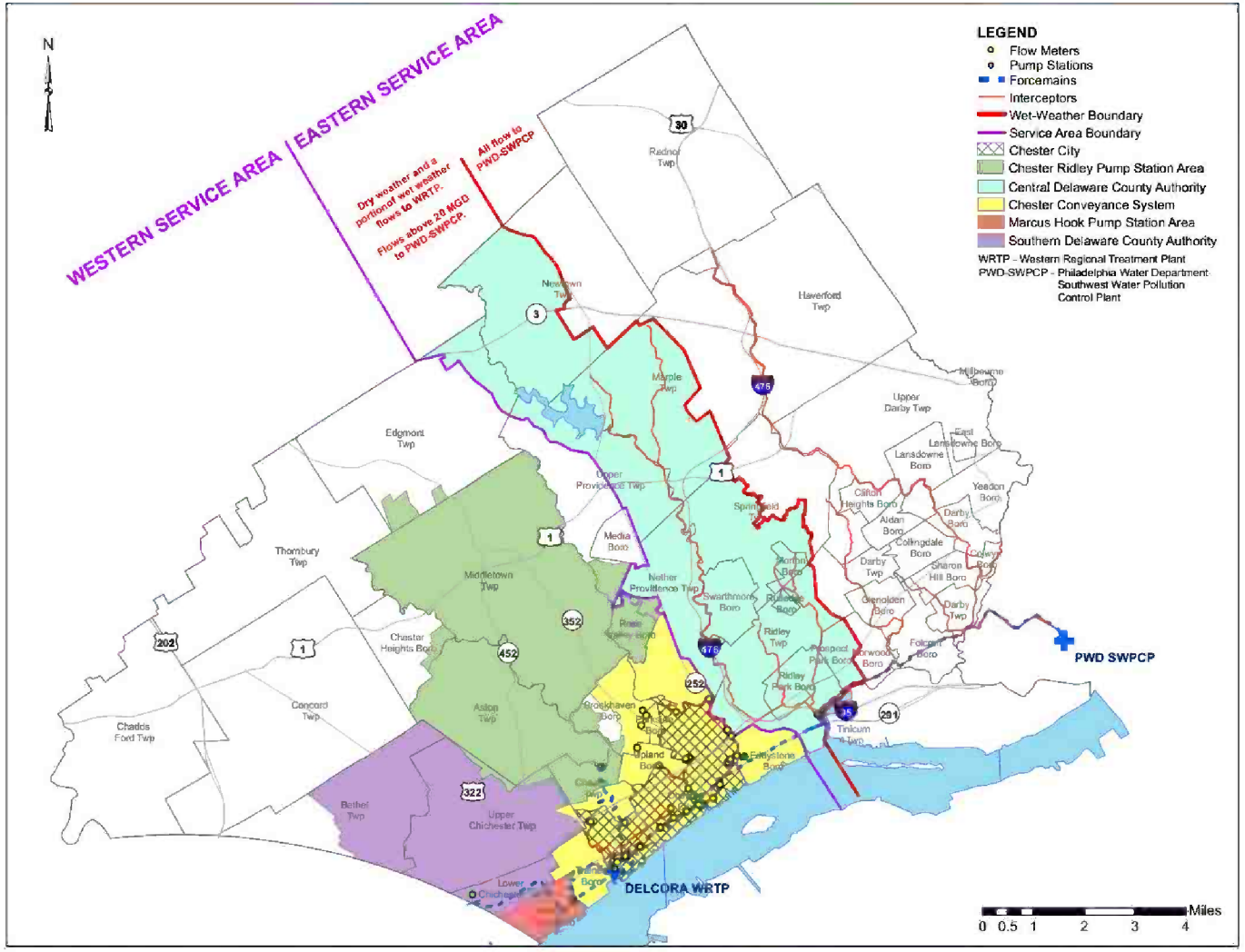
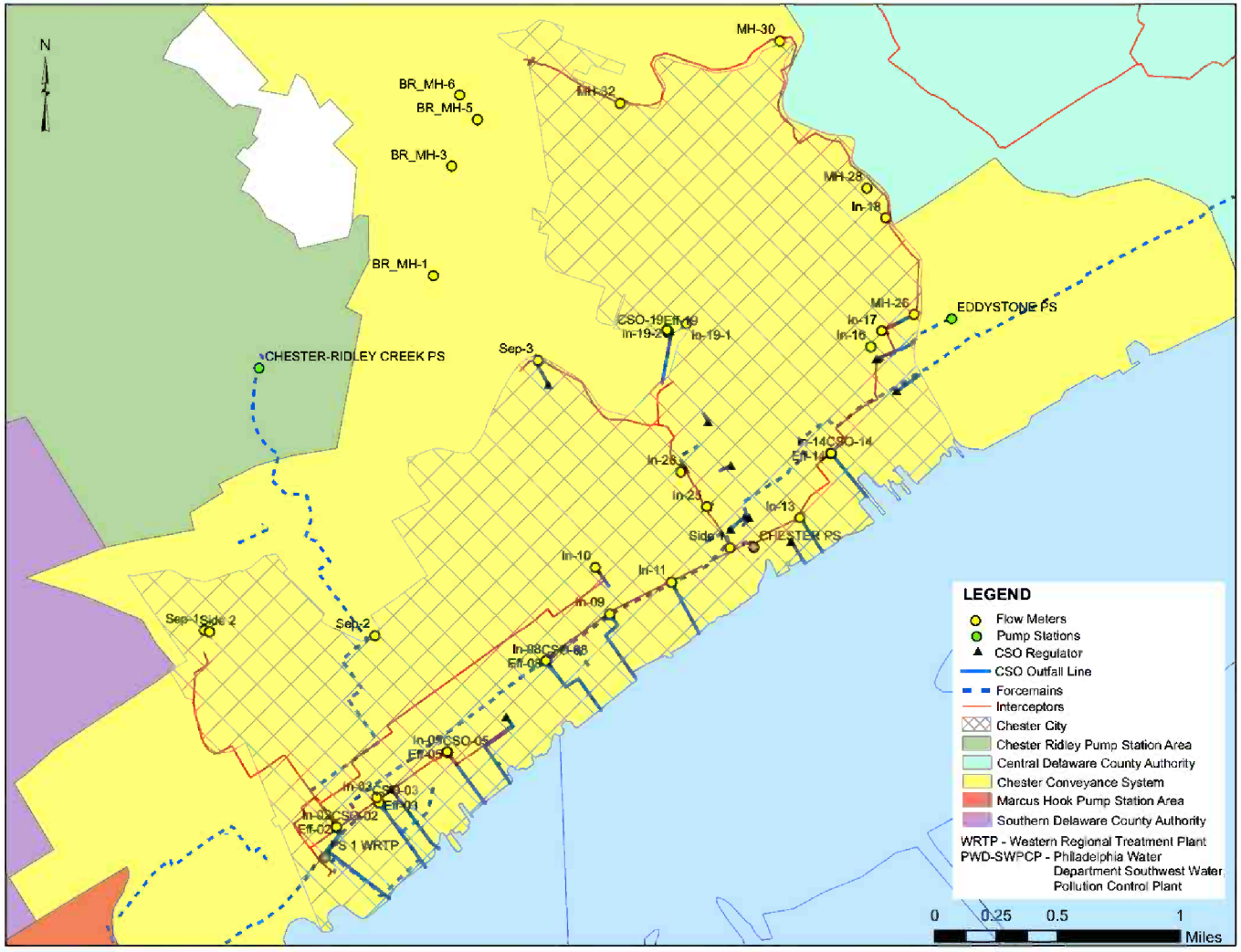


Figure 4-3: Enlarged Map of Flow Meters



The network of flow meters can be grouped to define metersheds where flow from a given area discharges through a common flowmeter. Subcatchments associated with each metershed are shown in Table 4-3 along with the associated metershed acreage. Rainfall and flow data gathered for each metershed will be used to calibrate the associated subcatchments in the H&H Model.

Table 4-3: Metersheds in the H&H Model

Metershed ID	Subcatchment ID	Metershed Area (ac)
BR_MH-1	BR_TWP_2	49
BR_MH-3	BR_TWP_3	236
BR_MH-5	BR_TWP_4	21
BR_MH-6	BR_TWP_5	44
In-02	02A	112
	02B	
	SC1	
In-03	03B	82
	03C	
	03D	
In-05	05C	161
	05D	
	CH_TWP_2	
In-08	08A	237
	08B	
	CH_CTY_12	
In-09	09A	27
In-10	10A	60
In-11	11A	44
In-13	13A	50
	13C	
In-14	14A	53
	14B	
	14C	
In-16	16A	2
In-16,In-17	16/17A	77
	16/17B	
In-17	17A	12
In-18	18A	130
	18B	

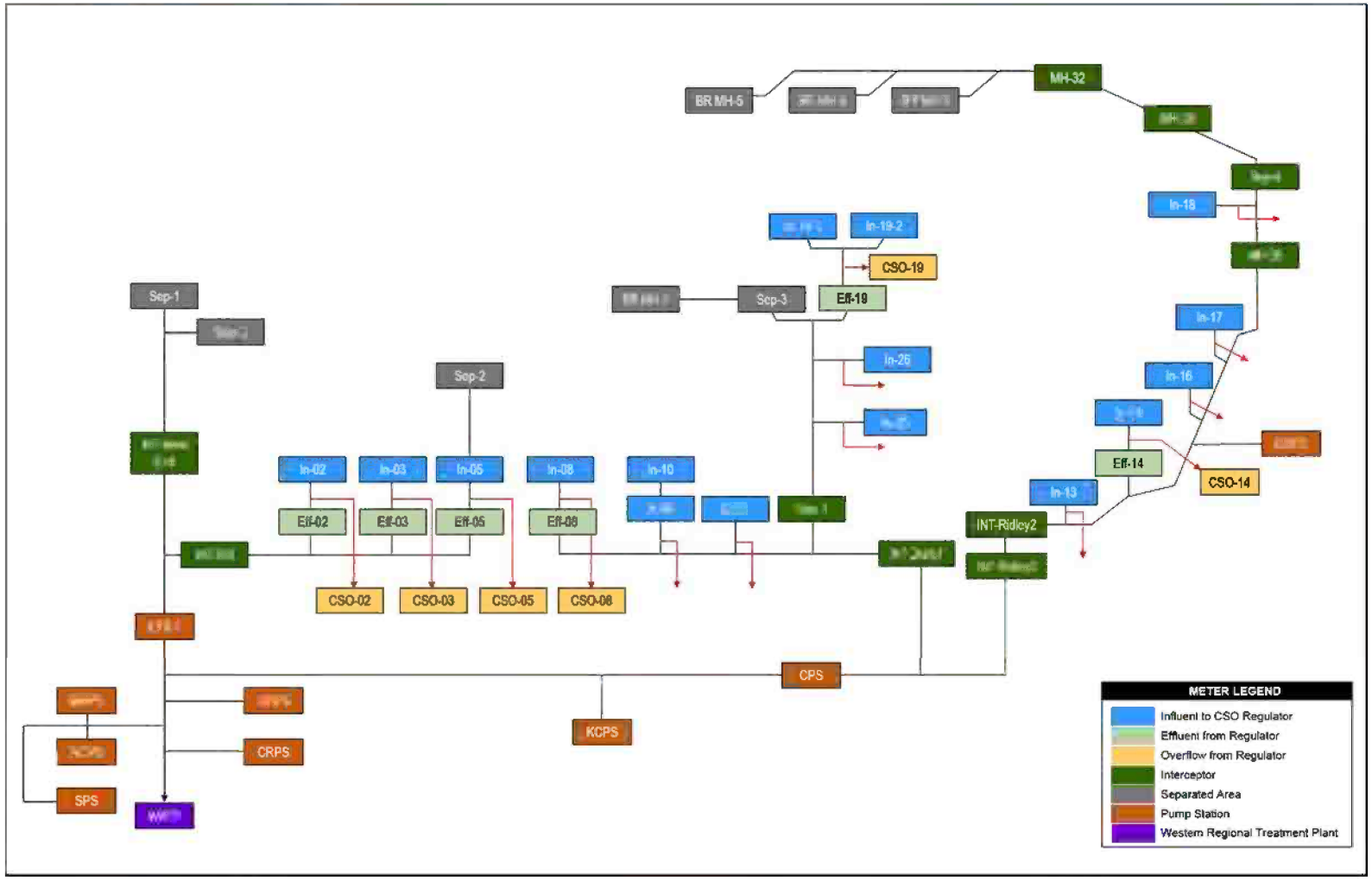
Metershed ID	Subcatchment ID	Metershed Area (ac)
	18C	
In-19-1	18C	327
	CH_CTY_08	
	19B	
	19D	
	PA_BORO_1	
In-19-2	19E	94
	19G	
In-25	25A	12
In-26	26A	37
	26B	
INT-2nd St	24A	6
INT-DRI	04A	57
	04B	
	07A	
	07B	
INT-Ridley 2	15A	16
	31A	
	RC1	
INT-Ridley 3	21A	53
	22A	
	23A	
	12A	
INT-West End	DR1A	26
	DR1C	
	CH_CTY_10	
MH-26	CH_CTY_07	44
MH-28 (Sep-4)	CH_CTY_04	137
MH-30	CH_CTY_06	1,035
	NP_TWP_2	
MH-32	PA_BORO_2	531
	33A	
	BR_TWP_6	
	CH_CTY_05	
Central PS (PS-1)	CH_CTY_02	514

Metershed ID	Subcatchment ID	Metershed Area (ac)
	CH_CTY_03	
Eddystone PS (PS-10)	EDD_BORO_1	664
Marcus Hook PS (PS-11)	LC_TWP_1	1,401
	MH_BORO_1	
Naamans Creek PS (PS-15)	BE_TWP_1	6,528
	UC_TWP_1	
Chester Ridley Creek PS (PS-24*)	EDG_TWP_2	14,513
	MI_TWP_1	
	NP_TWP_3	
	RV_BORO_1	
	UPR_TWP_2	
	AS_TWP_1	
	BR_TWP_7	
	CH_BORO_1	
	CH_TWP_4	
	UC_TWP_3	
Existing PS-1 (PS-3)	TR_BORO_1	1,001
	DR1B	
	CH_CTY_01	
Central Delaware PS Total and Central Delaware PS to WRTP (PS-7)	EDG_TWP_1	18,806
	MA_TWP_1	
	MO_BORO_1	
	NE_TWP_1	
	NP_TWP_1	
	PR_BORO_1	
	RI_TWP_1	
	RP_BORO_1	
	RU_BORO_1	
	SP_TWP_1	
	SW_BORO_1	
	UPR_TWP_1	
Sep-1	CH_TWP_3	296
	UC_TWP_2	
Sep-2	CH_CTY_09	45
	CH_TWP_1	

Metershed ID	Subcatchment ID	Metershed Area (ac)
Sep-3	BR_TWP_1	480
	CH_CTY_13	
	PA_BORO_3	
	UPL_BORO_1	
Side-1	20A	52
	CCE1	
	CCW1	
	CCW2	
	PS1	
	PS3	
	CH_CTY_11	
Side-2	BS3	32
	BS2	

A schematic of the collection system was created to facilitate the development, calibration and validation of the H&H Model and is shown below as Figure 4-4. The schematic illustrates the relationship between all major trunk sewers, force mains, interceptors, pump stations, and other major appurtenances. The schematic also includes the location of the flow meters, and provides and good understanding of the relationship between them. Figures of the diversion structure configurations were also developed to help give a better understanding of the collection system.

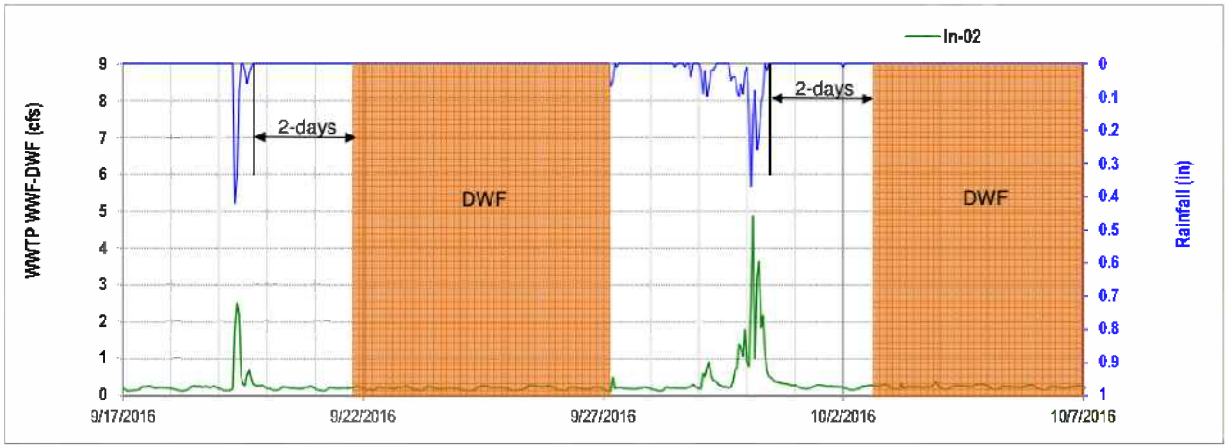
Figure 4-4: Flow Monitoring Schematic



4.6 Dry Weather Flow (DWF) Analysis

A "dry weather" condition was defined as a period with no precipitation that begins 48 hours after the last wet weather event ends and lasts until the beginning of the next precipitation event (i.e. the rain gauge read a 0.01 inch value). Dry weather flow (DWF) periods based on this definition are illustrated in the hydrograph shown in Figure 5-4.

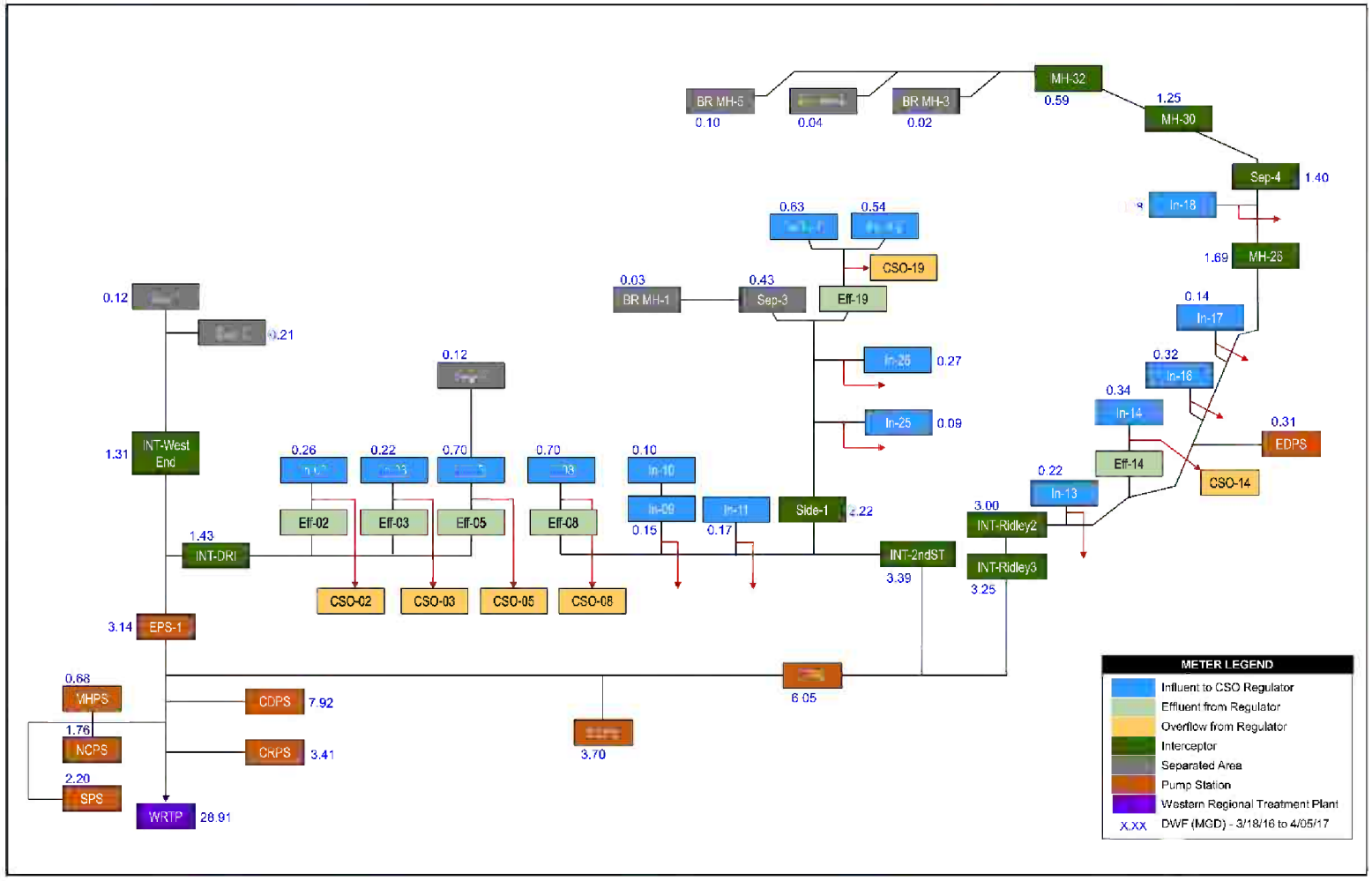
Figure 4-5: Hydrograph to Show Dry Weather Flow



Overall hourly average DWF was calculated by taking the average of the monitored DWF for each hour during the flow monitoring period. Monthly DWF was calculated by averaging the DWF for each month during the flow monitoring period. The overall hourly and monthly DWFs for all monitoring sites were analyzed and used as inputs in the H&H Model.

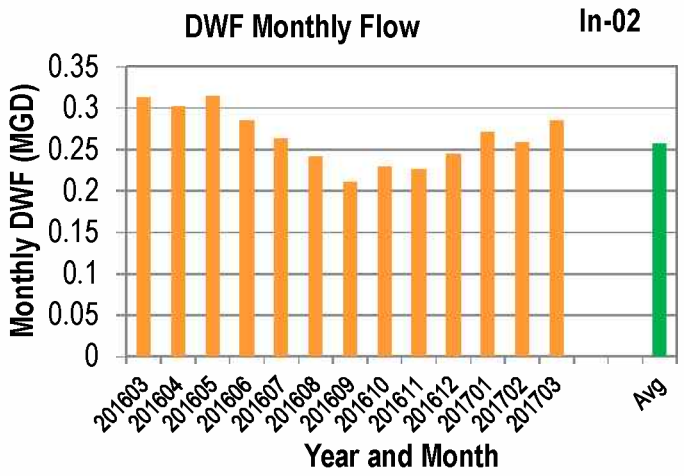
The DWFs for the one year monitoring period are also shown in the schematic in Figure 4-6. Each value displayed next to each flow meter represents the DWF overall average (in MGD) for one quarter. These values were ultimately averaged and input into the model as the overall annual average DWF. Generally the downstream dry weather flow is greater than the upstream locations for all of the meters. For meters immediately upstream and downstream of CSO regulators, the upstream and downstream dry weather flows should be similar.

Figure 4-6: Dry Weather Flow Balance Schematic



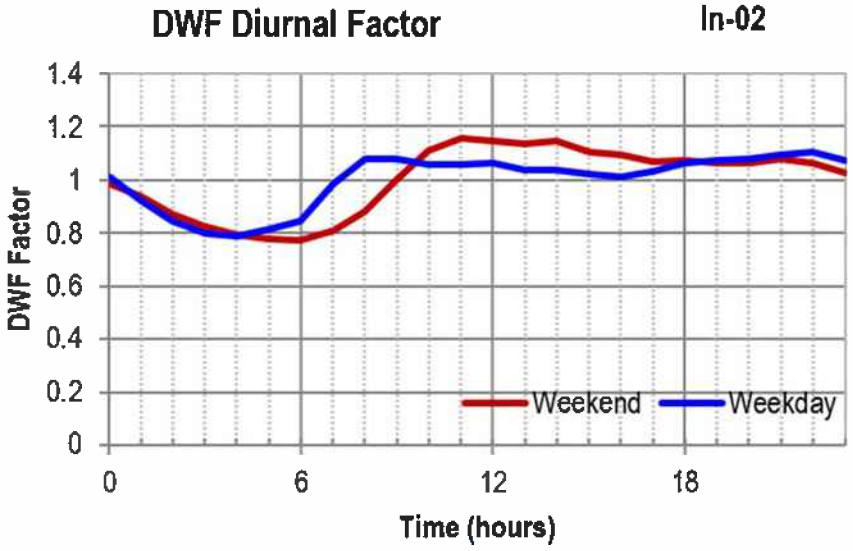
Monthly DWFs were calculated during the DWF analysis by averaging the overall DWF during each month. Average monthly DWFs were input into the model along with the overall annual averages for each flow meter. Figure 4-7 below shows the monthly DWFs input into the model for meter In-02.

Figure 4-7: Average Monthly DWF



The DWFs vary throughout the day, with the highest flows normally occurring around noon and the lowest rates between midnight and early morning. Flow data from the dry weather periods were used to develop a diurnal pattern for each flow meter. Diurnal patterns were analyzed for both weekdays and weekends. In the plot shown on Figure 4-8, the weekend DWF peak and valley have a 3-hour lag compared to the weekday pattern. The weekday and weekend diurnal patterns were input into the model along with the overall annual average values discussed above.

Figure 4-8: Weekday and Weekend Dry Weather Flow Diurnal Pattern

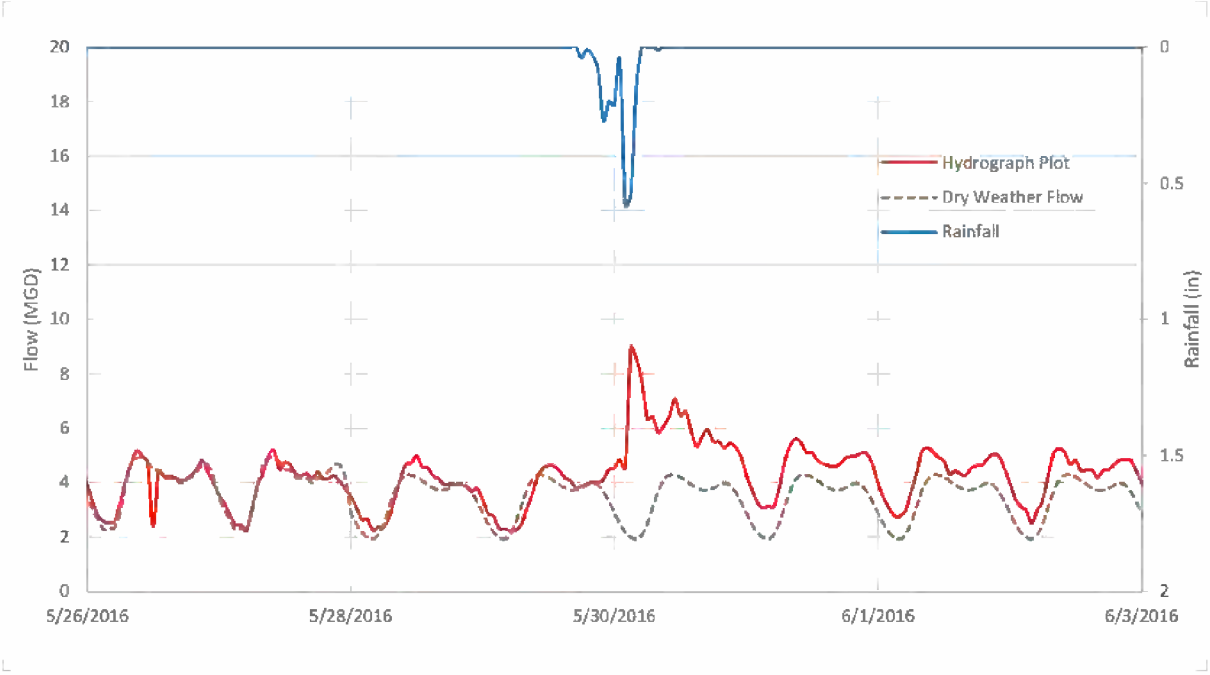


4.7 Wet Weather Flow Analysis

Wet weather flows are the combination of dry weather flows and additional flows that enter the system during wet weather conditions. The additional flows are from combined area surface runoff and RDII. Inflow normally occurs when rainfall enters the system through direct connections such as roof leaders, yard drains, catch basins, sump pumps, manhole covers and frame seals or indirect connections with storm sewers. Inflow is usually recognized graphically by large magnitude, short duration spikes immediately following a rain event. Infiltration occurs during wet weather conditions when water enters a sewer system from the ground through means which include, but not limited to, deteriorated pipes, pipe joints, connections, or manholes. It is significantly influenced by the size and duration of the rainfall event. Infiltration is often recognized graphically by a gradual increase in flow after a wet weather event. The increased flow typically sustains for a short period after rainfall has stopped and then gradually drops off.

The peaking factor represents the ratio of the peak wet weather flow to the average dry weather flow. Usually, an hourly peaking factor is used to represent the wet weather peaking factor. Peaking factors were analyzed for each flow monitoring site. The peaking factors in the separated area can be used to determine the extent of the RDII within a particular basin. Figure 4-9 is a flow hydrograph plot showing an hourly peaking factor of approximately 4.5 for the monitoring site. This high peaking factor indicates that a significant amount of RDII enters the collection system. The immediate flow increase shortly after the rainfall indicates significant inflow into the collection pipes, and the long tail back to the base flow indicates infiltration occurrence at the site as well.

Figure 4-9: Hydrographs of Flow Meters in Separated Area (Example Plot)



4.8 Wet Weather Event Selection for Model Calibration and Validation Flow Analysis

Based on the rainfall and flow monitoring data analysis, the rainfall events shown in Table 4-4 were selected for model calibration and validation. The events were selected from the top ten rain events that are shown in Table 4-1. The calibration and validation events cover variations in terms of rainfall depth, intensity, duration and antecedent conditions.

Table 4-4: Calibration and Validation Rainfall Events

Event	Start	End	Chester-PS Rainfall (in)	Duration (hr)	Max Intensity (in/hr)
E1	5/29/16 19:00	5/30/16 5:00	1.82	11.00	0.78
E2	9/28/16 12:00	9/30/16 10:00	2.36	47.00	0.37
E3	11/29/16 7:00	11/29/16 20:00	1.08	14.00	0.21
E4	3/30/2017 21:00	4/1/20170 3:00	1.83	31.00	0.25
E5	5/21/16 11:00	5/22/16 21:00	1.71	35.00	0.33
E6	7/28/16 15:00	7/29/16 9:00	1.26	19.00	0.74

Storms were chosen from the top ten rain events based first on their accumulation, with larger depths being preferred. But, if a rain event had a preceding storm, it was lowered in rank. Events with varying durations were chosen so that variations in length of time of a storm could be calibrated in the model. Higher intensity storms were chosen over lower intensity storms. But, again, if an event had a preceding storm, it was lowered in rank.

The amount of rainfall that accumulated at the Chester Pump Station rain gauge during event 2 was the largest at 2.36 inches. Event 2 also had the longest duration at 47 hours. However, event 1 had the highest intensity at 0.78 inches per hour.

4.9 Flow Monitoring Data Summary

The majority of the flow meters measured flow, level and velocity data for each flow monitoring site at 5-minute intervals, other flow meters measured the same parameters in 15 minute intervals. Metering data was analyzed for dry weather flows (DWF) and wet weather flows (WWF) for each monitoring site.

The DWF was ultimately used as inputs into the model. Overall annual average DWFs, average monthly DWFs, and weekday and weekend diurnal patterns were input into the model for each flow meter in the combined area. The WWF were used to calibrate the model output. Model data was compared side by side with metered data for each wet weather event for each flow meter.

4.10 Collection of WRTP Operational Data

In addition to flow data collected from the flow meters located in the collection system, flow data from DELCORA's WRTP influent flow meter was obtained for the same time period. A summary of the plant flow data is shown in Figures 4-10-through 4-13.

Figure 4-10: DELCORA WRTP Influent Flow

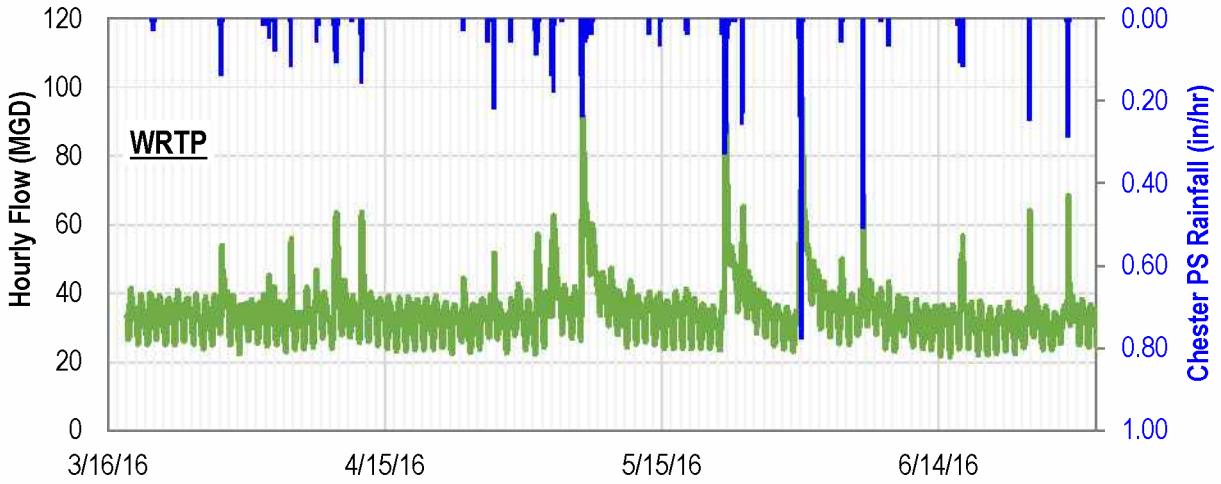


Figure 4-11: DELCORA WRTP Influent Flow

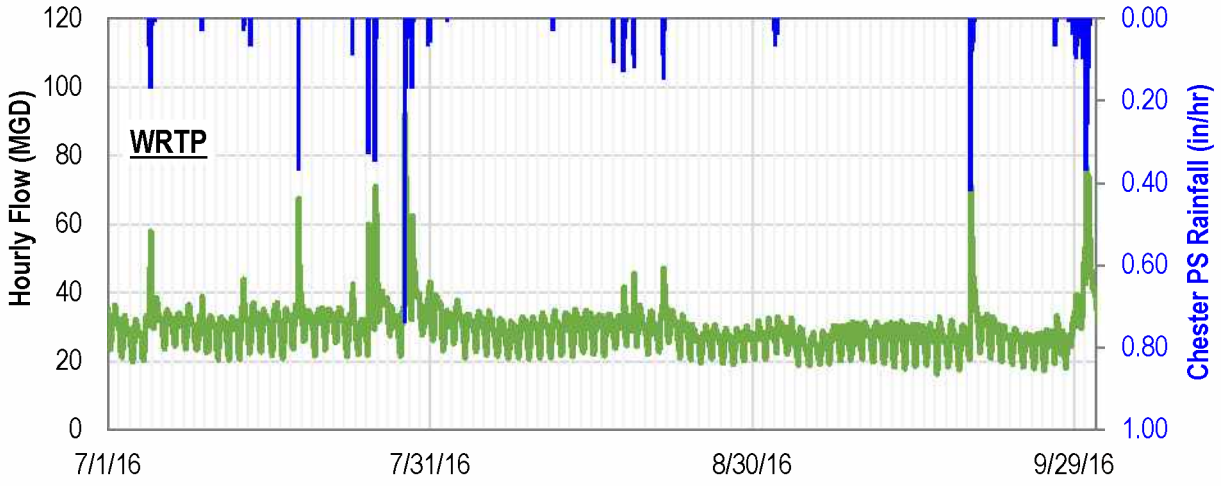


Figure 4-12: DELCORA WRTP Influent Flow

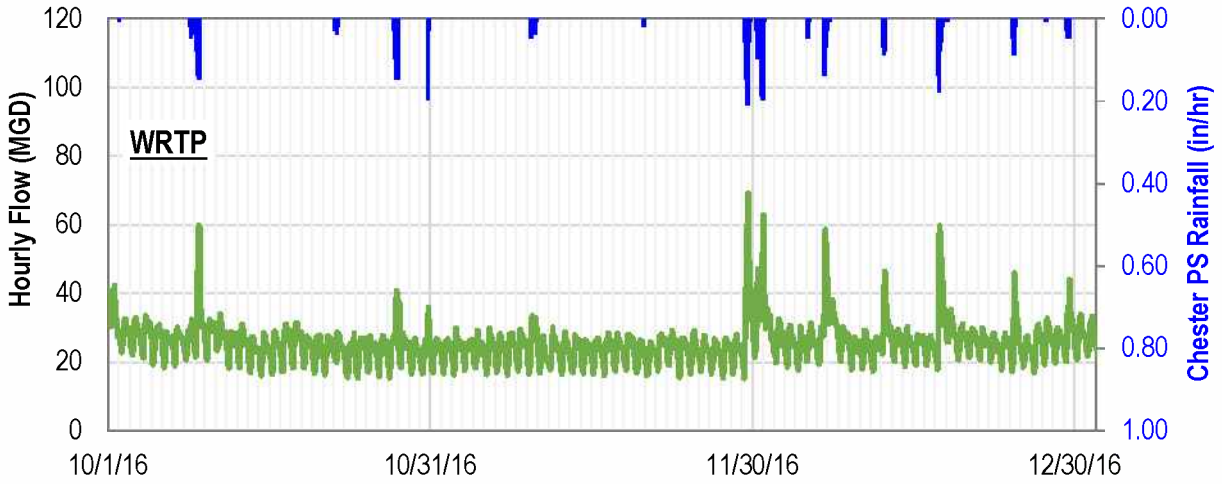
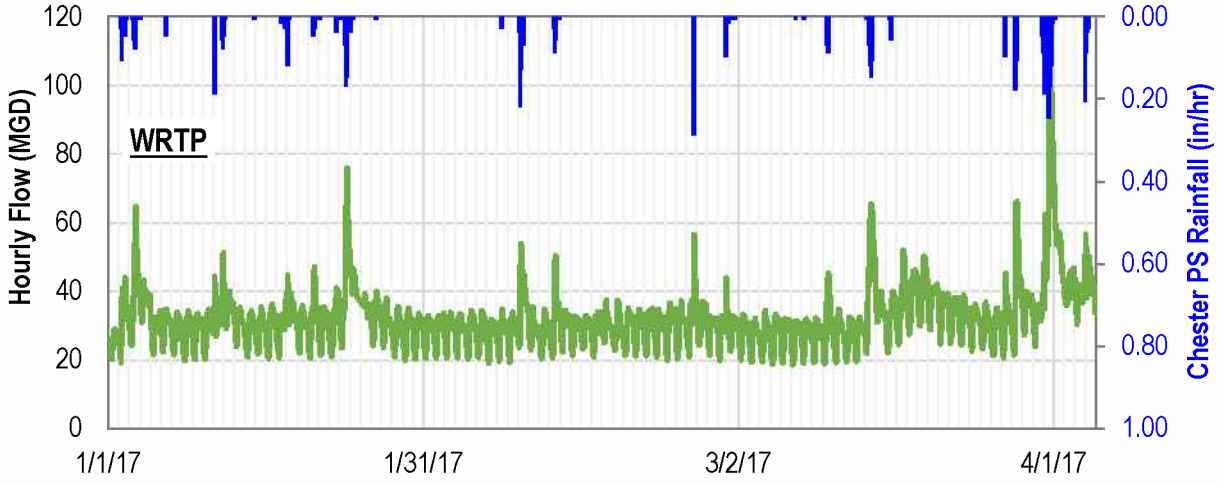


Figure 4-13: DELCORA WRTP Influent Flow



4.11 Summary

The rainfall and flow monitoring program was developed to provide adequate data for the development, calibration and validation of the H&H and Water Quality Models. The goals of this program were met with the collection of the flow monitoring and rainfall data for more than 12 months.

Rainfall data was collected for five rain gauges throughout the Model Area. The Chester rain gauge was analyzed to determine which wet weather events would be used for model calibration. All rain gauge data was ultimately compared with GARR data as a quality check. The GARR data was input into the model as rainfall data.

The flow meter data was analyzed based on the rainfall patterns and then input into the model as overall annual average DWF, average monthly DWFs, and weekday and weekend diurnal curves for each meter in the combined area. To calibrate the model, model-generated data was compared to the metered-data hydrographs for each wet weather event for each flow meter.

Section 5 Characteristics of the Receiving Waters

5.1 Physical Characteristics

The CSS discharges to portions of the Delaware River and two of its tributaries, Chester Creek and Ridley Creek. These receiving waters are located in the tidal portion of the Delaware River Basin, which stretches from the mouth of the Delaware Bay (River Mile 0) to Trenton (River Mile 133.4). The segment of the Delaware River directly impacted by DELCORA's CSO discharges is Zone 4, which extends from River Mile 78.8 to River Mile 95.0 (see Figure 5-1). Chester Creek is located at River Mile 82.93 and Ridley Creek at River Mile 83.8. These creeks are tidally influenced tributaries to the Delaware River. For Chester Creek, the tidal portion extends from the mouth of the tributary at Delaware River upstream to Kerlin Street in Chester City while for Ridley Creek, the tidal portion extends from the mouth of the tributary at the Delaware River upstream to MacDade Boulevard in Chester City (PAFBC, 2017).

In March 2017, an elevation (bathymetric) survey was conducted by LimnoTech for the lower portions of Chester and Ridley Creeks. Figure 5-2 shows the transect locations where elevation measurements were collected. Reaches surveyed included the lower 2.75 miles of Chester Creek and 3.25 miles of Ridley Creek to their discharge into the Delaware River. Transects were collected on ¼-mile interval spacing. Access to the creeks on the upper portions, generally greater than 1 mile upstream, was by wading where the bottom was shallow and firm. The portions below 1 mile were too deep and soft to be accessed on foot and a john boat with tagline was utilized.

Each creek cross section was surveyed at approximately five locations across the bed, water surface, bank toe, and bank top. Access to the entire upland bank at transect locations was not always possible; so the closest points safely accessed to the bank toe were surveyed.

Elevation measurements from this survey were compared with similar elevation data from a 1977 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) of the creeks (FEMA, 2015). Though the FEMA study was completed several decades ago, it serves as a useful check on the accuracy and sufficiency of the bathymetric survey data. Figures 5-3 and 5-4 compare the LimnoTech survey data with the FEMA data.

In Chester Creek, the LimnoTech bed elevations are substantially higher (about five to ten feet) than FEMA elevations. Higher contemporary creek elevations influence both the degree of tidal exchange in the lower reaches of the creeks, and travel times of upland runoff and base flow to the Delaware River. To check for potential bias in the LimnoTech measurements, the LimnoTech measurements of water surface elevation were compared to similar data maintained by NOAA at a nearby tide gage (Philadelphia gage, #8545240). These measurements of water surface elevation agreed well (within two inches) which is a strong indication that the LimnoTech creek bed elevations are not biased high.

Figure 5-1: Zones of the Delaware River and Bay

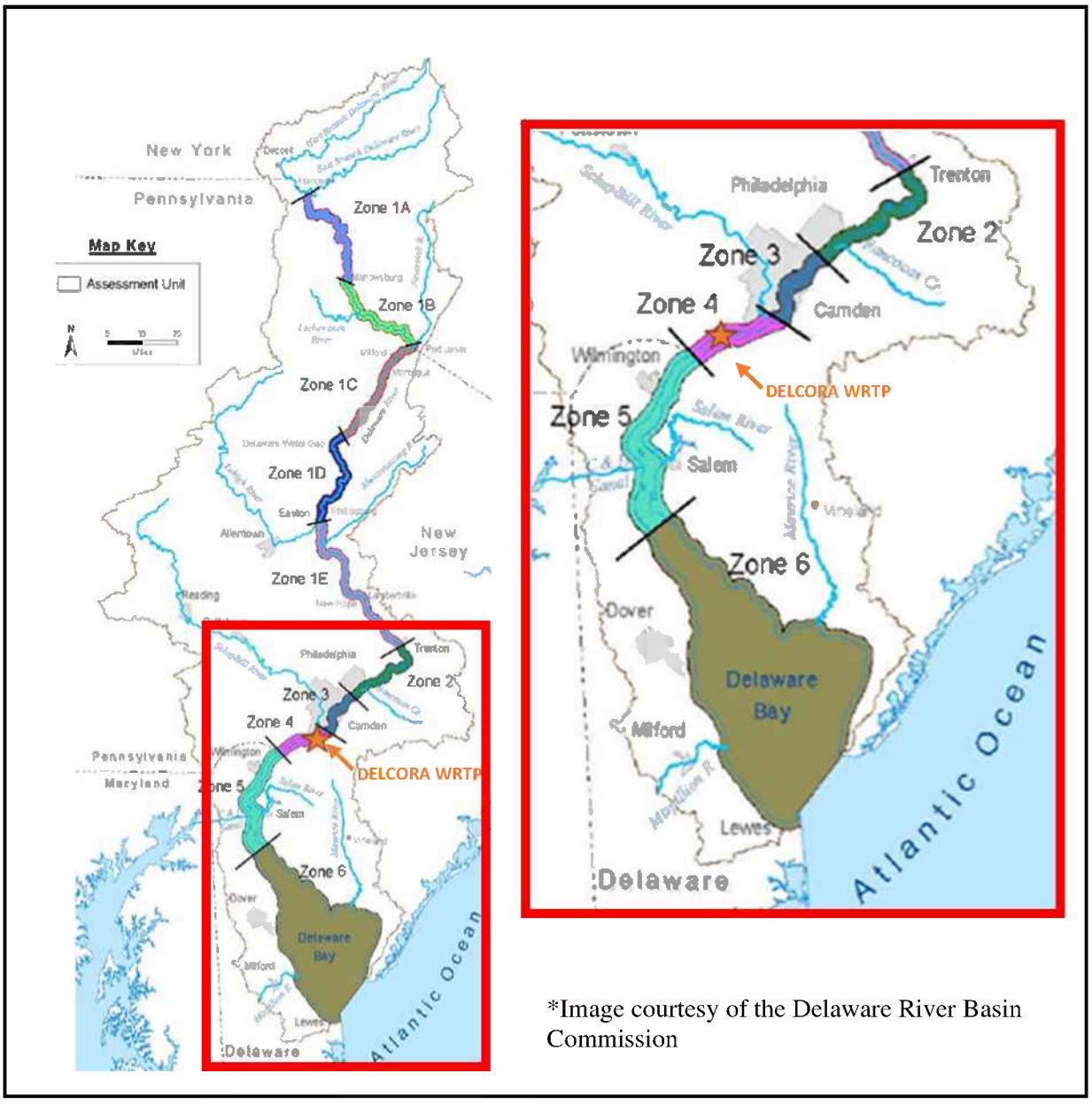


*Image courtesy of the Delaware River Basin Commission

Figure 5-2: Locations of Creek Elevation Measurements in Chester and Ridley Creeks

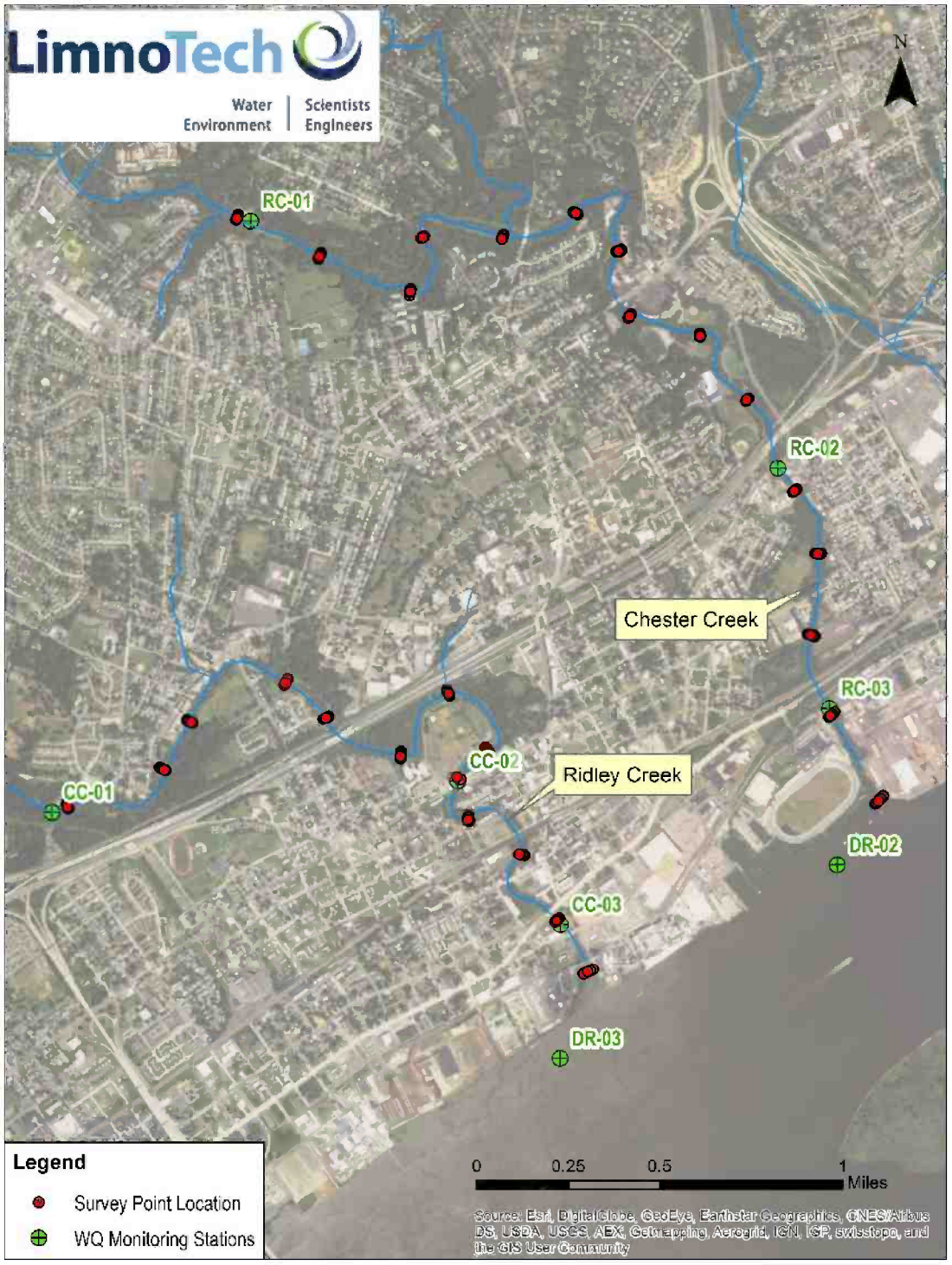


Figure 5-3: Comparison of Chester Creek bed elevation measurements

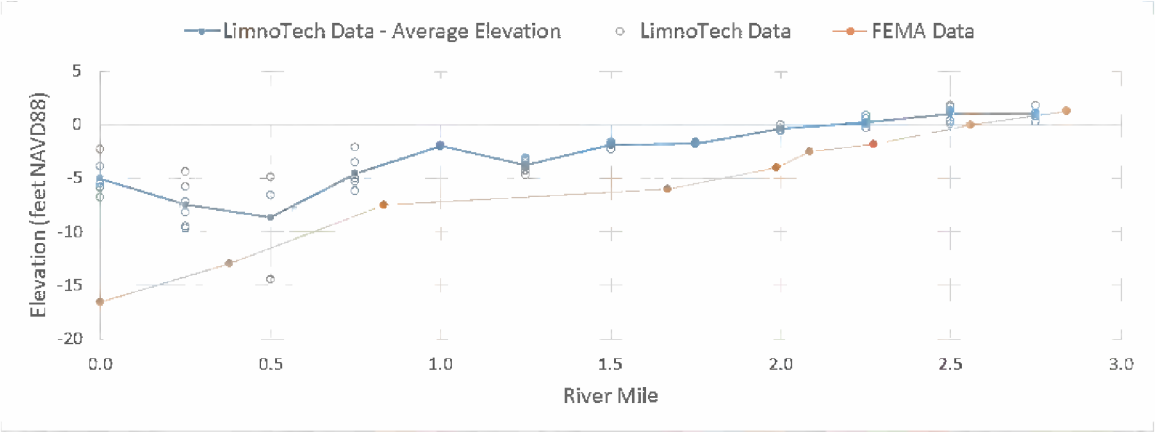
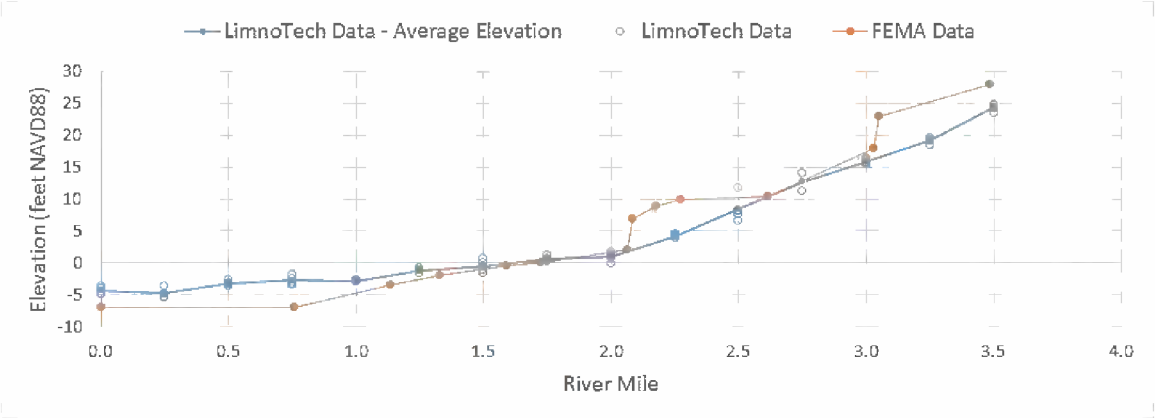


Figure 5-4: Comparison of Ridley Creek Bed Elevation Measurements



Higher creek bed elevations near the Chester Creek mouth are an indication that soft sediments have accumulated there since the 1970s. The highest observed peak flow in Chester Creek occurred a few years before the FEMA survey (in 1971, peak flow of 21,000 cfs) while recent peak flows have been significantly lower (average peak flow of 4,000 cfs in the last ten years) (USGS, 2017). Lower contemporary peak flows may have allowed for the accumulation of soft sediments in the lower reaches of Chester Creek.

Another significant observation from the LimnoTech data is that a pipe crossing near river mile 1.0 in Chester Creek created a high point in the creek bed profile. This high point acts to slightly reduce upstream water currents during lower flow conditions. This would tend to lengthen travel times of bacteria.

In Ridley Creek the LimnoTech data show a more constant bed slope between river miles 2.0 and 3.5 than the FEMA data. This is because low head dams existed in the 1970s near river miles 2.0 and 3.0, but are no longer in place. These dams previously acted to accumulate sediments in their shallow upstream pools, but when the dams were no longer present these accumulated sediments were likely washed away downstream.

These comparisons between the LimnoTech survey data, the historical FEMA data, and the NOAA tide gage, show consistency and provide confidence in the data collected. These comparison also help to identify locations where the creek bed has changed in the last several decades in ways that would influence creek hydraulics and pollutant transport.

The Delaware River bathymetric survey information was obtained online from National Oceanic and Atmospheric Administration (NOAA) website.

- NOAA, 2009. Hydrographic Survey H12149. Pennsylvania and New Jersey. Delaware River. Data obtained online at: https://www.ngdc.noaa.gov/nos/H12001-H14000/H12149.html
- NOAA, 2009. Hydrographic Survey H12150. Pennsylvania and New Jersey. Delaware River. Data obtained online at: https://www.ngdc.noaa.gov/nos/H12001-H14000/H12150.html

The survey was conducted in 2009, although other surveys conducted by NOAA over time (going back several decades) will also be used to construct the bathymetry datasets for the Water Quality Model. This information will serve to assist in determining tidal currents and mixing within the Delaware River Estuary as part of the Water Quality Modeling.

5.2 Watershed Drainage Basins

The Chester Creek and Ridley Creek watersheds extend from the mouth of the tributaries upstream through Delaware County and into Chester County, well beyond the boundaries of DELCORA's Model Area. The extent of the watersheds within Delaware County is illustrated in Figure 2-4, along with the boundaries of DELCORA's Model Area.

5.3 Pollutants of Concern

This section provides a summary of the current water quality in DELCORA's receiving waters based on DELCORA's efforts to identify Pollutants of Concerns, in order to meet the requirements of Section V.A.16.c of the Consent Decree. To satisfy this Consent Decree requirement, DELCORA submitted the *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c), which was approved by PA DEP and US EPA on October 13, 2016. The remainder of Section 5 is based on this approved report.

DELCORA's CSOs discharge to three receiving waters - the Delaware River, the Chester Creek and the Ridley Creek – all of which are within the Delaware Estuary portion of the Delaware River Basin. As part of the *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c), DELCORA conducted a literature review to determine the applicable water quality standards (WQS) for each of the three receiving water bodies, the designated uses for the water bodies, the primary causes of impairment, and the Total Maximum Daily Load (TMDL) status of the water bodies (if any).

Requirements of the USEPA's CSO Guidance Document

Section 2.5.3.3 of the USEPA's CSO Guidance document states that to assess the impacts of wet weather runoff, the water quality of the receiving waters should be understood for normal dry weather periods. The water quality data that is collected during dry weather conditions provides a basis for comparing the data collected during wet weather conditions. The CSO Guidance Document says:

> *"Receiving water monitoring should include identified parameters of concern. These parameters typically include those previously identified for combined sewage and CSO monitoring.*
>
> - *pH*
> - *BOD*
> - *TDS*
> - *TSS*
> - *Nutrients*
> - *Metals*
> - *Indicator bacteria*
>
> *Knowledge of the site-specific water quality concerns could expand the list to include dissolved oxygen, toxics, biological assessment, and sediment."*

5.4 Receiving Water Use Designations and Applicable Water Quality Standards

Information about the applicable water quality standards (WQS), the designated uses and the impairment status for the three receiving water bodies impacted by DELCORA's CSOs were obtained from the PADEP's 2014 Integrated Water Quality Monitoring and Assessment Report (or "303(d) list"), the Pennsylvania Code, the Delaware River Basin Commission's (DRBC's) Water Quality Regulations (WQRs) and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment (DRBC, 2014).

5.4.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

The primary source of information about the causes of impairment, and the Total Maximum Daily Load (TMDL) status of the water bodies (if any) is the 2014 PA Integrated Water Quality Monitoring and Assessment Report (PA Integrated Report), which satisfies Pennsylvania's requirement of both Section 303(d) and 305(b) of the Clean Water Act (CWA). The PA Integrated Report lists all impaired surface waters within Pennsylvania that are not attaining designated and existing uses, even after appropriate and required pollution control technologies have been applied. A TMDL is designed to reduce pollutant loads to impaired waters and enable these waters to meet water quality standards.

The Integrated Report uses a five-part categorization (lists) of water according to their use attainment status. The categories represent varying levels of use attainment, ranging from Category 1, where all designated water uses are met to Category 5, where impairment by pollutants required the development of a TMDL to correct. Each segment of the waterbody is placed into one of these five categories. "Impairment" of a receiving water body is indicated to exist for a particular parameter if the parameter appears in Categories 4A and 5, as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters.

The PADEP's website explains the categories as follows:

- *Category 1:* *Waters attaining all designated uses.*
- *Category 2:* *Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses maybe unknown because data are insufficient to categorize a water body consistent with the states' listing methodology or may be impaired.*
- *Category 3:* *Waters for which there are insufficient or no data and information to determine, consistent with the state's listing methodology, if designated uses are met.*
- *Category 4:* *Waters impaired for one or more designated use but not needing a TMDL. States may place these waters in one of the following three subcategories:*
  - *Category 4A: TMDL is approved.*
  - *Category 4B: Expected to meet all designated uses within a reasonable timeframe (three years).*
  - *Category 4C: Not impaired by a pollutant.*
- *Category 5:* *Waters impaired for one or more designated uses by any pollutant and requiring the development of a TMDL. Category five includes waters shown to be impaired as the result of biological assessment used to evaluate aquatic life even if the specific pollutant is not known unless the state can demonstrate that non-pollutant stressors cause impairment or that no pollutant(s) causes or contribute to the impairment.*"

The Category 5 list constitutes the Section 303(d) list that the USEPA will approve or disapprove under the CWA. For the purposes of the determination of Pollutants of Concern, Categories 4A and 5 are the relevant categories as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters. All of the lists are sorted by an 8-digit Hydrologic Unit Code (HUC) that is particular for the water body of interest. For DELCORA's drainage area, the HUC for the

Lower Delaware River (02040202) was used for searching the data in the PA Integrated Report for all three of DELCORA's receiving water bodies.

5.4.2 PA Code Title 25 §93.9g

The primary source of information for the Critical Use Designation for each section of the three receiving water bodies is 25 Pa. Code §93.9g – Drainage List. The relevant Critical Use Designations for DELCORA's receiving water bodies include Warm Water Fishes (WWF), Migratory Fishes (MF), Trout Stocking (TSF), and Water Contact Sports/Recreation (WC).

- The "WWF" designation indicates the maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
- The "MF" designation indicates the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters.
- The "TSF" designation indicates maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
- The "WC" designation indicates the use of the water for swimming and related activities.

5.4.3 DRBC's Water Quality Regulations and PA Code Title 25 §93.7

The applicable water quality standards for the three receiving water bodies are found in the Delaware River Basin Commission's Water Quality Regulations, and in Water Quality Criteria lists found in 25 Pa. Code §93.7 and §93.8c. For the Delaware River, the water quality standards are dictated by the DRBC's WQRs that have primacy over the standards in the PA Code. The water quality standards in the PA Code apply to the non-tidal portions of the Chester Creek and Ridley Creek, and to the Delaware River if there is no standard listed for a particular parameter in the DRBC's WQRs.

5.4.4 DRBC's 2014 Delaware River and Bay Water Quality Assessment

The DRBC's 2014 Delaware River and Bay Water Quality Assessment (DRBC, 2014) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commissions' Water Quality Regulations for the period October 1, 2008 through September 30, 2013. The 2014 Assessment involves the comparison of key water quality parameters with the applicable DRBC water quality regulations. The states of Pennsylvania, New Jersey, Delaware and New York consider the DRBC's Assessment report as part of their determinations as to whether sections of the Delaware River should be listed on the state 303(d) list for a certain pollutant.

5.5 Delaware River

5.5.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

The 2014 PA Integrated Water Quality and Assessment Report ("the 303(d) List") lists a 61.02 mile segment of the Lower Delaware River in Category 4A as having an approved TMDL for polychlorinated biphenyls (PCBs) from an unknown source related to its fish consumption use. The USEPA approved a

TMDL for PCBs for Zone 2 through Zones 5 in 2003, and a second PCB TMDL was approved for Zone 6 in 2006. The TMDLs for PCBs encompass the Delaware River Estuary and stretch from the mouth of the Delaware River upstream to the Trenton, NJ /Morrisville, PA Bridge. The segment of the Delaware River having an approved TMDL for PCBs is shown in yellow in the map in Figure 5-5, which was derived from the PADEP's eMapPA website.

While the Delaware River is impaired from PCBs, the PCBs are not normally associated with CSOs. Given this reason, and the fact that the PCB impairment begins well upstream of DELCORA's service area – PCBs were screened as not being a Pollutant of Concern (POC). Furthermore, the additional CSO sampling results from November/December 2015 showed that PCBs were found to be at a lower concentration than the Reporting Detection Limit (RDL). For this additional reason it was determined that PCBs are not associated with DELCORA's CSO discharges.

5.5.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code

The Critical Uses for the Delaware River in the area of DELCORA's CSO discharges are designated in Pa. Code §93.9. All stretches of the Delaware River in this area are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). Additionally the Delaware River has a Water Contact (WC) designation downstream of River Mile 81.8, which is located directly adjacent to the City of Chester between CSO #009 and #011.

For WC-designated waters, 25 Pa. Code §93.7 establishes the following as the water quality criterion for fecal coliform bacteria:

- Fecal Coliform – A geometric mean of 200 colonies per 100 mL during the swimming season (May 1 through September 30) based on a minimum of five samples collected during a 30-day period. For the remainder of the year, the maximum fecal coliform level shall be a geometric mean of 2,000 colonies/100 mL based on a minimum of five samples collected during a 30-day period. There are no fecal coliform bacteria criteria for the Delaware River or tributaries that are not designated as WC waters or for Potable Water Supply (PWS).

For WWF and MF waters the WWF designation is the more restrictive of the two, and 25 Pa. Code §93.7 establishes the following additional standards for WWF waters:

- Dissolved Oxygen – The minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 5.5 mg/L
- Alkalinity – A minimum of 20 mg/L as CaCO3, except where naturally occurring conditions are less
- Ammonia Nitrogen – the maximum total ammonia nitrogen concentration (in mg/L) at all times shall be the numerical value given by un-ionized ammonia nitrogen (NH3-N) x (log-1[pKT-pH] + 1)
- Iron – 30-day average 1.5 mg/L as total recoverable
- pH – From 6.0 to 9.0 inclusive

Figure 5-5: Non-Attaining Streams and TMDL Streams within DELCORA's Service Area

- Temperature – A table is included within 25 Pa. Code §93.7 for maximum water temperatures in the receiving water body at various times of the year
- Total Residual Chlorine – Four-day average 0.011 mg/L; 1-hour average 0.019 mg/L

5.5.3 Designated Zone and Water Quality Regulations from the DRBC

25 Pa. Code §93.9 lists the DRBC regulations for Water Quality Zone 4 as exceptions to PA Code's specific water quality criteria. The DRBC's water quality regulations have primacy over the standards in the PA Code for the Delaware River.

The DRBC defines Zone 4 as that part of the Delaware River extending from R.M. 78.8 to R.M. 95.0, the Pennsylvania-Delaware state boundary line to the upstream side of the Philadelphia Navy Yard, including the tidal portions of the tributaries thereof. The DRBC states that the quality of Zone 4 waters shall be maintained in a safe and satisfactory condition for the following uses:

- Industrial water supplies after reasonable treatment
- Maintenance of resident fish and other aquatic life
- Passage of anadromous fish
- Wildlife
- Recreation - secondary contact above R.M. 81.8
- Recreation (all water-contact sports) below R.M. 81.8
- Navigation

The DRBC's Stream Quality Objectives for Zone 4 are as follows:

1. Dissolved Oxygen
   - 24-hour average concentration shall not be less than 3.5 mg/L.
   - During the periods from April 1 to June 15, and September 16 to December 31, the DO shall not have a seasonal average less than 6.5 mg/L.

2. Temperature shall not exceed:
   - 5°F (2.8°C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or
   - A maximum of 86°F (30.0°C), whichever is less.

   (NOTE: The DRBC's 2014 Delaware River and Bay Water Quality Assessment states that *"atmospheric temperatures and meteorological conditions are strong drivers of water temperature. DRBC previously demonstrated that water temperatures are strongly liked to air temperatures, and that a notable increase in air temperatures is observable between the temperature gradient period (1961-1966) and the current period. At present, we [i.e., DRBC] lack the tools to determine which portion of the exceedance is attributable to potentially controllable anthropogenic thermal inputs, and which portion is due to metrological drivers beyond our control"*.

3. pH between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions.

4. Phenols maximum 0.02 mg/l, unless exceeded due to natural conditions.

5. Threshold Odor Number not to exceed 24 at 60°C.

6. Synthetic Detergents. (M.B.A.S.). Maximum 30- day average 1.0 mg/L.

7. Radioactivity
   - Alpha emitters - maximum 3 pc/L (picocuries per liter);
   - Beta emitters - maximum 1,000 pc/L.

8. Bacteria
   - Fecal Coliform
     - Above R.M. 81.8: maximum geometric average 770 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 200 per 100 milliliters
   - Enterococcus
     - Above R.M. 81.8: maximum geometric average 88 per 100 milliliters
     - Below R.M. 81.8: maximum geometric average 33 per 100 milliliters

9. Total Dissolved Solids not to exceed 133% of background.
   (NOTE: The background TDS concentration is at present undefined, according to the DRBC's 2014 Delaware River and Bay Water Quality Assessment.)

10. Turbidity unless exceeded due to natural conditions.
    - Maximum 30-day average 40 units (NTU)
    - Maximum 150 NTU

11. Alkalinity between 20 and 120 mg/L.

12. Toxic Pollutants
    - Applicable criteria to protect the taste and odor of ingested water and fish are presented in the DRBC's WQRs Table 4.
    - Applicable freshwater stream quality objectives for the protection of aquatic life are presented in the DRBC's WQRs Table 5.
    - Applicable freshwater stream quality objectives for the protection of human health are presented in the DRBC's WQRs Tables 6 and 7.

5.5.4 DRBC Evaluation of Use Attainment Status

Table 5-1 presents a summary of Table 23 from the DRBC's 2014 Delaware River and Bay Water Quality Assessment for Zone 4 of the Delaware River. Zone 4 is the portion of the Delaware River directly impacted by DELCORA's CSO discharges and it extends from R.M. 95.0 to R.M. 78.8, the

Pennsylvania-Delaware state line including the tidal portions of the tributaries thereof. The extent of Zone 4 can be seen in Figure 5-1.

Table 5-1: Summary of the 2014 DRBC Integrated Assessment for Zone 4 of the Delaware River

Zone	Designated Use			
	Aquatic Life	Drinking Water	Recreation	Fish Consumption
4	NS	N/A	S	NS

Notes:
N/A - Not applicable
NS - The Designated Use is not supported
S - The Designated Use is supported

5.5.4.1 Water Contact Recreation

Table 5-1 shows that the designated use for Water Contact Recreation is being attained for the Delaware River below R.M. 81.8.

5.5.4.2 Aquatic Life

Table 5-1 shows that the designated use for Aquatic Life is not being attained. According to the DRBC's Assessment report (DRBC, 2014), *"the composite aquatic life assessment for 2014 yields a result of "Not Supporting" for all assessment units* (or zones). *It is important to note, however, that this result is largely driven by the requirement to categorize as not meeting criteria any assessment unit* (or zone) *with 1 exceedance plus 1 confirmatory exceedance."*

The DRBC's Assessment Report also states: *"Data showed multiple exceedances of aluminum acute and chronic freshwater objectives for the support of aquatic life in Zone 4. Of 35 surface water samples tested for aluminum in Zone 4 during the assessment period, 34 exceeded the chronic criterion and 8 exceeded the acute criterion at 21PA_WQX-WQN0182 near Marcus Hook, PA. No exceedances of aluminum were reported in Zones 2, 3, 5 and 6."* As part of the Recommendations for Future Action at the end of the report, the DRBC states that the *"exceedances of aluminum criteria in Zone 4 warrant further attention"*.

5.5.4.3 Fish Consumption

Table 5-2 shows that the designated use for Fish Consumption is not being attained. The DRBC's 2014 Delaware River and Bay Water Quality Assessment report states that their assessment criterion for fish consumption is based on the presence of fish consumption advisories from the four Basin states for the mainstem of the Delaware River. If a fish consumption advisory is present, this resulted in the DRBC making an assessment of "not supporting the designated use".

The Assessment report states that the violation criteria for PCBs is also supported by the presence of measureable concentrations of PCBs in the river that exceeded the surface water quality standard.

Twenty-two mainstem channel sites were sampled for PCBs in 2012, from Biles Channel near Trenton, NJ to the ocean boundary between Cape May and Lewis. It was found that all of the samples exceeded the current PCB water quality criteria of 16 µg/L for the protection of human health from carcinogenic effects.

The 2016 Commonwealth of Pennsylvania Fish Consumption Advisories for Zones 2, 3, and 4 of the Delaware River (Trenton, NJ/Morrisville, PA Bridge to PA/DE border) are as shown below in Table 5-2. These advisories identify PCBs as a pollutant of concern in fish tissue.

Table 5-2: PA Fish Consumption Advisory Summary for PCBs in the Delaware River

Fish Species	Meal Frequency	Contaminant
White Perch	1 meal/month	PCB
Flathead Catfish	1 meal/month	PCB
Channel Catfish	1 meal/month	PCB
Striped Bass: over 28 inches in length	1 meal/month	PCB
Carp	6 meals/year	PCB
American Eel	Do Not Eat	PCB

5.6 Chester Creek

5.6.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

Chester Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its recreational use due to pathogens, and for not meeting its aquatic life use due to siltation. "Pathogens" were listed in 2006 for three segments totaling 0.94 miles, and a TMDL is anticipated in 2019. The source for the pathogens is listed as "unknown", and these three stream segments are all well upstream of DELCORA's service area. Therefore it appears that the noted impairment of the Chester Creek due to pathogens is not related to DELCORA's CSO discharges.

"Siltation" was listed in 2014 for four segments of the creek totaling 18.41 miles, and a TMDL is anticipated in 2027. The source for the siltation was identified as "urban runoff/storm sewers". The majority of Chester Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located upstream of DELCORA's service area and are shown in red in the map in Figure 5-5. However, one of DELCORA's CSO outfalls does discharge to the furthest downstream segment of the Chester Creek that is impaired by siltation, which is Outfall #020 near Kerlin Street and Finland Drive. Siltation is measured by the water quality parameter Turbidity with units of Nephelometric Turbidity Units (NTU). The impacts of DELCORA's CSO discharges on the levels of Turbidity within the impaired sections of the Chester Creek have been evaluated further and are discussed herein.

For the Chester Creek, the 2014 PA Integrated Water Quality & Assessment Report shows the creek to be impaired for Aquatic Life from siltation, with Urban Runoff/Storm Sewers identified as the source. The impairment of the Chester Creek by siltation primarily occurs upstream of DELCORA's service area as shown in Figure 5-5. The term "Siltation" is not defined in the 2014 PA Integrated Water Quality & Assessment Report, but through various sources could be defined as:

> *"the pollution of water by fine particulate terrestrial clastic material, with a particle size dominated by silt or clay. It refers both to the increased concentration of suspended sediments, and to the increased accumulation (temporary or permanent) of fine sediments on bottoms where they are undesirable. Siltation is most often caused by soil erosion or sediment spill."*

There is not a water quality standard for "siltation", however, siltation can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. For this reason "Turbidity" was reviewed further as a surrogate for siltation to determine if it might be considered as a POC. Per available USEPA STORET data, the Turbidity concentrations on the Chester Creek was found to be below the WQS and therefore siltation was screened-out as not being a POC.

Category 4A lists a 0.81-mile segment of Chester Creek at its mouth that does not meet its designated use for fish consumption due to PCBs from an unknown source, and for which a TMDL for PCBs was issued in 2006. This is shown in yellow in the map in Figure 5-5 and is related to the TMDL for PCBs in the Delaware River Estuary.

5.6.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code

The Critical Uses for the Chester Creek in the area of DELCORA's CSO discharges are designated in 25 Pa. Code §93.9. All stretches of the Chester Creek in this area are designated as Warm Water Fishes (WWF) (maintenance only) and Migratory Fishes (MF) (passage only). The same specific water quality criteria apply to the WWF and MF Critical Use designations for Chester Creek as apply for the Delaware River.

5.7 Ridley Creek

5.7.1 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) list)

Ridley Creek is listed in Category 5 of the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report as not meeting its aquatic life use due to siltation. The "Siltation" was listed in 2012 for five segments totaling 26.76 miles, and a TMDL is anticipated in 2025. The source for the siltation was identified as "unknown" or from "urban runoff/storm sewers".

In actuality, it appears that the majority of Ridley Creek is not attaining its designated use for aquatic life due to siltation, and the vast majority of these impaired segments are located well upstream of DELCORA's service area and are shown in red in the map in Figure 5-5. However, all of Ridley Creek within DELCORA's service area is shown as impaired for aquatic life due to siltation. As with the

Chester Creek, the Ridley Creek is listed in the 2014 PA Integrated Water Quality & Assessment Report as impaired for Aquatic Life from siltation, with Urban Runoff/Storm Sewers identified as the source.

However as noted for the Chester Creek, there is not a water quality standard for "siltation" but it can be considered as closely related to the widely used water quality parameter of "Turbidity", which is associated with CSO discharges. Per available USEPA STORET data, the Turbidity concentration for the Ridley Creek was found to be below the WQS and therefore siltation was screened-out as not being a POC.

5.7.2 Designated Critical Uses and Specific Water Quality Criteria from PA Code:

The Critical Uses for the Ridley Creek in the area of DELCORA's CSO discharges are designated in 25 Pa. Code §93.9. All stretches of the Ridley Creek in this area are designated as Warm Water Fishes (WWF) (maintenance only), Migratory Fishes (MF) (passage only), or Trout Stocking (TSF). The TSF stretch only applies in the sections of the Ridley Creek upstream of the Chestnut Street bridge crossing.

The same specific water quality criteria apply to the WWF and MF Critical Use designations for Ridley Creek as apply to the Chester Creek and Delaware River, except for the parameters of Dissolved Oxygen and Temperature – which are more stringent in the TSF stretch because of the high oxygen needs of trout.

Specifically, for TSF waters 25 Pa. Code §93.7 establishes the following additional standards:

- Dissolved Oxygen – For the period February 15 to July 31 of any year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 6.0 mg/L. For the remainder of the year, the minimum value for dissolved oxygen must be above 5.0 mg/L, with the 7-day average value above 5.5 mg/L.
- Temperature – A separate table is included within 25 Pa. Code §93.7 for maximum water temperatures in the receiving water body at various times of the year for TSF waters.

5.8 Pollutants of Concern in the Receiving Waters

As part of the requirements of the Consent Decree, DELCORA was tasked to identify the Pollutants of Concern associated with it CSOs into the Delaware River, Chester Creek and Ridley Creek. The result of these investigations were documented in DELCORA's *Identification of Sensitive Areas and Pollutants of Concern* Report. This section summarizes the Pollutant of Concerns that were determined for each of DELCORA's receiving waters.

5.8.1 Consent Decree Requirements for the Determination of POCs

For the Identification of Pollutants of Concern, Section V.A.11 of the Consent Decree specifically states:

> *"For each of its Receiving Waters, DELCORA shall review existing water quality data and recent PADEP CWA § 303(d) listings to identify POCs. Even if a water body has not been formally listed as out of compliance with its water quality standards and designated uses, if available data indicate such impairment exists and such impairment involves pollutants associated with CSOs, DELCORA shall consider the related pollutants to be POCs."*

5.8.2 Methodology for Determination of the POCs

In the effort to identify the Pollutants of Concerns related to its CSO discharges, DELCORA reviewed the 2014 PA Integrated Water Quality Monitoring and Assessment Report (303(d) List), the historic sampling data for the influent to the Western Regional Treatment Plant, the USEPA's Storage and Retrieval (STORET) Data repository, historic water quality sampling data from the Chester and Ridley Creeks, and additional sampling results from the CSOs that were taken in November and December of 2015.

For the identification of the POCs, DELCORA took an inclusive approach to determine that all relevant water quality parameters were appropriately considered and evaluated. The first step was to develop a comprehensive list of the overall "Parameters Considered", which was then further evaluated and refined to determine the list of the applicable POCs. Development of the list of Parameters Considered was meant to cast a wide net as the first step towards identifying any parameters that might possibly be of concern.

The initial list of the Parameters Considered was compiled from six (6) primary reference sources from the USEPA, PADEP and the DRBC. The Parameters Considered list initially consisted of those specific parameters listed in the USEPA's CSO Guidance Document. Additional parameters were added from the parameters requiring sampling per DELCORA's NPDES permit, from the PA Code's specific water quality criteria for DELCORA's three receiving water bodies, from the DRBC's Water Quality Regulations for Zone 4 of the Delaware River, from the 2014 PA Integrated Water Quality Monitoring and Assessment Report (a.k.a. "303(d) List"), and from the DRBC's 2014 Delaware River and Bay Water Quality Assessment report (DRBC, 2014). Once the initial list of Parameters Considered was developed, additional parameters were added onto the list if they had been detected during the historical sampling data of the influent to the WRTP, and in the existing CSO monitoring data (as required by the NPDES permit). One year's worth of DELCORA's plant influent historical sampling data from September 1, 2014 through September 1, 2015 was collected and analyzed to identify additional Parameters Considered.

To help narrow the list of the Parameters Considered additional wet weather sampling at the CSOs was required. The additional sampling occurred on November 19th and December 1st, 2015 at the three CSO locations DELCORA is required to regularly monitor; the Chester Pump Station wet well, CSO #018 at Sun Drive and Hancock Street, and at CSO #019 at 14th Street and Crozer Hospital. The CSO sampling results were used to confirm if the Parameters Considered were actually prevalent in DELCORA's CSO discharges. If a parameter on the Parameters Considered list was not detected in the November and December 2015 wet weather sampling of the CSOs, those parameters were not considered further as POCs.

For each of the remaining Parameters Considered, the receiving stream water quality data from the USEPA STORET data warehouse for the years 2010 through 2015 was compared to the applicable WQS to check for exceedances. Both the acute and chronic conditions for the Parameters Considered were reviewed, where applicable, to determine if there had been exceedances of the applicable water quality standards. The segments of the Delaware River, Chester Creek and Ridley Creek have unique water quality standards that apply to them depending on the regulating authority, their designated uses, and the specific location within the waterbody. The Delaware River was broken down into two sections for the evaluation; one for the Delaware River upstream of R.M 81.8 ("upper Delaware") and the second for the Delaware River downstream of R.M 81.8 ("lower Delaware") based on the Water Contact Recreation

designated use for the Delaware River below R.M. 81.8 and the more stringent requirements associated with primary contact.

Once the Parameters Considered list was narrowed using the November/December 2015 additional sampling results at the CSOs, the parameters remaining on the narrowed list of Parameters Considered were further evaluated to determine if they are Pollutants of Concern. A parameter was considered to be a "Pollutant of Concern" for a water body if more than 10% of the samples taken exceeded the applicable water quality standard. This criteria was based on guidance provided by the USEPA, which recommends a "greater than 10% exceedance percentage" for determining that waters only partially meet their designated use for aquatic life support. If a parameter was determined to be a POC, it is to be further investigated through additional receiving water quality monitoring and modeling. A parameter was considered to be only a "Parameter of Potential Concern" (POPC) if 2 – 10% of the samples taken exceeded the applicable water quality standard, and any identified POPCs are to continue to be monitored and re-evaluated should the monitoring show their concentrations to increase over time.

5.8.3 Summary of the Identified POCs for each Receiving Water

Three (3) POCs were determined and these include Fecal Coliform bacteria, Enterococcus bacteria and E. coli bacteria. These three POCs apply to each of DELCORA's three receiving waters; the Delaware River, Chester Creek and Ridley Creek. These three POCs are parameters typically associated with CSO discharges, and the list of the POCs is summarized below. The concentrations of these identified POCs in the Delaware River, Chester Creek and Ridley Creek have been further investigated through the receiving water quality monitoring and modeling, subsequently described in Section 6 of this report.

The identified POCs for each of the receiving water bodies are listed below.

- For the lower Delaware River (Downstream of R.M. 81.8)
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria
- For the upper Delaware River (Upstream of R.M. 81.8)
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria
- For the Chester Creek
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria
- For the Ridley Creek
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - E. coli Bacteria

No Parameters of Potential Concern were identified.

5.9 Identification of Sensitive Areas

This section presents information on the identification of Sensitive Areas to meet the requirements of Section V.A.16.b of the Consent Decree, and Paragraph II.A.C.1.b of the USEPA's CSO Control Policy. The information in this section is summarized from the Sensitive Areas investigation originally presented in DELCORA's report *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c).

5.9.1 Regulatory Requirements

5.9.1.1 Consent Decree Requirements

For the Identification of Sensitive Areas, Section V.A.11 of the Consent Decree states:

> *"For each of its Receiving Waters, DELCORA shall contact appropriate agencies, access available data sources, and collect additional data as necessary to identify Sensitive Areas. DELCORA shall fully document all such contacts and the associated responses, and all additional investigations carried out to identify Sensitive Areas. DELCORA shall also identify any additional areas that, while not Sensitive Areas, have been identified by DELCORA as being appropriate for prioritization ("Priority Areas")."*
>
> *Additionally, "For each of its Receiving Waters, DELCORA shall conduct community outreach and appropriate studies to determine whether and to what extent primary contact recreation is occurring in each Receiving Water, and shall fully document its outreach and study methods, and its findings."*

5.9.1.2 Requirements of the USEPA's CSO Control Policy and Sensitive Areas Definition

The USEPA's CSO Control Policy (59 Fed Reg 75 [April 19, 1994]: 18688-18698) "expects a permittee's long-term CSO control plan to give the highest priority to controlling overflows to sensitive areas" (Section II.C.3). The CSO Control Policy states the six (6) criteria for defining an area as a "Sensitive Area" include:

1. Designated Outstanding National Resource Waters
2. National Marine Sanctuaries
3. Waters with threatened or endangered species and their habitat
4. Waters with primary contact recreation
5. Public drinking water intakes or their designated protected areas
6. Shellfish beds

The CSO Control Policy states that if Sensitive Areas are present and impacted, the LTCP should include provisions to:

- Prohibit new or significantly increased overflows
- Eliminate or relocate overflows wherever physically possible and economically achievable
- Treat overflows where necessary
- Where elimination or treatment is not achievable, reassess impacts each permit cycle

Sensitive Areas should be considered prior to the evaluation of CSO control alternatives. This allows a CSO community to identify and estimate costs for controls that could eliminate or relocate CSOs from Sensitive Areas where pollutant loadings pose a high environmental or public health risk and where control efforts should be focused.

5.9.1.3 Priority Areas Definition

The term "Priority Areas" is not specifically defined by the USEPA in the Consent Decree nor in the CSO Control Policy or Guidance Document. For the purposes of this report, the term "Priority Areas" is defined as follows:

> *"Areas having some environmental significance but not to the level of "sensitive areas" as defined in the federal CSO Control Policy. These priority areas may include: public access areas (i.e., near marinas, schools, playgrounds, parks, or athletic fields); or use of shallow streams for recreational activity, with something less than full contact (i.e., wading)".*

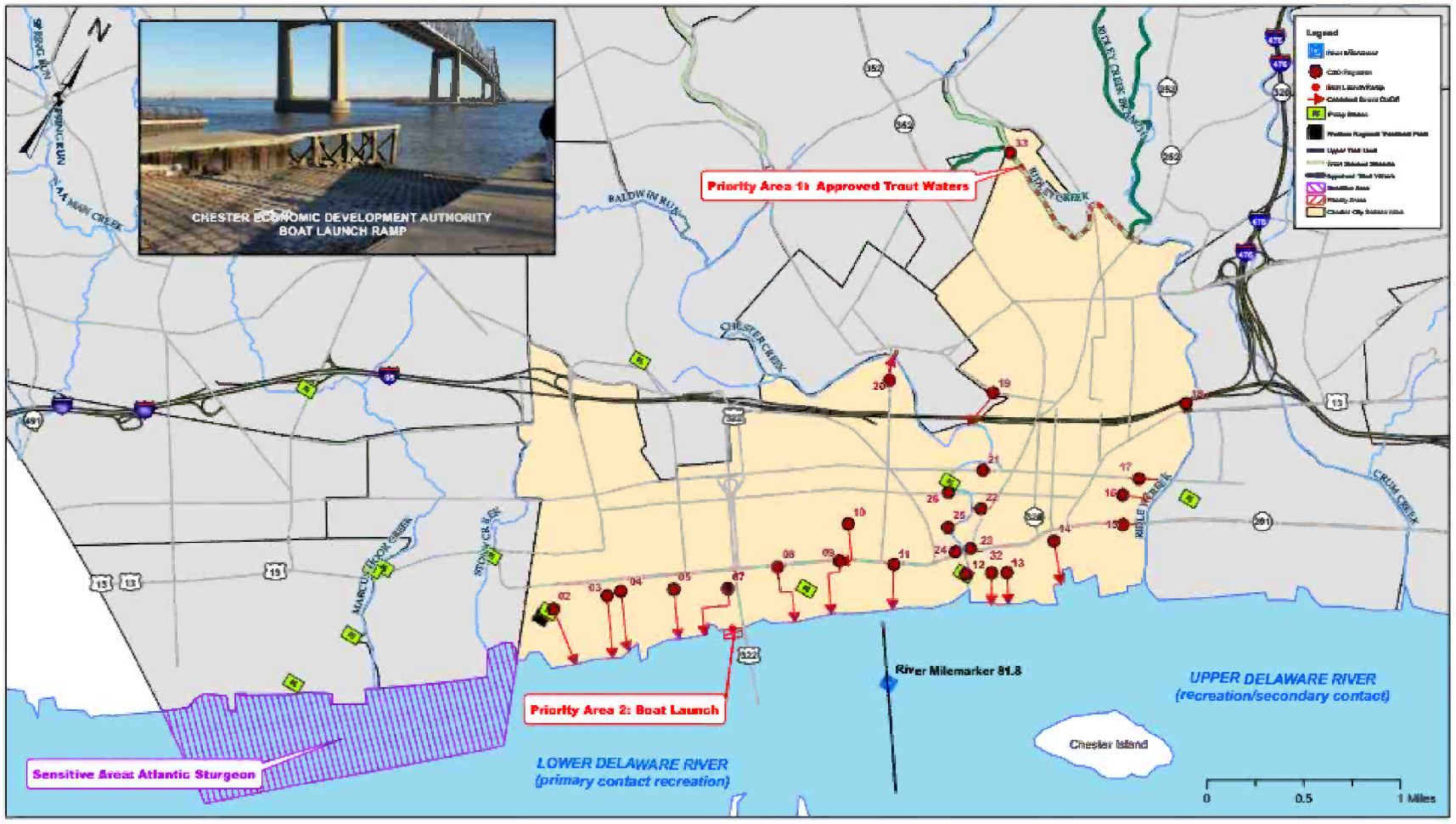
5.9.2 Summary of Sensitive and Priority Areas

The six criteria for Sensitive Areas identified in the CSO policy were evaluated for the Delaware River, Chester Creek and Ridley Creek within DELCORA's service area including reaches upstream of the CSOs. Special consideration was given to areas downstream and within the tidal influence of DELCORA's CSOs as any potential Sensitive Areas within hydraulic proximity to outfalls that may be impacted by their discharge. A comprehensive review of online databases, correspondence with regulatory agencies and local environmental organizations, and responses to the public survey was conducted to identify potential Sensitive Areas and Priority Areas within the CSS portion of the collection system. A summary of the findings for areas within the project boundary is presented below. A map of the sensitive and priority areas is shown in Figure 5-6. Additional details can be found in the report *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c).

5.9.2.1 Summary of Sensitive Areas

The habitat for year-of-young Atlantic Sturgeon downstream of CSO #002 in the Delaware River meets the Sensitive Area criteria for Endangered or Threatened species. The Atlantic Sturgeon is listed as a threatened species by the US Fish and Wildlife Service with documented habitat in the Delaware River downstream approximately one-half mile downstream of DELCORA's most southern outfall.

Figure 5-6: Sensitive and Priority Areas



There are no Outstanding National Resource Waters nor National Marine Sanctuaries within the project area. Shellfish beds are located well downstream of the CSO locations and are outside the project boundaries. There are numerous drinking water intakes in the geographical area but none are located in close proximity downstream of DELCORA's CSOs on the Delaware River. No drinking water intake locations were found that meet the criteria of a Sensitive Area.

5.9.2.2 Summary of Priority Areas

Priority Areas include areas having some environmental significance but not to the level of "Sensitive Areas" as defined in the federal CSO Control Policy. Two Priority Areas were identified:

- Approved trout waters in Ridley Creek
- Chester Economic Development Authority's boat launch in Chester City

The northern reaches of Ridley Creek within DELCORA's service area are designated as Approved Trout Waters and Trout Stocked Streams. The portion of the approved trout waters from CSO #033 downstream to Chestnut Street (see Figure 5-6) is considered a Priority Area because of this special environmental use.

The boat launch located between CSO #007 and #008 along the Delaware River is located within the portion of the waterbody rated for primary contact. The boat launch is considered a Priority Area due to its location to CSO #007 and #008.

5.9.2.3 Other Considerations

Bald eagles are known to nest in the vicinity of the project area. While the Bald Eagle has been removed from the Federal list of threatened and endangered species, the Bald Eagle along with the Golden Eagle continues to be protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act (MBTA). These Acts prohibit anyone to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, disturb, or otherwise harm eagles, their nests, or their eggs". Under the BGEPA, "disturb" means to agitate or bother a Bald or Golden Eagle to a degree that causes, or is likely to cause, based on the best scientific information available: (1) injury to an eagle; (2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. Since the Bald Eagle has been removed from the Federal list of threatened and endangered species, the Sensitive Area criteria for Threatened or Endangered Species does not apply to the project study area. However, it is acknowledged that these species require special consideration. During the development of CSO abatement alternatives, the project will be evaluated for project size, location and layout in order to comply with the BGEPA and MBTA.

Section 6 Collection of Water Quality Data

6.1 Background

The USEPA CSO Control Policy Section II.C.4 states that the long term CSO control plan should adopt one of the two approaches, Presumptive or Demonstration Approach, for CSO controls sufficient to meet CWA requirements. The DELCORA *Alternatives Evaluation Approach Report* (Greeley and Hansen, 2016b) was submitted to the USEPA and the PADEP in April 2016 proposing to utilize the Demonstration Approach for the DELCORA receiving streams. The USEPA approved this report thereby approving the demonstration approach for each receiving stream in October 2016.

Consent Decree requires that if DELCORA utilizes the Demonstration Approach in one or more of its Receiving Waters, then it is to establish a Monitoring Program to collect any additional data needed to facilitate the development, calibration, and validation of the Receiving Stream Water Quality Modeling Program, once the existing data have been assessed. The calibrated and validated Water Quality Model will be used to evaluate Typical Hydrologic Period in-stream conditions for each identified Pollutant of Concern, previously identified in DELCORA's *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c).

This section presents the results of the Water Quality Monitoring Program and includes water quality data collected from CSO discharges, storm water discharges, and from the three receiving waters. The Water Quality Monitoring Program was run concurrently with the Rain fall and Flow Monitoring Program in the spring of 2017. The goal of this program was to collect water quality data for the calibration and validation of the Water Quality receiving stream model. The final sampling results analysis is being conducted at this time and will be included in the final Water Quality Sampling Report and the final Water Quality Modeling Report to be issued August 2017 and February 2018 respectively. This Section also includes summary information previously presented in DELCORA's *Water Quality Monitoring and Modeling Work Plan* (Greeley and Hansen, 2017a) and *Water Quality Monitoring and Modeling Quality Assurance Project Plan* (Greeley and Hansen, 2017).

6.2 Regulatory Requirements

6.2.1 Consent Decree Requirements

Paragraphs V.A.10.e and V.A.10.f of the Consent Decree require that the development of the LTCP include:

V.A.10.e.	*Develop and implementation of a Water Quality Model*
V.A.10.f	*Characterization of the service area and the Receiving Waters as required by CSO Control Policy Paragraph II.C.1 and associated guidance.*

Consent Decree Paragraph V.A.15.a.(iv) specifically requires that:

> *"For each water body in which the Demonstration Approach is to be used, the Water Quality Model Plan shall address:*
> *i. Background, Scope and Purpose, Description of System;*
> *ii. Water quality modeling software to be employed;*
> *iii. Model configuration and development, including reaches to be modeled, and segmentation and boundary conditions;*
> *iv. Calibration and validation (dry weather and wet weather, including events and data to be employed, detailed information regarding all additional data collection activities (if needed), quantitative and qualitative calibration criteria, and utilization of H&H Model outputs;*
> *v. Use of the Water Quality Model to evaluate Typical Year instream conditions for each identified pollutant of concern;*
> *vi. Schedule for model development and implementation, including integration into LTCP development consistent with other dates required pursuant to the Consent Decree."*

The Consent Decree further specifies that within sixty (60) days after the approved Water Quality Model Plan is fully implemented according to the schedule included therein, DELCORA shall submit to EPA and PADEP a Water Quality Model Report for review and approval which shall specifically address each item set forth in Paragraph 15(a)(i)-(vi). Per the Water Quality Model Work Plan schedule, the Water Quality Model Report will be submitted February 2018 and will address the items mentioned above including Water Quality Modeling sampling results and assessment.

6.3 Overview of Historical Water Quality Monitoring

The Water Quality Monitoring Program (WQMP) was designed to collect data that will be used to assess water quality concerns identified in the Delaware River watershed and its tributaries, Chester Creek and Ridley Creek, in the vicinity of Chester, PA. Pollutants of concern (POCs) are identified in the *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c) which was approved by US EPA on October 13, 2016. Table 6-1 below lists the POCs that were identified for the receiving streams and were approved for further investigation through water quality monitoring and modeling. The POCs are *Fecal coliform, Escherichia coli (E. coli)*, and *Enterococcus* and are the primary focus of the WQMP.

Table 6-1: List of Pollutants of Concern (POC)

No.	Upper Delaware River		Lower Delaware River		Chester Creek		Ridley Creek	
Pollutants of Concern (>10% of observed samples exceed WQS)								
1	Fecal Coliform[b]	100%	Fecal Coliform[b]	100%	Fecal Coliform[a],[b]	100%	Fecal Coliform[a],[b]	100%
2	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%	Enterococcus [b],[c]	100%
3	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%	E. coli[c]	100%

[a] Based on historical sampling conducted in 2010 upstream and downstream of CSO outfalls only on Chester and Ridley Creeks.

[b] Fecal Coliform and Enterococcus are listed as POCs due to both being parameters typically associated with CSOs.

[c] DRBC regulations are available for Enterococcus and it is typically associated with CSOs and therefore it is included as a POC. However, in consultation with PADEP Enterococcus could be replaced with E. coli bacteria in the future (based on the anticipation that national standards on E. coli will be adopted in Pennsylvania) and therefore E.coli is also included as a POC.

In completing the initial step of characterizing the watershed, historical data was compiled, reviewed and assessed to determine the need to augment existing data to address the watershed issues identified. This review indicated that one of the POCs, *E. coli*, has not been sampled in all the receiving waters and the data that have been collected for the remaining POCs were of insufficient frequency and spatial density to be useful in the modeling process.

6.3.1 Historic Water Quality Sampling

The Water Quality Model requires robust flow and water quality datasets to build confidence in its use as a tool for CSO planning. Data are needed in the modeled receiving waters for use in model calibration and validation as well as for the predominant wet weather sources, such as DELCORA's CSOs and the City of Chester's MS4 runoff to estimate pollutant loadings to the model. The existing water quality data were reviewed for their adequacy in meeting the data needs of the water quality model for the POCs (fecal coliform, *E. coli*, and *Enterococcus*). The review indicated that Chester Creek and Ridley Creek have limited POC data. Although the Delaware River has more extensive POC data, it lacks the temporal frequency needed to characterize wet weather impacts from DELCORA's CSOs.

It would have been difficult to constrain the Water Quality Model's representation of DELCORA's sources on the receiving waters without additional monitoring data designed specifically for calibrating and validating a robust water quality model. Existing flow data were also reviewed for adequacy; reports of mean daily stream discharge are available from several stream gages along the Delaware River and in tributaries near the DELCORA service area, ranging from as early as 1912 to the present. The existing flow and water quality data are described in this section.

Flow data for the Delaware River and tributaries in the DELCORA service area were obtained from the USGS National Water Information System. Reports of mean daily stream discharge were

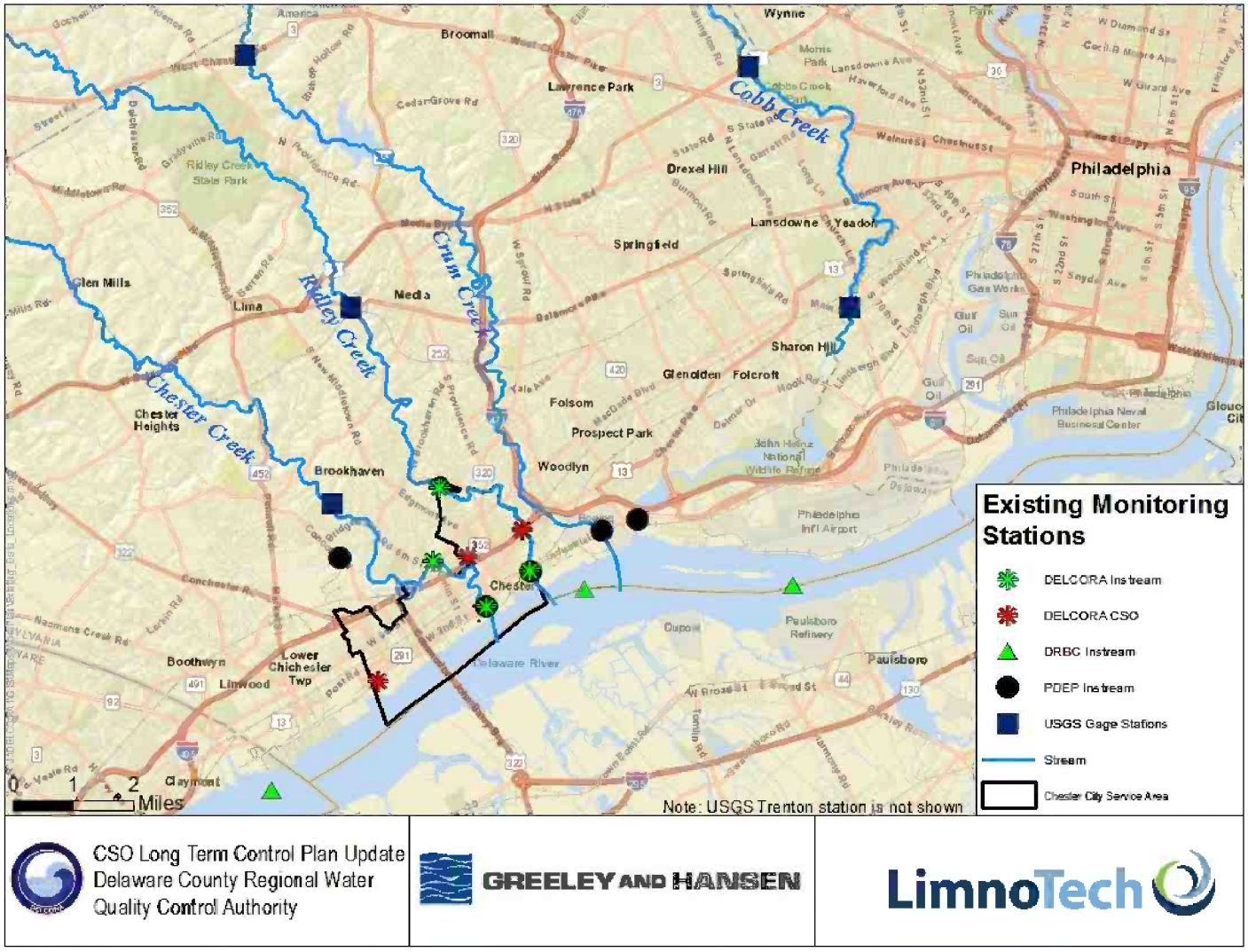
available from five stream gages in DELCORA service area measuring daily mean discharge: Crum Creek near Newtown Square, PA (1980-2016); Chester Creek near Chester, PA (1931-2016); Ridley Creek near Media, PA (1986-2016); Cobbs Creek at U.S. Highway No. 1 at Philadelphia, PA (1964-2016); and Cobbs Creek at Mt. Moriah Cemetery, Philadelphia, PA (2005-2016). Though not in service area, mean daily discharge data were also obtained from the gage at the Delaware River at Trenton, NJ (1912-2016) because it is expected that these data will be used to inform the upstream boundary for the hydraulic portion of the water quality model. The USGS Pennsylvania Water Science Center has conducted water quality sampling at various points in the state. However, none of their sampling locations are near to the DELCORA service area or local waterways.

Monthly effluent data from DELCORA's WWTP are available from the Pennsylvania Department of Environmental Protection's (PADEP) eDMR website (*www.dep.pa.gov/edmr*). Reported data include monthly geometric mean and instantaneous maximum values for fecal coliform from 2009 through 2016. PADEP also monitors water quality of tidal streams that empty into the Delaware River, through the Pennsylvania Water Quality Tributary Project funded by the Delaware River Basin Commission (DRBC). This program monitored for fecal coliform levels in Chester Creek, Ridley Creek, Darby Creek, Crum Creek, and others twice annually from 2007-2010. PADEP also operates the PA Surface Water Quality Monitoring Network, through which Baldwin Run (a tributary to Chester Creek) was sampled monthly for fecal coliform from 1998-1999.

The Delaware River Basin Commission operates its Boat Run program to monitor ambient, sampling for *E. coli*, *Enterococcus*, and fecal coliform at various sites along the Delaware River (Figure 6-1). Samples were collected from each station between one and three times each month from March through November every year since 1999. Through this program, data are available at three sites near DELCORA: Eddystone (2005-2016), Paulsboro (1999-2016), and Marcus Hook (1999-2016).

Since 2009, DELCORA has also done their own sampling at CSO outfall sites and in receiving waters. In 2010, a survey was conducted to measure fecal coliform levels in Ridley and Chester Creeks during wet and dry weather. There were two sample sites in each creek, and over the course of the study, six surveys were conducted. Four surveys occurred during dry weather, one during a wet event, and one during a wet event after a storm. During each survey, one sample was collected at each site. In 2009, DELCORA began sampling in the CSO system as required by their NPDES permit. Four outfalls and pump stations were sampled once annually for fecal coliform from 2009-2011, and three outfalls were sampled once annually for fecal coliform from 2012-2014. In 2015, four outfalls and pump stations were sampled for fecal coliform and *Enterococcus*, on three separate occasions. *E. coli* was not measured in any of these surveys.

Figure 6-1: Historical Flow and Water Quality Sampling Locations Near DELCORA Service Area



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The extent of the historical water quality data and its adequacy to support the Water Quality Model development and calibration can be summarized as follows:

- Some CSO water quality data had been collected but mostly for fecal coliform. There were no CSO data for *E. coli*. Another limitation in the CSO data is that the CSO samples did not coincide with in-stream sampling, making it difficult to directly link CSO loads to in-stream impacts.
- No water quality sampling for the POCs had been done of the stormwater runoff in the separated areas of the DELCORA service area.
- The Delaware River had the most data of the receiving waters and it had data for all three POCs. However, the data were collected at regular intervals, independent of weather condition, and typically only one sample per location per survey was collected. These periodic sampling events do not provide enough data to characterize DELCORA loads on the river.
- The tributaries (Chester Creek and Ridley Creek) have been sampled sporadically and rarely within the tidal zone adjacent to DELCORA's service area. Wet weather data collected by DELCORA, consisting of only one sample per event, were not sufficient to characterize the magnitude and duration of the POCs' pollutographs over a storm event. Data are most robust for fecal coliform. There was less data for *Enterococcus* and none for *E. coli*. In addition, no sampling had been conducted in these tributaries since 2010.

DELCORA's Water Quality Monitoring Program conducted during Spring 2017 builds on the water quality sampling that had already been done while addressing the limitations identified in the historical data. The WQMP included a comprehensive monitoring assessment of all of the POCs to characterize loads and in-stream conditions, and these data were used to inform the Water Quality Model development, calibration and validation.

There has not been routine, on-going monitoring for the pollutants of concern in the tributary waterways adjacent to the DELCORA service area. The Delaware River Basin Commission samples the Delaware River near Chester approximately once a month between April and October. The analysis of these samples includes fecal coliform, *E. coli*, and *Enterococcus*, which are the pollutants of concern (POCs).

6.4 Overview of the Water Quality Monitoring Program

6.4.1 Water Quality Monitoring Objectives

The Water Quality Monitoring Program (WQMP) is designed to collect data that will be used to develop and calibrate watershed and receiving water quality models that will be used to assess water quality concerns for the POCs identified in the *Identification of Sensitive Areas and Pollutants of Concern Report* (Greeley and Hansen, 2016c). The report identified three indicator bacteria (fecal coliform, *Escherichia coliform* (*E. coli*), and enterococcus) as pollutants of concern (POC) that are potentially impacting receiving water quality during CSO discharges in all three of the receiving waters (Delaware River, Chester Creek and Ridley Creek).

Existing water quality data provides insight into the conditions in the river and streams in the project area but are of insufficient frequency and spatial density to fully support the modeling process. In addition, *E. coli*, one of the identified POCs, was not monitored in the available data. The water quality monitoring objectives are to collect water quality data for the POCs during dry and wet weather event periods that can be used to characterize the bacteria sources in the Delaware River watershed in the vicinity of the City of Chester, PA, and to calibrate and validate the Water Quality Model, consistent with the Consent Decree requirements in Paragraph V.A.15.a. Additional in situ parameters that included salinity, temperature and conductivity were collected to inform the development of the Water Quality Model.

The collection of new water quality data was required to address the shortcomings of the historical water quality data by:

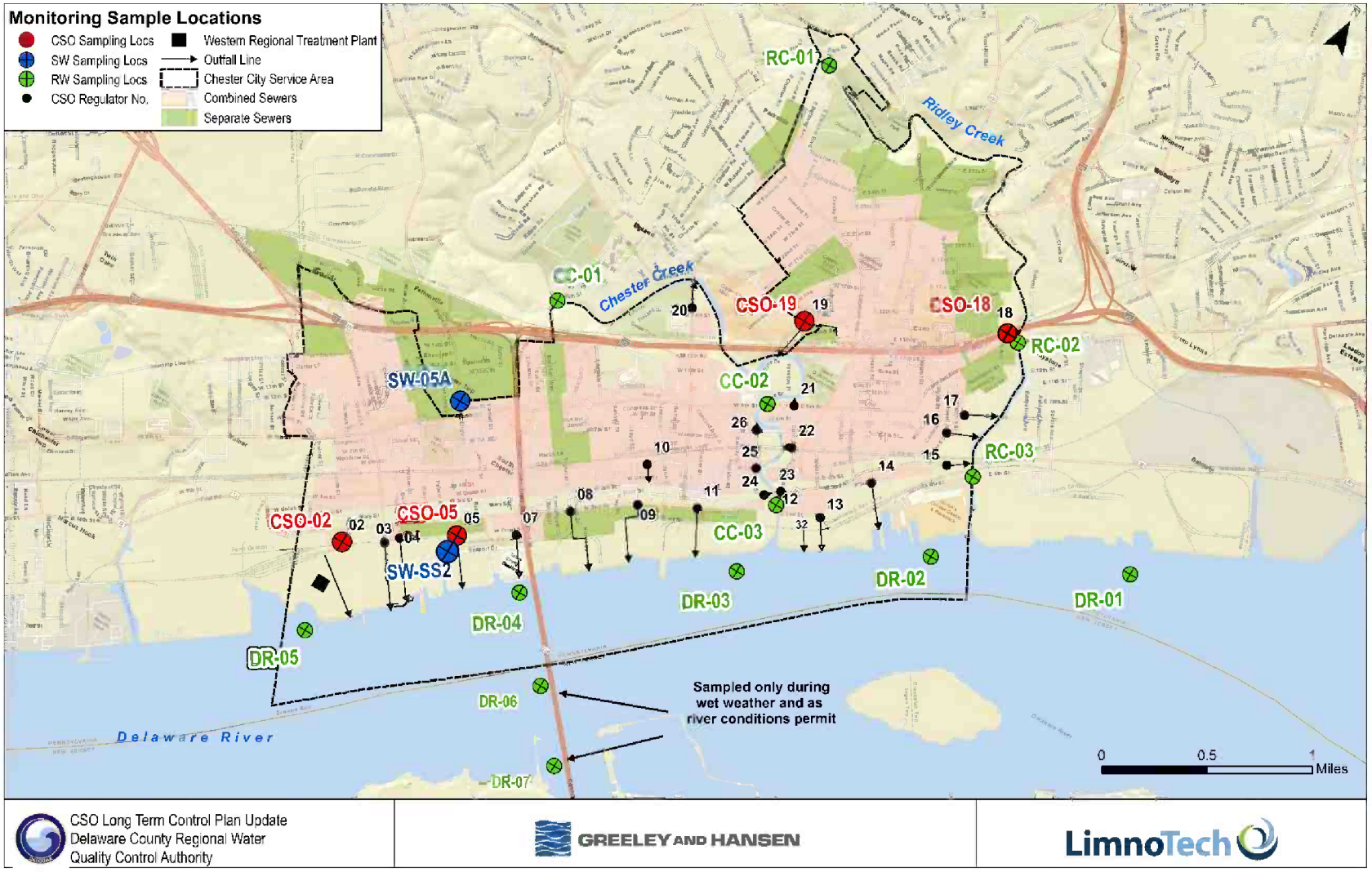
- Providing the frequency needed for in-stream concentrations (multiple samples spaced over several days) during wet weather to calibrate fecal coliform, *E. coli* and *Enterococcus* concentrations in the Receiving Water Quality Model;
- Providing wet weather event data for a range of storm conditions to calibrate and validate the Receiving Water Quality Model;
- Capturing the effects of the wet weather event throughout the CSO model area;
- Providing better constraints on calculated loads from storm water, tributary, and CSO sources than when using historical data

6.4.2 Water Quality Sampling Locations

Water quality monitoring was undertaken at thirteen (13) in-stream locations (seven of which are Delaware River sampling locations), four (4) CSO locations in the DELCORA combined sewer system area, and two (2) stormwater locations in the City of Chester municipal separate storm sewer system, as shown in Figure 6-2. Water quality monitoring and sampling was conducted as follows:

- Eleven (11) in-stream locations in the vicinity of the DELCORA CSO area were sampled for water quality for (3) dry weather events; one of which was targeted for collection during a tributary low-flow period (less than 25th percentile flow). The mid-stream and far-shore Delaware River locations were not sampled during the dry weather surveys because it was expected that water quality in the river is relatively uniform laterally due to

Figure 6-2: Receiving Water (RW), Combined Sewer (CSO) and Stormwater (SW) Monitoring Locations



the lack of active sources during dry weather. Grab samples and *in situ* measurements were collected at each location during each event.

- All thirteen (13) in-stream locations were sampled for water quality using grab samples and in situ monitoring for three (3) discrete wet weather events, according to the surface water quality monitoring program protocols described in the Monitoring Work Plan;
- Up to four (4) CSO and two (2) stormwater outfall locations were sampled for water quality for the same three (3) discrete wet weather events according to the outfall monitoring program protocols described in the Monitoring Work Plan. Samples for all outfalls were collected as grab samples.

The sampling events were planned to be distributed across the sampling season, which is assumed to be March through June 2017. Additionally, bathymetry surveys in the lower portion of the Chester and Ridley Creek were conducted to inform the development of the Water Quality Model.

Monitoring locations were selected to characterize the watershed at a sub-watershed level, recognizing various political and hydrologic features, land uses and potential pollutant sources. Site selection and analytical parameters were designed to characterize stormwater outfalls, CSOs, tributaries upstream and within the Chester CSO discharge area, and the main stem of the Delaware River in the project area. The sampling locations are shown in Figure 6-2 and listed in Tables 6-2, 6-3 and 6-4.

Tables 2-1, 2-2 and 2-3 include summaries of the rationales for each sampling location selected. The Chester Creek and Ridley Creek locations were selected to distinguish, to the extent possible, between upstream, stormwater and Chester CSO pollutant loads. The Delaware River sampling locations provided a characterization of water quality entering the Chester CSO area from either tidal direction as well as water quality within the CSO discharge area. During wet weather, three samples were collected across the transect corresponding to the DR-03 sampling location during each sampling round, when sampling across the river was feasible, to characterize lateral variability in the Delaware River during storm events.

The CSO sampling locations were selected based on their outfall discharge location, relatively high frequency of overflow, their overflow volume, and their accessibility. The stormwater sampling locations were selected to characterize the water quality associated with the predominant land uses (residential and commercial/industrial) in the study area. Each stormwater sampling location is in an area that is representative of the land use elsewhere in the City's stormwater area.

Table 6-2: Tributary Receiving Water Sampling Locations

Station ID	Easting[1]	Northing[1]	Receiving Water	Type	Description	Rationale
CC-01	243291.419	371541.259	Chester Creek	Tributary	Chester Creek at Upland-Incinerator Rd.	Upstream of all City sources and upstream of tidal influence
CC-02	248598.992	372750.444	Chester Creek	Tributary	Chester Creek at North Eyre Rd[2]	Characterize impacts from non-CSO urban runoff sources
CC-03	250712.383	369489.807	Chester Creek	Tributary	Chester Creek at E 2nd St.	Characterize impacts from all CSOs discharging to Chester Creek
RC-01	243755.086	380967.554	Ridley Creek	Tributary	Ridley Creek at East Brookhaven Road	Upstream of all City sources and upstream of tidal influence
RC-02	253932.835	376122.878	Ridley Creek	Tributary	Ridley Creek at Chester Pike	Characterize impacts from non-CSO urban runoff sources
RC-03	254545.954	372628.232	Ridley Creek	Tributary	Ridley Creek at East 4th St.	Characterize impacts from all CSOs discharging to Ridley Creek

Notes:
[1] Northing/Easting are referenced to NAD 1983 State Plane New Jersey FIPS 2900 Feet
[2] 9th Street may be used as sampling location if conditions for sampling from the bank at North Eyre St. are deemed unsafe.

Table 6-3: Main Stem Receiving Water Sampling Locations

Station ID	Easting[1]	Northing[1]	Receiving Water	Type	Description	Rationale
DR-01	259153.030	372425.510	Delaware River	Main stem	Delaware River between Ridley Creek and Crum Creek	"Upstream" of DELCORA's CSO discharges[2]
DR-02	250456.388	367784.535	Delaware River	Main stem	Delaware River between CSO-14 and Ridley Creek	Characterize Ridley Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03	245922.404	364715.470	Delaware River	Main stem	Delaware River between CSO-11 and Chester Creek	Characterize Chester Creek impacts on Delaware River, in the upper Delaware River (Secondary contact area)
DR-03-MID[3]	252036.389	365265.510	Delaware River	Main stem	Delaware River mid-stream along the transect of DR-03	Characterize lateral variability in the Delaware River during storm events
DR-03-LDB[3]	253703.965	362951.038	Delaware River	Main stem	Delaware River far shore (left descending bank) along the transect of DR-03	Characterize lateral variability in the Delaware River during storm events
DR-04	241663.723	361297.935	Delaware River	Main stem	Delaware River at the boat launch off Highway 322	Priority area, in the lower Delaware River (Primary contact area)
DR-05	254551.896	370426.118	Delaware River	Main stem	Delaware River between CSO-002 and Stony Creek	"Downstream" of DELCORA's CSO discharges[2], in the Atlantic sturgeon sensitive area

Notes:

[1] Northing/Easting are referenced to NAD 1983 State Plane New Jersey FIPS 2900 Feet

[2] "Upstream" and "downstream" subject to tidal conditions at time of sampling

[3] These locations will be sampled during the wet weather events only, when river conditions permit. POC concentrations are assumed to be laterally well-mixed during dry weather due to the absence of significant pollutant sources.

Table 6-4: CSO and Stormwater Sampling Locations

Station ID	Easting	Northing	Receiving Water	Type	Description	Rationale
CSO-19	248984.7240	374039.747	Chester Creek	CSO	14th and Crozer Hospital	Discharges to Chester Creek, one of the largest volume CSOs in DELCORA system
CSO-05	243892.0527	365166.574	Delaware River	CSO	Front and Townsend	Discharges to Delaware River, one of the largest volume CSOs in DELCORA system
CSO-02	241439.9527	363646.588	Delaware River	CSO	Front and Booth	Aggregates cumulative effect of CS conditions, one of the volume CSOs in DELCORA system
CSO-18	253767.9703	376303.599	Ridley Creek	CSO	Sun Drive and Hancock St.	Discharges to Ridley Creek
SW-05A	242360.2937	368165.917	Chester Creek	SW		Characterize runoff quality from predominantly residential area representative of the residential portion of the study area
SW-SS2	248649.2079	368230.704	Delaware River	SW		Characterize runoff quality from predominantly commercial/industrial area representative of the commercial/industrial portion of the study area

Note: The sampling locations will be finalized once a sampling contractor has been selected and potential sampling locations are assessed with respect to accessibility, feasibility, safety, and representativeness. The northing/eastings information will likely be updated prior to the initiation of the Sampling Program. Northing/Easting are referenced to NAD 1983 State Plane New Jersey FIPS 2900 Feet

6.4.3 Analytical Parameters

All of the in-stream dry and wet weather samples were analyzed for the parameters shown in Table 6-5: Analytical and Field Parameters. The outfall samples were analyzed for only *E. coli*, *Enterococcus* and fecal coliform.

Table 6-5: Analytical and Field Parameters

Parameter	Description	Sampling Program	Type of Measurement
E. coli	Escherichia coli	Dry, Wet	Grab
Enterococcus	Enterococcus sp.	Dry, Wet	Grab
Fecal Coliform	Fecal coliform	Dry, Wet	Grab
wTemp	Water temperature	Dry, Wet, Receiving Water Only	In-situ
Cond	Conductivity	Dry, Wet, Receiving Water Only	In-situ
Salinity	Salinity	Dry, Wet, Receiving Water Only	In-situ

6.4.4 Sampling Schedule and Dates

6.4.4.1 Dry Weather Sampling

The collection of water quality samples was performed for three (3) dry weather (DW) events; with one dry weather sampling event occurring during a low-flow period (less than 25th percentile flow) in Chester Creek and Ridley Creek. Below are the River and Creeks flows for during each of the dry weather sampling events. Table 6-6 below presents the Delaware River, Chester Creek and Ridley Creek flow during each dry weather sampling event. Dry Weather Sampling Event 3 is closest to the 25th percentile river flow.

Table 6-6: Observed River and Creek Flow Statistics

Water Body	Gage Identification	Gage Description	25th Percentile Flow	Dry Weather Event 1		Dry Weather Event 2		Dry Weather Event 3	
			(cfs)	(cfs)	Percentile	(cfs)	Percentile	(cfs)	Percentile
Delaware River	USGS 01463500	Delaware River at Trenton, NJ	4,600	13,323	70.1	16,306	78.1	10,862	62.1
Chester Creek	USGS 01477000	Chester Creek near Chester, PA	41	75.7	60.5	63.9	50.7	46.8	32.2
Ridley Creek	USGS 01476480	Ridley Creek at Media, PA	18	29.4	49	25.0	41.7	19.0	27.5

Source:
- 25th percentile flow (cfs) and percentile for each water body is courtesy of the U.S. Geological Survey (USGS) StreamStats (https://streamstats.usgs.gov/ss/)
- Observed flow data (cfs) for each Dry Weather Event is courtesy of the following current/historical observations link on the National Water Information System (NWIS) webpage:
  Delaware River: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01463500
  Chester Creek: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01477000
  Ridley Creek: https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=01476480

Two rounds of sampling were conducted for each dry weather survey: one round was completed during ebb (outgoing) tide and the second round was completed during flood (incoming) tide. The following table summarizes the dates of the DW events.

DW Sampling Event	Event Date
DW-1	3/23/2017
DW-2	5/10/2017
DW-3	6/13/2017

These events were distributed across the sampling season, of March through June 2017. The criteria used to define a dry weather event are as follows:

- No precipitation within the upstream watershed at least 48 hours before the event
- No precipitation forecasted for a minimum of three days; and

Dry weather event samples were taken at eleven (11) locations:

- **Three (3) locations on Chester Creek** intended to characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay River, the downstream sampling locations were intended to also reflect these tidal influences on water quality.

- **Three (3) locations on Ridley Creek** intended to characterize water quality upstream of DELCORA's service area as well as in the portion of the creek adjacent to DELCORA's CSO discharges and the area adjacent to the City of Chester outside the combined sewer service area. Additionally, because DELCORA's CSO discharges are within the tidal extent of the Delaware Bay, the downstream sampling locations were intended to also reflect these tidal influences on water quality
- **Five (5) locations on the Delaware River** intended to characterize water quality in the vicinity of DELCORA's CSO discharges. Sampling locations were selected to separate to the extent possible the effect of DELCORA's CSOs on water quality from other sources contributing pollutants to the waterways. Sampling was conducted near the shoreline adjacent to the City of Chester.

The locations of these sample stations are shown in Figure 6-2, and details for these stations are provided in Tables 6-2, 6-3 and 6-4. The set of parameters for which the samples were analyzed is provided in Table 6-5. In-situ measurements of physical parameters, such as salinity, temperature, and conductivity were collected at each sampling location with a YSI sonde. .In the Delaware River, *in situ* measurements were made at three depths at each sampling location during each round of sampling.

6.4.4.2 Wet Weather Sampling

The collection of water quality samples was performed for three (3) wet weather events. The purpose of the wet weather sampling was to characterize the impact of CSO discharges and non-CSO source runoff on in-stream water quality. The wet weather events spanned a range of precipitation, flow and seasonal conditions. One of the wet weather sampling events was also chosen as a calibration event for the H&H Model and the Water Quality Model.

The goal was to sample storms of at least 0.5 inches of precipitation. The criteria used to define a wet weather event included:

- No precipitation within the upstream watershed 48 hours before the event;
- Forecasts for a 60% (or greater) chance of rain over the entire DELCORA project area; and,
- Approximately 0.50 inches of rainfall forecasted over a six-hour period.

The following table lists the dates that each wet weather sampling event occurred:

WW Sampling Event	Event Date
WW-1	3/31/2017
WW-2	5/5/2017
WW-3	5/22/2017

Wet weather event samples were taken at all 13 in-stream locations as well as at six source locations in the intervals described below:

- **Six (6) In-Stream Tributary Sampling Locations:** Three (3) locations were on the Chester Creek and three (3) locations were on the Ridley Creek. The locations were the same locations

used for the dry weather surveys. Tributary locations were sampled up to five times per event at the following approximate intervals: Hour 0.5-2.5, Hour 4.5-6.5, Hour 8.5-10.5, Hour 14.5-16.5, and Hour 22-24. Sampling intervals were defined by the start of rainfall rather than CSO or SSO activation. A total of 30 samples was collected during each wet weather sampling event from in-stream locations. One field blank and one field duplicate was collected during each event to be used as field quality control (QC).

- **Seven (7) In-Stream Delaware River Locations:** Seven locations were on the Delaware River and were sampled up to ten times per event at the following approximate intervals: Hour 0, Hour 2, Hour 4, Hour 6, Hour 9, Hour 12, Hour 15, Hour 18, Hour 21, and Hour 24 intervals were defined by the start of rainfall rather than CSO or SSO activation. The frequency of sampling was intended to capture in-stream impacts in the vicinity of DELCORA's service area from both DELCORA's CSOs as well as upstream sources. Two additional locations on the Delaware River, one at mid-stream and one near the far shore, were added to characterize lateral variability in water quality during storm event conditions, when sampling across the river was feasible. The sampling regimen was also designed to allow a semi-quantitative mass balance to be computed over a complete tidal cycle. A total of 70 samples were collected during each wet weather sampling event. If river conditions were unsafe for sampling (e.g. small craft advisories, heavy barge traffic, etc.), sampling was suspended for one or more locations and/or sampling rounds. One field blank and one field duplicate was collected during each event to be used for field QC. Final selection of sampling locations and sampling intervals was determined prior to the start of the sampling program and based on logistic considerations (e.g. can seven locations be sampled and dropped off to a courier within the 3 hour sampling window), safety and accessibility to the Delaware River, and available resources. For some of the sampling events some of the planned intervals samples were not obtained if the storm event stopped before the designated sample time or if the boat could not reach the location due to restrictions on the Delaware River.
- **Six (6) Outfall Locations:** Sampling was conducted at two (2) stormwater outfalls and four (4) combined sewer overflow outfalls. The CSO and stormwater sampling locations were finalized prior to the initiation of the sampling program based on accessibility of sampling, safety of sampling personnel, equipment risk, and available resources. Each of the outfall locations had eight sets of samples collected for each event at the following intervals: 1st flush, 30 minutes, and 60 minutes, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours. Samples were collected from CSO-05, CSO -02 and CSO-18 and during each wet weather sampling event, and if all monitored outfalls discharge for 24 hours. If a location was not flowing, no sample was collected. However, the actual number of samples was less than the amount indicated since not all the monitored outfalls discharged for the full 24 hour monitoring period. One field blank and one field duplicate were collected during each event to be used as field QC.

The locations of these stations are shown in Figure 6-2. Details for these stations are provided in Tables 6-2, 6-3 and 6-4. The set of parameters for which the samples were analyzed are summarized in Table 6-5. *In-situ* measurements were not collected at the outfall locations.

Sampling crews conducted all wet weather event sampling using the protocols described in the DELCORA's *Water Quality Monitoring and Modeling Quality Assurance Project Plan* (Greeley and Hansen, 2017b). Samples were delivered to the laboratory and analyzed for the parameters shown in Table 6-5: Analytical and Field Parameters.

Determination to mobilize for a Wet Weather Event was a collaborative effort between Greeley and Hansen, LimnoTech, Eurofin (Lab) and DELCORA field sampling team. The intent was to identify a storm that was at least ½ inch rainfall and a 4 to 6 hour window in which a wet weather event may commence 24 hours in advance to assist in mobilization of the sampling crews meeting the requirements stated above for a WW event.

6.4.4.3 In situ Measurements (Receiving Water Only)

Instantaneous water quality measurements (such as salinity, temperature, and conductivity) using field instruments was also collected at the receiving water locations as specified in the *Water Quality Monitoring and Modeling Work Plan* (Greeley and Hansen, 2017a). These measurements, along with calibration and maintenance, were conducted following the SOPs for Water Quality Field Measurements in the Work Plan. Field instruments were calibrated before initiating monitoring activities for each event and a post-monitoring calibration check was conducted at the end of the event.

Salinity, temperature, and conductivity were measured at all in-stream sampling locations using a YSI 6920 sonde during both wet and dry sampling events, prior to sample collection. Whenever possible in the Chester Creek and Ridley Creek, measurements were made mid-channel at mid-depth. Whenever possible in the Delaware River, measurements were made at the surface, mid-depth and near the bottom.

6.4.5 QAPP Overview

Prior to the start of the spring 2017 water quality sampling activities, DELCORA submitted to the EPA and PADEP its *Water Quality Monitoring and Modeling Quality Assurance Project Plan* (Greeley and Hansen, 2017b). This Quality Assurance Project Plan (QAPP) was developed to meet the requirements of the DELCORA Consent Decree Paragraph Section V.A.15.a.(iv) requiring detailed information regarding all additional data collection and water quality modeling activities. The purpose of the QAPP was to document the necessary procedures required to assure that the project is executed in a manner consistent with applicable USEPA guidance documents and with generally accepted and approved quality assurance objectives. The QAPP was organized in accordance with the basic groups and subgroup elements discussed in the USEPA guidance for QAPPs. The four basic groups include project management (Group A); data generation and acquisition (Group B); assessment and oversight (Group C); and data validation and usability activities (Group D). The groups are subdivided into elements covering specific topics related to each group. The Section and Subsection headings of this QAPP include references to the USEPA QAPP Guidance group letters and element numbers to facilitate cross-reference with the Guidance.

The QAPP integrates quality control policies and project-specific work tasks to successfully conduct water quality monitoring and modeling to support the CSO Long Term Control Plan update. Greeley & Hansen served as the contracting authority for the project and provided overall project management. LimnoTech served as the technical advisor for the sampling program and provided the data integration and interaction role. The field contractor, Weston conducted the actual sampling program, and the laboratory contractor, Eurofins, performed laboratory analysis for the project.

The QAPP was designed and organized in terms of compliance with USEPA requirements. It was the overall intent of the QAPP to provide professional guidelines for activities by all personnel on the project and to ensure that quality assurance/quality control QA/QC procedures are followed.

6.5 Receiving Water Quality Results

The identified pollutant of concerns for the Delaware River, Chester Creek and Ridley Creek are the same three indicator bacteria; fecal coliform, *Escherichia coliform* (*E. coli*), and enterococcus. Consequently, the Water Quality Monitoring Program primarily focused on the concentrations of these three parameters.

Water Quality Sampling has been completed; however, the results are currently being reviewed for quality assurance and analyzed. A summary of the sampling results are presented in Appendix D of this report; however, the analysis and conclusions are currently being conducted and will be presented in the final Water Quality Sampling Report and the final Water Quality Modeling Report.

Section 7 Typical Hydrologic Period

7.1 Introduction

7.1.1 DELCORA's Consent Decree

According to the Consent Decree between the USEPA, PADEP, and DELCORA, DELCORA shall submit to Plaintiffs a report or technical memorandum describing DELCORA's statistical evaluation of long-term local rainfall patterns and the identification of an appropriate typical period for LTCP development purposes. To satisfy this Consent Decree requirement, DELCORA submitted the *Typical Hydrologic Period Report* (Greeley and Hansen, 2016a), which was approved by PADEP and USEPA on May 23, 2016. The remainder of Section 7 is based on this approved report.

The statistical evaluation in the *Typical Hydrologic Period Report* (Greeley and Hansen, 2016a) utilizes local long-term rainfall record from the Philadelphia International Airport. It considers various appropriate rain year characteristics, including distributions of event rainfall totals, event durations, and peak and average rainfall intensities.

7.1.2 Typical Year for CSO LTCP Development

Precipitation generates urban storm water, combined sewer overflows (CSOs), and increased wet weather flows to the wastewater treatment plant. These will contribute bacteria and pollutants to the Delaware River and its tributaries. The effect of these contributors on the Delaware River mainly depends on the magnitude and duration of rainfall events and on the prevailing ambient river conditions controlling dilution and transport of the pollutants. This variability and complexity poses a significant challenge for assessing the performance of wet weather and CSO control alternatives.

In accordance with the USEPA CSO Control Policy (CSO Policy), dated April 19, 1994, the CSO control alternatives should be assessed on a "system-wide, annual average basis". This is accomplished by continuous simulation using a typical hydrologic period for the combined sewer system (CSS) and receiving water quality modeling applications. The CSO Policy supports continuous simulation modeling, i.e., using long-term rainfall records rather than records for individual storms. Long-term continuous rainfall records enable simulations to be based on a sequence of storms so that the additive effect of storms occurring close together can be examined. They also enable storms with a range of characteristics to be included.

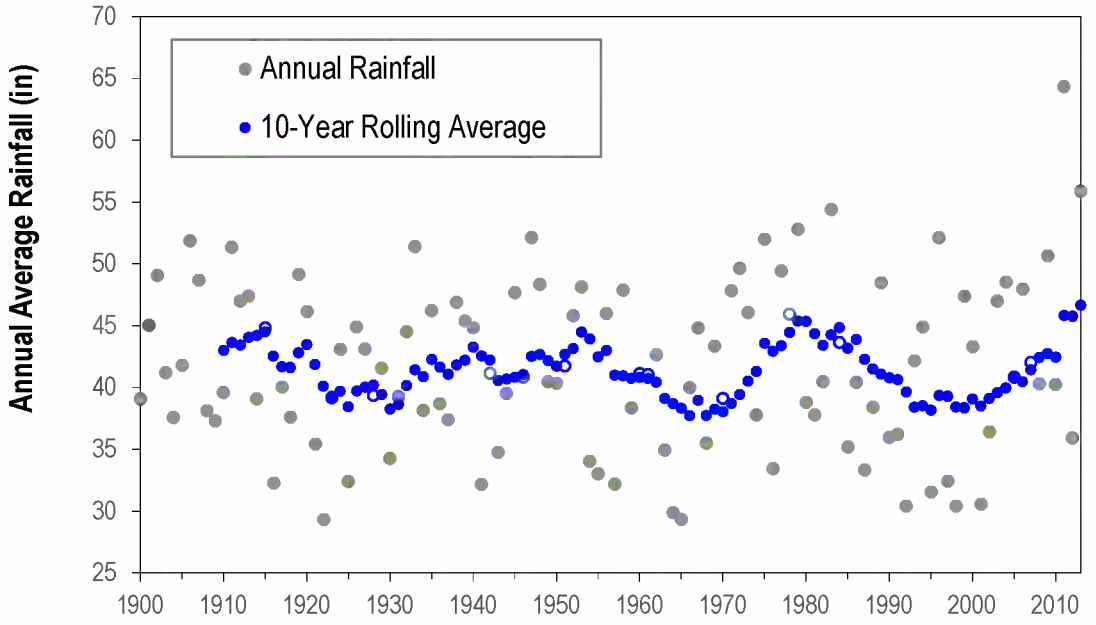
Typically, a 3- to 5-year period is evaluated to balance between manageable model simulation time and representation of various rainfall/river conditions. In this study, a 3-year period is deemed most appropriate considering the modeling complexity. The representative three-year period is intended to contain a relatively wet year, a dry year and an average year. Average year conditions are defined as the arithmetic average of the predictions for the selected period.

7.1.3 Climate Change Considerations

Average U.S. precipitation has increased since 1900, but there are regional differences, with some areas having larger increases, and others, decreases. Local climate change should be considered when selecting appropriate data records for the typical period analysis.
Rainfall data from the Philadelphia International Airport were obtained from the National Oceanic and Atmospheric Administration (NOAA). Hourly rainfall data is available from 1900 through 2013. This provides sufficient data to evaluate climate change in the area. Figure 7-1 shows annual rainfall from 1900 to 2013. A 10-year rolling average trend line is also shown in the figure for characterizing long-term precipitation pattern. In the past 114 years, annual rainfall ranges from 29.3 to 64.33 inches, with the wettest year in 2011. The 10-year rolling average rainfall indicates that precipitation in the area runs through various dry and wet cycles, however with more extreme conditions (dry and wet) in recent years.

Considering the climate change, it is determined that the typical period for the LTCPU be selected based on statistical analysis of rainfall records in recent 30 years (i.e., 1984-2013).

Figure 7-1: Historical Annual Rainfall at Philadelphia International Airport



7.1.4 Methodology of Typical Year Selection

The typical hydrologic period is selected to provide representative and unbiased approximations of expected future conditions in terms of both averages and historical variability. Representativeness is assessed using objective criteria for each of the ambient factors (i.e., river flow and rainfall). As indicated in the previous section, the selection of the typical hydrologic period is based on the historical records in the past 30 years from 1984 through 2013.

The following datasets are used for the analysis of the typical hydrologic period:

- Hourly precipitation data for the National Climate Data Center gauge at Philadelphia International Airport for 1984 - 2013.
- Daily Delaware River stream flow data from the U.S. Geological Survey gauge at Trenton, NJ (USGS 01463500) for 1984 - 2013. This is the closest USGS gauge that with daily river flow available.

Key criteria parameters used in the evaluation are listed in Table 7-1. Each parameter is given a weighting factor to describe the individual importance on the averageness of the analyzed time period. The parameters that are given the highest impact weighting include the following:

- The total annual rainfall depth, which drives the total runoff volume.
- The maximum peak intensity, which usually defines the biggest overflow event.
- The median Delaware River flow; the impact of sewer overflows on the water quality of the receiving water is dependent on the magnitude of the flows in river, and in the project area, intense local rainfall events are typically independent from watershed wide high flow events.

Table 7-1: Hydrologic Period Ranking Parameters

Key Parameter	Weighting Factor	Comments
Annual rainfall depth	25.0%	Important for evaluating annual overflow volume
Number of events > 0.1" rainfall depth	2.5%	Typically storms over 0.1" would start to cause surface runoff
Number of events > 0.25" rainfall depth	2.5%	Previous model indicates system overflows at storms over 0.25"
Number of events > 1.5" rainfall depth	7.5%	Storms to be controlled to meet potential presumption approach
Number of back-to-back events	5.0%	Important for evaluating the antecedent conditions
Maximum peak intensity	20.0%	Storms with high intensity causes overflows
Average rainfall duration	2.5%	Important for evaluating wet weather durations
Average rainfall intensity	5.0%	Important for evaluating overall rainfall intensity
Delaware River flow - 25th percentile	2.5%	Important for evaluating dilution power of the Delaware River flow for water quality
Delaware River flow - 50th percentile	25.0%	
Delaware River flow - 75th percentile	2.5%	

7.2 Typical Year Selection for DELCORA

7.2.1 Annual Rainfall and River Flow Statistics

30-year hourly precipitation data (1984 - 2013) from the Philadelphia International Airport was analyzed to evaluate all individual rainfall events in the period. An inter-event time (IET) of 6 hours (i.e. minimum dry time of 6 hours between rainfall events was used to differentiate between individual events. Precipitation periods with a total rainfall volume of greater than 0.1 inch were counted as rainfall events. If the next rainfall event's starting time is within one day of the previous rainfall event's ending time, these two rainfall events are considered as back-to-back rainfall events. All rainfall events for the data period were analyzed for duration, inter-event duration, total rainfall amount, as well as maximum and average rainfall intensities. A total of 1,934 rainfall events were counted for the period of 1984 - 2013.

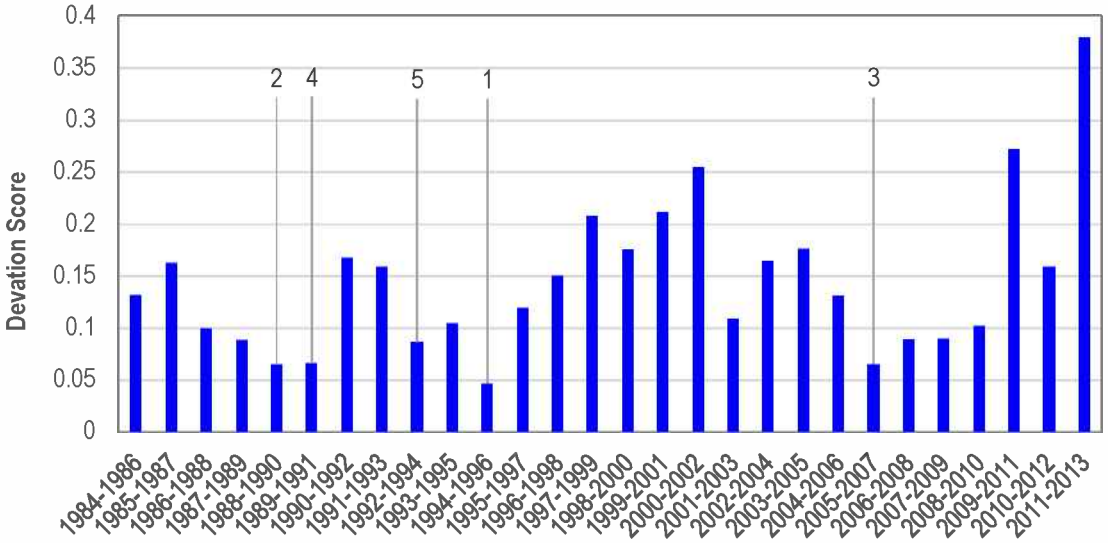
7.2.2 Three-year Rainfall and River Flow Analysis

Once annual rainfall and river flow statistic were determined for the 30 year period, three-year rainfall and river flow characteristics were developed based on an annual average of the three consecutive years. The goal of using a three-year analysis period was to find a period that had a relatively dry year, a relatively wet year, and a relatively average year. That way, any evaluations done using the typical hydrologic period have a more diverse spectrum of wet weather events and dry weather periods.

7.2.3 Ranking Analysis

With the weighting factors listed in Table 7-1, a deviation score was developed for each individual period. The 3-year periods were then ranked based on the deviation score. The lower the deviation score (Figure 7-2 Y-axis), the higher the rank for the hydrologic period (i.e., the closer it is to the average condition). Figure 7-2 shows the ranking results of the 28 hydrologic periods, with a ranking of 1 being the highest and a ranking of 28 being the lowest ranked hydrologic period. Hydrologic period 1994-1996 is ranked No.1 because it has the lowest deviation score of 0.047.

Figure 7-2: Ranking Score of 3-year Period, 1984-2013



7.2.4 Top 5 Ranked 3-year Hydrologic Periods

Based on the ranking analysis, the top 5 ranked hydrologic periods are:

- Rank 1: 1994-1996
- Rank 2: 1988-1990
- Rank 3: 2005-2007
- Rank 4: 1989-1991
- Rank 5: 1992-1994

Table 7-2 shows rainfall and river flow statistics for these top ranked hydrologic periods.

Table 7-2: Top 5 Ranked Hydrologic Periods

Rank	Year	Rainfall								Delaware River Flow (cfs)		
		Annual Rainfall (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Average Rainfall Duration (hr)	Events ≥0.10 in.	Events ≥0.25 in.	Events ≥1.5 in.	Back-to-Back Event	25th Percentile	50th Percentile	75th Percentile
1	1994-1996	42.9	1.50	0.08	10.1	65	47	5	7	5,611	9,710	16,775
2	1988-1990	41.0	1.69	0.08	10.5	63	44	5	10	5,598	8,338	13,925
3	2005-2007	43.6	1.55	0.09	10.6	61	45	6	10	6,030	10,450	17,533
4	1989-1991	40.2	1.50	0.08	10.8	63	45	5	10	5,187	8,043	14,467
5	1992-1994	39.2	1.50	0.08	10.6	64	41	5	8	5,070	7,760	13,167
Average 1984-2013		**41.3**	**1.53**	**0.08**	**10.7**	**62**	**44**	**5**	**9**	**5,540**	**9,325**	**15,770**

Rainfall return frequency during 1988 through 2013 was analyzed to understand the distribution of the large rainfall events with return frequencies above 1-year. Table 7-3 summarizes quantity of large rainfall events with return frequencies for the top 5 ranked hydrologic periods.

- All of the top 5 hydrologic periods have a 25-yr storm.
- Hydrologic period 1994-1996 (Rank 1) contains one 25-yr storm, one 10-yr storm and three 1-year storm. Hydrologic period 1988-1990 (Rank 2) contains one 25-yr storm, one 10-yr storm, three 2-year storm and one 1-year storm.
- Hydrologic period 1994-1996 (Rank 1) is more conservative because its annual average rainfall amount of 42.9" is slightly greater than the 30-yr average. It is considered a better option than hydrologic period 1988-1990 (Rank 2), which has a slightly less annual rainfall than the average.

Table 7-3: Rainfall Return Frequency Summary for the Top 5 Ranked Hydrologic Periods

Rank	Year	Quantity of Rainfall Events with Return Frequency above				
		25-yr	10-yr	5-yr	2-yr	1-yr
1	1994-1996	1	1			3
2	1988-1990	1	1		3	1
3	2005-2007	1	1		2	4
4	1989-1991	1			2	3
5	1992-1994	1	1			3

The analysis was also conducted with an IET of 12 hours, and the top five ranked hydrologic periods. The top four hydrologic periods based on the IET of 12 hours are the same as the analysis based on the IET of 6 hours, which include the 3-year period 1994 - 1996 remaining as Rank 1.

7.2.5 Selected Hydrologic Period

The 3-year period 1994-1996 (Rank 1) will be used as the typical hydrologic period for the CSO LTCPU. This period contains a wide range of storms and antecedent conditions. The hydrologic period of 1994-1996 is also evaluated for longer historical rainfall records up to 100 years. It is ranked No. 1 for the 50-years record and No. 2 for the 100-year records (Table 7-4).

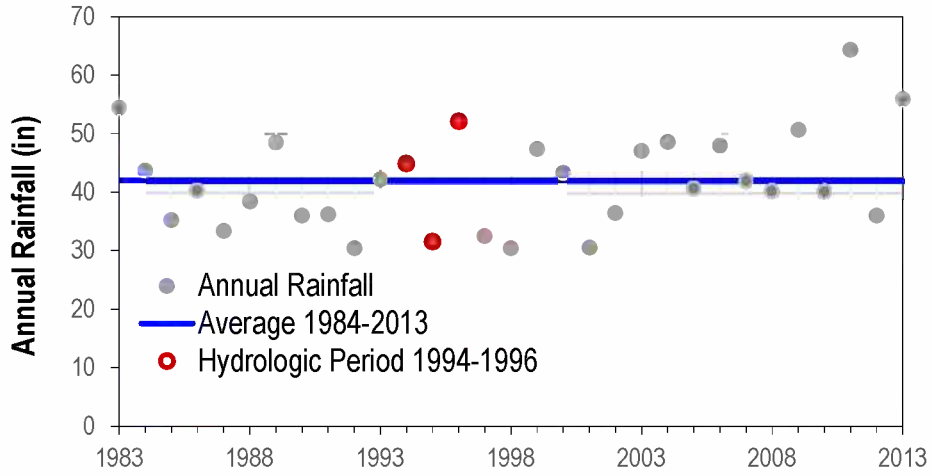
Table 7-4: Rank of Hydrologic Period 1994-1996 from Various Rainfall Data Set

	30-year Rainfall Records, 1984-2013	50-year Rainfall Records, 1964-2013	100-year Rainfall Records, 1914-2013
Rank of 1994-1996	1	1	2 (1925-1927 as Rank 1)

7.2.6 Additional Information on Statistical Analysis of Rainfall Data

Figure 7-3 shows annual rainfall and average annual rainfall for years 1983-2013. The hydrologic period 1994-1996 contains a relatively wet year (1996 with 52.1 inches), a dry year (1995 with 31.6 inches) and a year close to average conditions (1994 with 44.9 inches).

Figure 7-3: Annual Rainfall 1983 - 2013



Characteristics of the top 10 storms (by rainfall depth) in each year of the hydrologic period 1994-1996 are shown in Tables 7-5, 7-6 and 7-7.

Table 7-5: Ten Largest Storms and Return Frequencies in 1994

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	7/18/1994 7:00	3.45	4	1.5	25-yr
2	7/14/1994 15:00	2.89	7	1.41	10-yr
3	3/9/1994 11:00	2.00	27	0.37	< 1 year
4	8/21/1994 19:00	1.76	18	0.49	< 1 year
5	3/28/1994 0:00	1.41	37	0.14	< 1 year
6	5/7/1994 15:00	1.37	15	0.25	< 1 year
7	3/2/1994 9:00	1.32	22	0.14	< 1 year
8	1/27/1994 19:00	1.15	20	0.2	< 1 year
9	7/27/1994 17:00	1.11	8	0.49	< 1 year
10	1/17/1994 10:00	1.07	18	0.18	< 1 year

Table 7-6: Ten Largest Storms and Return Frequencies in 1995

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	10/4/1995 18:00	1.82	33	0.54	< 1 year
2	10/27/1995 20:00	1.81	13	0.5	< 1 year
3	9/16/1995 22:00	1.6	13	0.24	< 1 year
4	1/6/1995 18:00	1.43	11	0.27	< 1 year
5	1/20/1995 0:00	1.25	10	1	< 1 year
6	10/20/1995 21:00	1.21	16	0.52	< 1 year
7	3/8/1995 17:00	1.16	8	0.29	< 1 year
8	10/14/1995 7:00	1.12	21	0.25	< 1 year
9	2/3/1995 22:00	1.04	15	0.2	< 1 year
10	7/17/1995 22:00	1.00	4	0.48	< 1 year

Table 7-7: Ten Largest Storms and Return Frequencies in 1996

Top 10 Rainfall Event	Rainfall Start Date and Time	Rainfall Volume (in)	Rainfall Duration (hr)	Max Rainfall Intensity (in/hr)	Rainfall Return Period
1	12/13/1996 13:00	3.03	33	0.27	1-yr
2	8/12/1996 19:00	2.34	13	0.52	1-yr
3	9/16/1996 14:00	2.26	16	0.38	< 1 year
4	10/18/1996 16:00	2.22	19	0.54	1-yr
5	7/12/1996 15:00	2.11	22	0.4	< 1 year
6	12/1/1996 7:00	1.62	23	0.56	< 1 year
7	6/29/1996 22:00	1.61	17	0.26	< 1 year
8	11/25/1996 23:00	1.58	10	0.38	< 1 year
9	7/31/1996 20:00	1.48	4	1.03	< 1 year
10	10/8/1996 10:00	1.32	11	0.24	< 1 year

Section 8 Hydrologic and Hydraulic Modeling

This section describes the development and application of the Hydrologic and Hydraulic Model for DELCORA's combined sewer system. This model will aid in the identification and evaluation of a range of potential water pollution treatment/control alternatives for use as part of DELCORA's Combined Sewer Overflow Long-Term Control Plan Update (CSO LTCPU).

8.1 Background

Since 1997, DELCORA has conducted annual modeling of the CSS using the USEPA's Storm Water Management Model (SWMM) to estimate overflows to its receiving waters. SWMM is a dynamic rainfall-runoff simulation model that can simulate single-event or continuous runoff quantity and quality from primarily urban areas. The model simulates the time-varying process of rainfall onto land surfaces, the conversion of rainfall to infiltration, evaporation, or surface runoff, and the routing of mixed stormwater runoff and sanitary sewage through the collection system. This model is also referred to as DELCORA's Hydrologic and Hydraulic (H&H) model.

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP, but it did not include the entirety of DELCORA's service areas. The original model included one (1) rain gage located at the WRTP, 67 subcatchment areas, 29 outfall nodes (CSO outfalls), 736 storage nodes (sewer manholes), 735 conduit links (sewer mains) and 34 orifice links (CSO regulators), but no pump stations and force mains were included.

The model was set up to simulate monthly CSO discharges with reasonable continuity error in EPASWMM 5.0. The model had been updated and expanded over the years to account for changes in the combined sewer system, but it had not been re-calibrated during the development of the 2012 revisions to the LTCP.

Monthly CSO overflow estimates using the model are reported to the PADEP as part of DELCORA's Annual Municipal Wasteload Management Report (Chapter 94 Report) and monthly with the PADEP electronic Discharge Monitoring Report (e-DMR). The H & H Model is also used as a scenario model to evaluate potential upgrades to the CSO system.

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was updated and expanded over the years to account for changes in the CSO system, but it was not re-calibrated during the development of the 2012 LTCP (Weston, 2012). Section V.A.14 of the 2015 Consent Decree requires DELCORA to update and calibrate the H&H Model to include hydrologic representations of all areas tributary to the Model Area. The project team reviewed the 2012 model in order to:

- Assess adequacy of the original model for use in DELCORA's LTCPU.
- Identify gaps with the original model in meeting the requirements in the Consent Decree.
- Identify updates required to reflect current hydrologic and hydraulic conditions of DELCORA's collection system.
- Determine refinements needed for the model update.

Results from the review of the 2012 H&H Model were presented in the *Hydrologic and Hydraulic Model Update and Calibration Plan* (Greeley and Hansen, 2015). DELCORA completed the expansion and revisions to the H&H model in the summer of 2017, and it now includes all of Model Area and more accurately reflects the current collection system conditions. .

The revised H&H model uses Gauge Adjusted Radar Rainfall (GARR) data to estimate the frequency and volume of CSO overflows and to evaluate long-term strategies for minimizing CSO overflows. Precipitation breaks of at least 12 hours are used to establish separate storm events.

8.2 H & H Modeling Capabilities

The H & H Model simulates runoff from the CSO service areas into the sewers and then routes the flow through the major trunk sewers, CSO regulator structures, and the interceptors to the Western Regional Treatment Plant. A number of hydraulic modeling software packages are available, including EPA SWMM5, InfoSWMM, InfoWorks, Mike Urban and PCSWMM. For this H&H Model update, EPA SWMM, Version 5.0, Build 5.0.022 and Innovyze InfoSWMM Version 14.5 Update 4 were selected as the modeling software. EPA SWMM5 is a fully dynamic model and has been used extensively throughout the United States and abroad to assess CSO, flooding and water quality issues. It can be applied to simulate single events or long periods of time in a continuous mode. It can estimate runoff flow from several subcatchment basins and route the flow through the sewer system to treatment facilities or to the receiving waters. InfoSWMM uses the current EPA SWMM 5 engine as its computational solution and is fully integrated with ArcGIS which provides greater flexibility of importing model network from existing GIS database and preparing initial model inputs from existing datasheets. InfoSWMM was used during the model development and the calibration phase.

8.2.1 Combined Sewer System Model

The InfoSWMM model has the following capabilities for modeling DELCORA's combined sewer system:

- A user-friendly, ArcGIS integrated graphical interface for cost-effective use and updating.
- A physical based model with model formulations explicitly linked to actual conditions in the field as input by the user.
- Simulates the hydraulic conditions of the modeled trunk sewers, interceptors, gravity sewers, force mains, pump stations, and treatment plant during dry and wet weather.
- Evaluates CSO control alternatives and interceptor capacities.
- Can be periodically updated to reflect the implementation of the CSO control plan and increased development within the service areas.
- Estimates of Run-off from combined sewer areas.
- Estimates wet weather flows from separate sewered areas (rainfall derived inflow and infiltration (RDII)).
- Real-Time Control operations.
- Technical and regulatory credibility (developed from U.S. EPA SWMM software).

8.3 Data Collected

The data requirements needed for the sewer system model include

- Physical characteristics of the sewer system, which are used to configure the model specifically for DELCORA's collection system. (The physical characteristics of the sewer system are described in Section 3 of this report)
- Land use data, which influences the amount of runoff delivered to the sewer system. (See information presented in Section 3 of this report)
- Rainfall data, which are used as inputs to the model. (The collection of rainfall data is for validation and calibration is described in Section 4 of this report. Rainfall data for use as the typical hydrologic period is described in Section 7 of this Report)
- Flow monitoring data, which are used to calibrate and validate the collection system model output. (The collection of flow monitoring data is described in Section 4 of this report)

The model update is based on information obtained from a variety of sources including DELCORA's input, GIS, record drawings and field survey. Other documents pertaining to standard/actual operating procedures for CSO regulators, pump stations and the WRTP were also used to set up real time controls in the model. The model network consists of all major interceptors and force mains and extends to all active overflow points. The datum for the model is NGVD 29.

8.4 H & H Model Development

The development of a sewer system model is complicated and includes many components. The following paragraphs describe how the data described in the previous section are used in the model development.

8.4.1 H & H Model Inputs

Inputs to the Model include rainfall data and the hydrologic watershed parameters. The watershed parameters pertains to the combined sewer service areas only and were as follows:

- Subcatchment areas
- Percent imperviousness (pavement, rooftops, and structures impervious to rainfall infiltration)
- Subcatchment widths
- Overland slope within the subcatchments
- Depression storage within the subcatchments
- Manning's roughness coefficient for overland flow
- Soil infiltration of rainfall in pervious areas
- Base flow

The rainfall data and watershed parameters are described in the following subsections.

8.4.2 Rainfall Data

Rainfall data within the model represent the average precipitation that falls on an area within a defined time interval. Rainfall data was entered in the model as total rainfall or rainfall intensity occurring within a time interval. The rainfall time interval can be as short as a minute or as long as an hour. Generally, the model results satisfactorily match observed flow monitor data when the rainfall input time interval is at a minimum of 15 minutes. Actual rainfall data recorded at 5-minute frequency were entered into the model for model calibration.

8.4.3 Subcatchment Areas

Subcatchment areas are the discrete surface areas that contribute runoff and overland flow to the combined sewers. Delineation of subcatchments was described in Section 3 of this Report. The model represents a subcatchment as a polygon area with the overland slope perpendicular to the subcatchment width. The point where the runoff enters the sewer is called the point of concentration (receiving node). The major trunk sewers from each CSO service area along with all interceptor sewers and CSO regulators were incorporated into the model.

8.4.4 Percent Imperviousness

The initial percent imperviousness for the combined area was calculated as described in Section 3 of this Report. Then, the impervious percentage values were adjusted during the model calibration process to best simulate the observed hydrologic response over the selection of precipitation events. All open areas not tributary to the sewer system were measured from the aerial photographs and subtracted from the subcatchment areas. The open areas are considered non-point sources, which drain directly to the receiving waters.

8.4.5 Subcatchment Widths

Subcatchment width affects the shape of the runoff hydrograph and is generally an H&H model calibration parameter. Higher peak flow rates and more immediate response to a storm event are simulated when the subcatchment width is increased for the same subcatchment. The initial inputs for the subcatchment width were determined by dividing the total area of the subcatchment by the representative overland flow length in the subcatchment. These initial inputs were adjusted based on model calibration comparisons to data.

8.4.6 Overland Slope

Overland slope is a measure of the steepness of the land in the subcatchments. It is a model input and affects the travel time of overland flow, peak runoff rate, and runoff volume. Steeper slope decreases the travel time, increases the peak runoff rate and increases the runoff volume. The slope of a subcatchment should reflect the average slope along the pathway of overland flow to inlet locations. For the combined sewer subcatchments, slopes from the 2012 H&H model were retained for use in the updated model.

8.4.7 Depression Storage

Some rainfall on the pervious and impervious areas is held in small depressions rather than becoming part of the overland flow. It is defined as the amount of incidental surface depressions that must be filled before runoff typically begins. Initial values for depression storage were described in Section 3 of this Report. For all practical purposes, depression storage is difficult to measure and is typically adjusted during the calibration process.

8.4.8 Manning's "n" Roughness Coefficient

Overland flow travels slower or faster depending on the roughness of the surface in the subcatchment. The higher the roughness coefficient, the greater the friction and the slower the flow travels. Again, this is a model parameter that cannot be practically measured. A typical range of Manning's "n" suggested by the SWMM is 0.011-0.024 for impervious area and 0.06-0.80 for pervious area. The initial values were set to 0.013 for impervious surfaces and 0.15 for pervious surfaces. Roughness is an empirical value and may be treated as a calibration parameter if necessary.

8.4.9 Separate Sewer Areas

The DWF for each separate sewer service area was determined as described in Section 4 and input into the model at the appropriate combined sewer node. To estimate the wet weather impacts on the separate sewer service areas, the flow monitoring data collected during the monitoring program was evaluated.

8.4.9.1 Rainfall Derived Infiltration and Inflow (RDII)

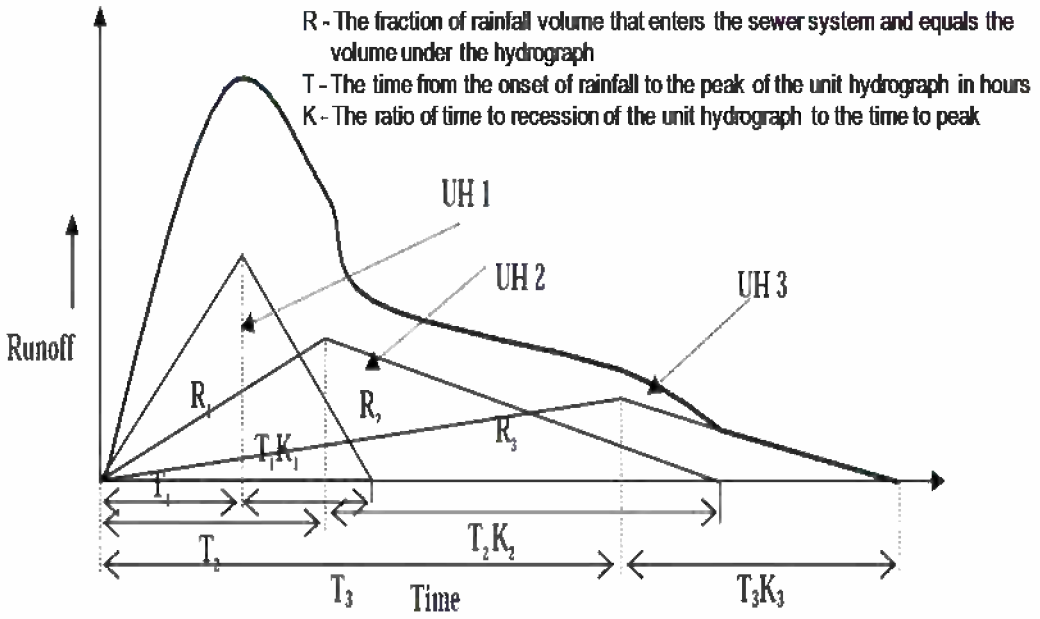
The model uses the RTK unit hydrograph (UH) to estimate RDII into the separated area sewer systems. As shown in Figure 8-1 (Muleta & Boulos, 2008), a RTK UH set contains up to three hydrographs: one for a short-term response (UH1), one for an intermediate-term response (UH2), and one for a long-term response (UH3). UH1 represents the most rapidly responding inflow component and has a short T value, UH2 includes both inflow and infiltration and has a longer T value, and UH3 includes infiltration that may continue long after the storm event has ended and has the longest T value. The unit hydrograph is defined by the following three parameters:

- R: the fraction of rainfall volume that enters the sewer system and equals to the volume under the hydrograph,
- T: the time from the onset of rainfall event to the peak of the unit hydrograph in hours, and
- K: the ratio of time to recession of the unit hydrograph to the time to peak.

The same set of RDII parameters were applied in the same metershed because of the availability of the flow hydrograph for model calibration. The initial values of RTK were estimated using the RDII Analyst tool in the InfoSWMM. The RTK values are calibration parameters to be refined during model calibration.

Rainfall and sewershed area information was needed for RDII calibration. Subcatchment areas were estimated as described in Section 3. Rainfall and flow data from the monitoring program (see Section 4) were used for the calibration.

Figure 8-1: RTK Unit Hydrographs



Source: M.K. Muleta and P.F. Boulos, Analysis and Calibration of RDII and Design of Sewer Collection Systems, ASCE Conference Proceedings 316, 642 (2008)

8.4.10 Soil Infiltration

Infiltration parameters modestly influence the runoff hydrograph from the combined sewer system subcatchments by reflecting rainfall absorption into the soil. The H&H model uses the Horton method with infiltration parameters determined based on evaluation of soil types as described in Section 3.

8.4.11 Sewer Mains

Sewer mains are the conveyance element and were simulated as conduits in the model. The following input information was entered into the H&H model:

- Conduit ID
- Shape
- Number of barrels
- Upstream and downstream nodes
- Upstream and downstream offset
- Dimension (length, diameter/depth)
- Manning's roughness coefficient
- Minor loss coefficient (entry loss, exit loss, average loss)
- Flap gate installed or not (set at no flap gate for most of the sewer mains)

Most of the pipe input parameters, including upstream and downstream nodes, dimension, shape, number of barrels, and flap gate information, were found or estimated from record drawings, design drawings and sewer gravity main GIS shapefiles. For pipes that do not begin or end at the invert of the upstream or downstream node, an offset value was provided to describe the difference from the invert of the pipe to the invert of the upstream or downstream node.

Manning's roughness coefficient is related to the pipe material. The initial input of the Manning's n for different materials is summarized in Table 8-1. The Manning's n may be changed during calibration to account for minor loss or additional sediment depositions in the pipe.

The initial minor loss for pipe will be set at zero for most pipes. For those pipes with sharp turns, a higher minor loss was applied.

Table 8-1: Manning's Roughness Coefficient for Sewer Mains

Pipe Material	Manning's N
Polyvinyl Chloride (PVC)	0.011
Reinforced Concrete Pipe (RCP)	0.013
Ductile Iron (DI)	0.013
Cast Iron (CI)	0.013
Corrugated Metal Pipe (CMP)	0.020
Masonry	0.025
Unknown	0.013

8.4.12 Manholes

Sewer manholes were simulated as junction nodes in the model. The following information was entered into the H&H model:

- Node ID
- Invert
- Maximum Depth (approximated as the difference from manhole rim and manhole invert)
- Surcharge Depth

8.4.13 CSO Outfalls

CSO outfalls will be simulated as outfall nodes in the model. The following information was entered into the model:

- Outfall ID
- Type (free, normal, fixed stage, tidal stage, time series, stage-flow, flap gate)
- Invert
- Boundary conditions

Outfall characteristics were described in Section 3.

8.4.14 Flow Diversion Structure

As described in Section 3, most of the flow diversion structures are similar to Brown and Brown type regulators. The key components required for modeling these structures were described in Section 3.

Regulator Gates

Regulator gates will be simulated as orifices in the updated model. The following information was entered into the model:

- Regulator Gate ID
- Upstream and downstream nodes
- Type
- Shape (two shapes: circle, rectangular)
- Dimension (Height, Width)
- Discharge Coefficient

Characteristics of the regulator gates were described in Section 3. All regulator gates are modeled as rectangular except for REG_004_Gate which is modeled as a circular orifice. The updated model includes real time control rules for opening and closing of the gates based on levels in the float chamber and regulator limit settings

Orifices

Characteristics of the orifice plates are described in Section 3. The following information was entered into the model:

- Orifice ID
- Upstream and downstream nodes
- Type (two types: side, bottom)
- Shape (two shapes: circle, rectangular)
- Dimension (Height, Width, Crest Height)
- Discharge Coefficient

8.4.15 Weirs

Diversion weirs will be simulated as weirs in the model. Characteristics of the weirs are described in Section 3. The following information was entered into the model:

- Weir ID
- Upstream and downstream nodes
- Type (four potential weir types: transverse, sideflow, V-notch, trapezoidal)
- Dimension (Height, Weir Length, Weir Crest Height)
- Coefficient of Discharge
- Number of End Contractions

8.5 Summary

The 2012 H&H model was updated as described above. A summary of the key revisions is presented in Table 8-2. The detailed layout of the updated model is shown in Figure 8-2 and Figure 8-3.

Table 8-2: Summary of Revised H&H Model

Review Item	2012 Model Review Observation	Comments	Updated Model
Model Software	- EPA SWMM 5.0		Innovyze InfoSWMM version 14.5
Vertical Datum	- NAVD 88	- To be verified	- NGVD29
General Sub Models	- EPASWMM for the runoff model - Horton Equation for the infiltration model - Hydrodynamic wave for the flow routing model	- All these choices are commonly seen in collection system modeling practices	
Rain Gauge	- One (1) rain gage, located at the Western Regional Treatment Plant (WRTP)	- One rain gauge is not sufficient for the entire service area in the model	- Seven (7) rain gauges, as shown in Section 2 - Additional GARR analysis performed
Service Area	- 67 subcatchments, all for combined area - One set of Horton infiltration parameters are applied to most of the subcatchments (66 out of 67 subcatchments) - The infiltration parameters applied in the model is equivalent to infiltration parameters for soil type C/D	- All service area including separated area that contribute flow to the DELCORA collection system should be included in the model - Combined area delineation will be checked to include any changes along the years - Soil type need to be checked to verify Horton infiltration parameters in all subcatchments	- 114 subcatchments, 53 for combined area and 61 for separated areas - Combined area was modified to include newly separated areas. - Horton infiltration parameters applied to 56 out of 114 subcatchments - Horton infiltration parameters varied based on identified soil types -

Review Item	2012 Model Review Observation	Comments	Updated Model
Sewer Manhole	- 736 storage nodes. - All sewer manholes are simulated as storage units in the model. - The majority of the storage units (732 out of the 736) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - All storage units are set-up with a ponding area of 9,999 sf. to allow excess water to collect atop of the nodes and be re-introduced into the system as conditions permit.	- Sewer manholes will be simulated as common junction node - This will help with SSO evaluation in the collection system	- 860 common junction nodes. - The majority of the common junction nodes (836 out of the 860) have a diameter of 4-ft, and the rest (4 units) have a surface area of 100 square feet (sf.) (equivalent to 10'x10'). - There are 35 imaginary junctions created to receive flow from the subcatchments gravity network not included in the model network
CSO Outfall	- 29 outfall nodes - All CSO outfalls are free outfall	- All outfalls are located in the Delaware River in the tidal reach, a tidal stage instead of free outfall should be assigned to the outfalls - Outfall ID 101 has dry weather input of 1.76 cfs, it represents WRTP in the model	- 24 CSO outfall nodes - Tidal data is assigned to 24 outfalls using time series - Wherever tide gates are installed, a real time control is applied

Review Item	2012 Model Review Observation	Comments	Updated Model
Sewer Mains	- 735 conduit links. - Negative slopes at Nodes 73803 and 70709 not matching the GIS. - Pipe connectivity is not consistent with the GIS in Subcatchment EA1, 25A. - Pipe size and connectivity is not consistent with the GIS around Node: 5201242, 5201234. - Pipe size is not consistent with the GIS around Node: 52018-52015. - Pipe size is not consistent with the GIS around Node: 531-527, 522-517, 516-513, 510020301-5100202, 403-NCPS, 40801-40801A, 32405-32404, and 1110402-11103. - Pipe size and slope are not consistent with the GIS around Node: 422-4140. - NREG06 outfall pipe direction is opposite.	- All the negative slopes and inconsistencies need to be checked with the most updated GIS and record drawings during the model update	- 817 conduit links. - 45 imaginary conduit links created to receive flows from subcatchment gravity network not included in the model

Review Item	2012 Model Review Observation	Comments	Updated Model
CSO Regulators	- 34 orifice links. - All CSO regulators are simulated using orifices to intercept dry weather flows and partial wet weather flows to the collection system, and with elevated conduits to convey extra flows to the CSO outfalls. - Approximately 75% of the orifices (25 out of 34) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - None of the regulator diverting weir structures is simulated in the model.	- Diverting weir structures need to be added in the model - The slopes of all overflow pipes connected to the CSO outfalls need to verified - All orifice opening dimensions verified will be verified - All the RTC rules regulating orifice opening will be verified with actual operation	- 44 orifice links. - CSO regulators are simulated using orifices and float-operated gates to intercept dry weather flows and partial wet weather flows to the collection system, and with conduits set a verified inverts to convey extra flows to the CSO outfalls. Exceptions occur at several regulators where orifices have been removed and at one regulator where the float and gate have been removed. - Approximately 57% of the orifices (25 out of 45) are modeled with Real Time Control (RTC) to mimic regulator gate opening based on level. - Regulator diverting weir structures added to the model. - All regulator characteristics were verified using record drawings excepting Regulator 17 which was field verified.
Pump Station	- No pump station is included in the model	- All pump stations that contribute flow to the DELCORA collection system should be added to the model, with related force mains	- Pump stations added to model. - Related force mains added to model

Review Item	2012 Model Review Observation	Comments	Updated Model
Dry Weather Flow	- 94 dry weather flow (DWF) inputs - Total DWF is 7.01 MGD - No diurnal curve - DWF does not include all the separated service areas that contribute to the DELCORA system -	- DWF should be updated to include all the service areas that contribute to the DELCORA system - Weekday and weekend diurnal curve should be included in the model to effectively simulate dry weather diurnal pattern	- 114 dry weather flow (DWF) inputs - Total DWF is 29.57 MGD - DWF analysis was performed on all flow meters in separated and combined areas as well as pump stations - Weekday and weekend diurnal curves were generated as well as overall, weekday, weekend and monthly DWF factors.
RDII	- No rainfall-derived infiltration/inflow (RDII) element was found in the model	- RDII should be included in the model to estimate reasonable wet weather inflow from RDII	- RDII was included in the model to estimate reasonable wet weather inflow from RDII

8.6 H & H Model Calibration

Model credibility is developed through model calibration and validation. Model calibration involves application of the model to known external inputs (e.g., rainfall), evaluation of the model's ability to replicate monitored conditions (e.g., flow and volume), and adjustment of key model parameters as needed until an acceptable level of agreement is reached between simulated and monitored conditions.

The collection system H&H Model was calibrated in conjunction with the flow monitoring and sampling program. The H & H Model was calibrated by running the model with rainfall data collected from selected storms and then comparing the calculated results to the actual flow monitoring data collected. The model parameters were adjusted and the process repeated until the calculated results approximated the actual flow monitor measurements. Goals for the model calibration included:

- To match visually the shape of the curve between model and flow monitor.
- To match model runoff volumes (volume under curve) to actual runoff volumes.
- To match model runoff peak flow rates to actual runoff peak flow rates.

Once the model was calibrated to the selected storms, at least one additional storm was run through the model to validate that the model was sufficiently calibrated.

Figure 8-2: Updated H&H Model Layout

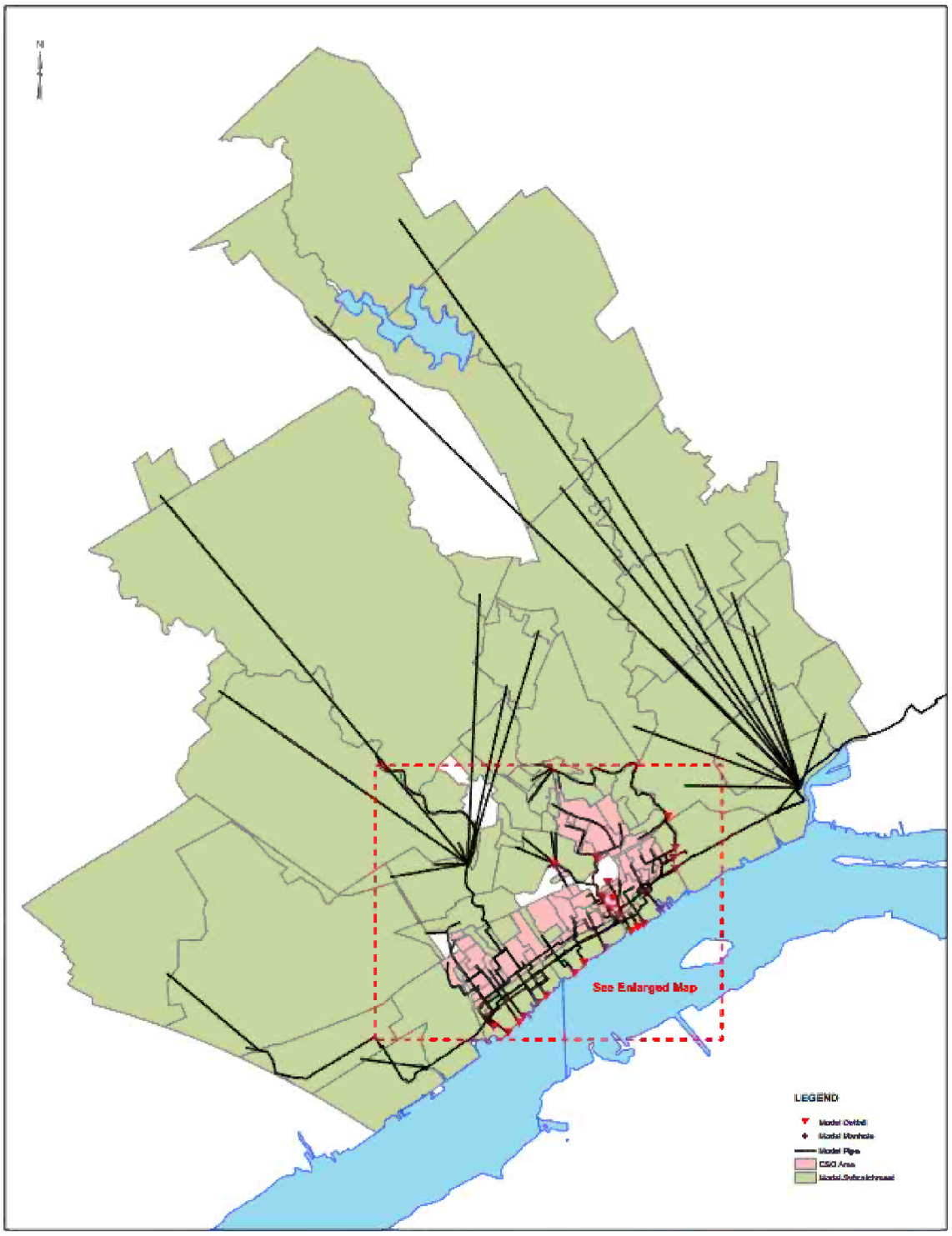
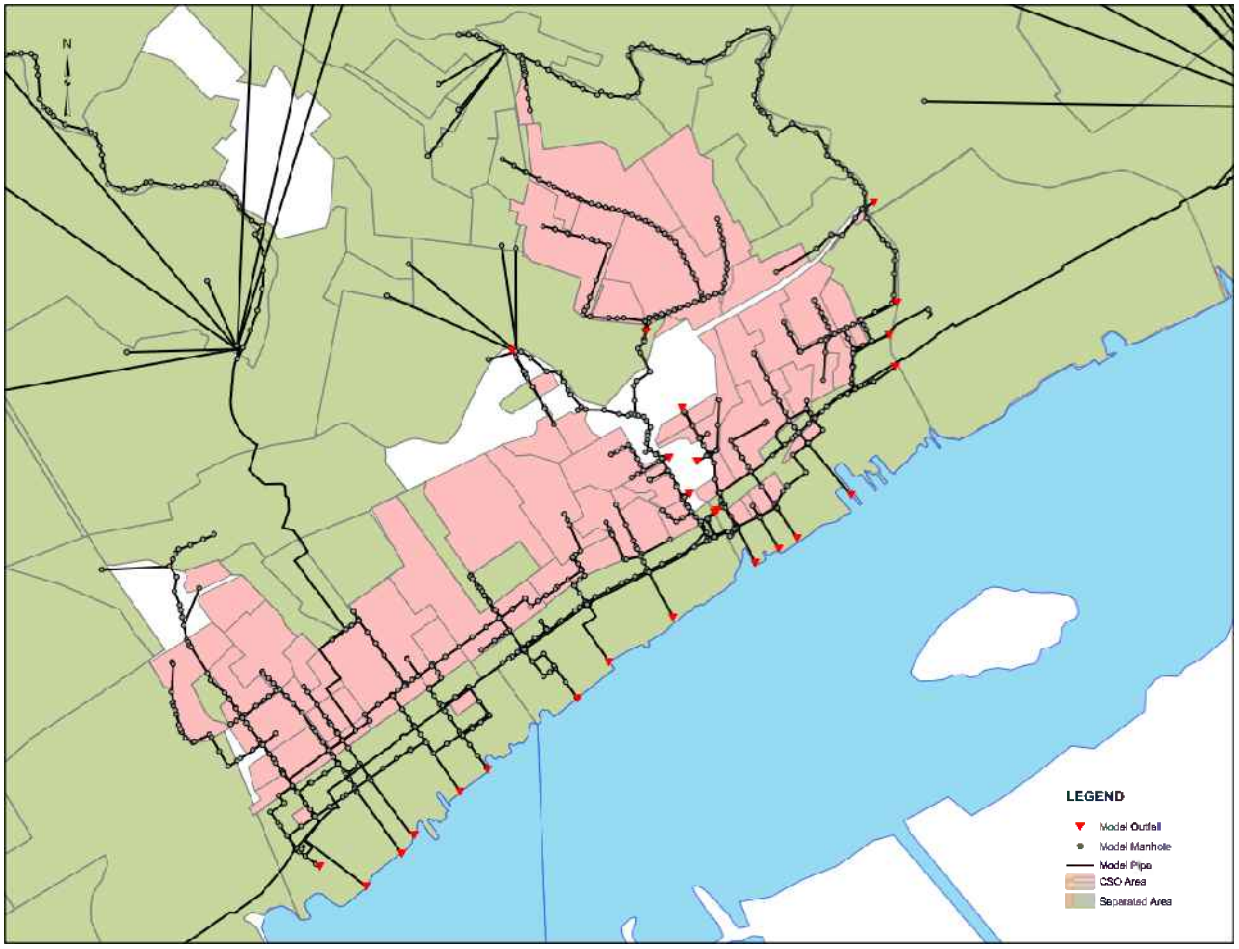


Figure 8-3: Updated H&H Model Layout – CSS Area



8.6.1 Dry Weather Flow Calibration

Dry weather flow (DWF) analysis was based on the rainfall and flow monitoring results. DWF distribution in the collection system was based on land use data. Weekday, weekend and monthly diurnal factors from the DWF analysis were applied for each flow meter service area. Upstream meters in the system were calibrated first, then flows through the system to the pumps stations and to the WRTP were balanced. Figure 4-4 shows the arrangement of the meters in the system and meter identification.

DWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be within 1 hour of the observed,
- The simulated peak flow will be within 10% of the observed flow, and
- The simulated flow volume over 24 hours will be within 10% of observed flow.

The dry weather calibration shows that model and the flow monitors are not all within the goal of ten percent. There are a number of reasons for the differences. The accuracy of flow monitors in large pipes is reduced as the flows get smaller. The dry weather flows are very small, especially in comparison to the wet weather flows. Dry weather flow also has a diurnal curve. The model does not replicate the dry weather flow diurnal curve, but takes the average of the diurnal curve and uses that as a constant dry weather flow. This could cause some discrepancy between the model and metered flows.

After the dry weather calibration was considered to be satisfactory, the model was calibrated for wet weather periods as described below.

8.6.2 Wet Weather Calibration

Wet weather flow (WWF) includes surface runoff from the combined area, RDII from the entire service area, and connected rooftops, if any, from the separated area. RDII parameters will be developed based on the separated area, and surface runoff parameters will be adjusted for the combined area to calibrate the system response to the wet weather conditions.

Four (4) wet weather events were selected for wet weather calibration. Final selections include wet weather events with various rainfall intensities and volume. Larger storm events will have more weighting factor in the calibration process because the large events are the ones that dominate the total overflow volume.

WWF calibration will adhere to industry standards and the criteria below:

- The simulated hydrograph should match the general observed hydrograph shape,
- The simulated time of peaks and troughs will be similar having regard to the duration of the event,
- The simulated peak flow for significant peaks will be within the range of -10% to +10%,
- The simulated flow volume will be within the range of -10% to +10%,

The four storms were selected for calibration of the collection system model met all the desired storm characteristics as describe in Section 4 of this Report. The May 29, 2016 storm was a 1.82-inch storm with a duration of approximately 11 hours and a maximum intensity of 0.78 in/hr. The September 28, 2016 storm was a 2.36-inch storm with a duration of 47 hours and a maximum intensity of 0.37 inches/hour. The November 29, 2016 storm was a 1.08 inch storm with a duration of 14 hours and a maximum intensity of 0.21 in/hr. The July 28, 2016 rain event was a 1.26-inch storm with a duration on 19 hours and a maximum intensity of 0.74 in/hr. Data on these storms is in shown in Table 8-3.

Table 8-3: Wet Weather Events for Model Calibration and Validation

Event ID	Start Time	Stop Time	Rainfall Duration (hr)	Rainfall Depth* (inches)	Max. Intensity (in/hr)	Used in Calibration	Used in Validation
E1	5/29/16 19:00	5/30/16 5:00	11.00	1.82	0.78	C	
E2	9/28/16 12:00	9/30/16 10:00	47.00	2.36	0.37	C	
E3	11/29/16 7:00	11/29/16 20:00	14.00	1.08	0.21	C	
E4	3/30/17 21:00	4/1/17 3:00	31.00	1.83	0.25		V
E5	5/21/16 11:00	5/22/16 21:00	35.00	1.71	0.33		V
E6	7/28/16 15:00	7/29/16 9:00	19.00	1.26	0.74	C	
*At Chester PS rain gauge							

The figures in Appendix B show the observed and simulated flow for the model calibration. Also included in Appendix B are plots of modeled versus monitored (i.e., observed) volumes and peak flows. A well calibrated model will result in plotted values that are close to a one-to-one relationship. These one-to-one plots can be found in Appendix B.

8.7 H & H Model Validation

According to USEPA's Guidance on Monitoring and Modeling (1999), "validation is the process of testing the calibrated model using one or more independent data set(s) of rainfall data." DELCORA's sewer system model was validated with rainfall from two rain events (May 21, 2016 and March 30, 2017). The May 21, 2016 rain event was a 1.71-inch storm with a duration of 35 hours and a maximum intensity of 0.33 in/hr. The March 30, 2017 storm was a 1.83 inch storm with a duration of 31 hours and a maximum intensity of 0.25 in/hr. The rainfall data for these storms is shown on Table 8-3 above. These storms were chosen for their size, intensity and because there were no rain events for five days before the storm. The figures in Appendix B show the observed and simulated flows for the model validation.

Also included in Appendix B are plots of modeled versus monitored (i.e., observed) volumes and peak flows. A well-calibrated model will result in plotted values that are close to a one to one relationship. These one-to-one plots can be found in Appendix B.

8.8 H & H Model Results

Following calibration, the typical hydrologic period (1994 to 1996) was used as the rainfall input to the H&H model. The hourly rainfall for the period 1994 to 1996 had been previously determined to be representative of annual average conditions with respect to rainfall amount (volume), number of rainfall events per year, rainfall duration, and rainfall intensity and has been discussed in Section 7.

A summary of estimated volume, frequency and duration of CSO discharge events based from the calibrated H&H model using the typical hydrologic period is presented in Appendix C. The total annual average CSO overflow volume was approximately 300 MG for the typical hydrologic period. The dry weather flows and their monthly factors in the calibration model are based on the flow monitoring period (March 2016 through March 2017). For future model application, the dry weather flows should be based on future flow projections and the monthly factors should be adjusted accordingly.

Section 9 References

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

MAR 01 2016

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Hydrologic and Hydraulic Model Update and Calibration Plan. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP).

EPA hereby approves the plan with the understanding that the term "two days" as stated in paragraph 5.1.2.1 (Dry Weather Overflow Analysis) shall mean 48 hours.

Thank you for your continued cooperation with this matter. Please do not hesitate to contact me at (215)814-2097 if you have any questions.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

MAY 23 2016

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Michael J. DiSantis, Director
Operations & Maintenance
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Disantis:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Typical Hydrologic Period Report (Updated April 2016). EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA hereby approves the subject plan.

Thank you for your continued cooperation with this matter. Please do not hesitate to contact me at (215) 814-2097 if you have any questions.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DiSantis, DELCORA
S. O'Neil, PaDEP SERO
J. Fields, PaDEP SERO

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Consent Decree

OCT 2 [illegible] 2016

Y. 2016-1211

cc: 2 tap group

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

OCT 1 1 2016

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Alternatives Evaluation Approach Report (AEAR) dated April 27, 2016. EPA understands DELCORA has chosen the "Demonstration Approach" and hereby approves the AEAR.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

OCT 13 2016

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Revised Identification of Sensitive Area Analysis (RISAA) dated May 13, 2016. EPA has consulted with the Pennsylvania Department of the Environment (PaDEP). EPA hereby approves the RISAA.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA

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DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

June 30, 2017

FED EX – NEXT DAY

Chief, Environmental Enforcement
Section
Environment and Natural
Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Chief
NPDES Enforcement Branch (3WP42)
Water Protection Division
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager – Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB
& DOJ Case Number 90-5-1-1-10972
Sewer System Hydrologic and Hydraulic Model Report

Dear Sir/Madam:

By this letter, the Delaware County Regional Water Quality Control Authority is enclosing a copy of the above mentioned report in accordance with the requirements of the Consent Decree.

If there are any questions, please contact me. Thank you.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
enclosure

ADMINISTRATION
☐610-876-5523
☐FAX: 610-876-2728

CUSTOMER SERVICE/BILLING
☐610-876-5526
☐FAX: 610-876-1460

PURCHASING & STORES
☐610-876-5523
☐FAX: 610-497-7959

PLANT & MAINTENANCE
☐610-876-5523
☐FAX: 610-497-7950

K:\Consent Decree 2015\Phase 1 - FCAP2 - Task 5 - Hydrologic-Hydraulic Model\DOJ-EPA-PADEP-Hydrologic & Hydraulic Model Report - 6-30-2017.doc

cc: via email
Margaret Hill, Blank Rome
Marlene Finizio, Greeley and Hansen
Michael Hope, Greeley and Hansen
Ed Bothwell, DELCORA
Michael DiSantis, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
Charles Hurst, DELCORA
File – Consent Order – LTCP CSO

Section 10 Abbreviations

BGEPA:	Bald and Golden Eagle Protection Act
CDCA:	Central Delaware County Authority
CDPS:	Central Delaware Pump Station
CPS:	Chester Pump Station
CRPS:	Chester Ridley Pump Station
CSO:	Combined Sewer Overflow
CSS:	Combined Sewer System
CWA:	Clean Water Act
DCJA:	Darby Creek Joint Authority
DELCORA:	Delaware County Municipal Utilities Authority
DEP:	Pennsylvania Department of Environmental Protection
DRBC:	Delaware River Basin Commission
e-DMR:	electronic Discharge Monitoring Report
EDPS:	Eddystone Pump Station
EPS:	Existing Pump Station
ESI:	Environmental Sensitivity Index
GIS:	Geographic Information System
H&H:	Hydrologic and Hydraulic
KCPS:	Kimberly Clark Pump Station
LTCP:	Long Term Control Plan
LTCPU:	Long-Term Control Plan Update
MBTA:	Migratory Bird Treaty Act
MDL:	Method Detection Limit
MF:	Migratory Fishes
MGD:	Million Gallons per Day
MHPS:	Marcus Hook Pump Station
NCPS:	Naamans Creek Pump Station
NPDES	National Pollutant Discharge Elimination System
NRCS:	Natural Resources Conservation Service
NTU:	Nephelometric Turbidity Units
PA Integrated Report:	PA Integrated Water Quality Monitoring and Assessment Report
PADEP:	Pennsylvania Department of Environmental Protection
PCBs:	Polychlorinated Biphenyls
PCCP:	Prestressed Concrete Cylinder Pipe
POC:	Pollutant of Concern
POPC:	Parameter of Potential Concern
PSWPCP:	Philadelphia Water Department's Southwest Water Pollution Control Plant
QA/QC:	Quality Assurance/Quality Control
QAPP:	Quality Assurance Project Plan
R.M.:	River Mile
RHM:	Radnor Haverford Marple Authority
SPS:	Sunoco Pump Station
STORET:	Storage and Retrieval for Water Quality Data
TMDL:	Total Maximum Daily Load

TSF:	Trout Stocking
UH:	Unit Hydrograph
USEPA or EPA:	United States Environmental Protection Agency
WQMP:	Water Quality Monitoring Program
WQR:	Water Quality Regulations
WQS:	Water Quality Standards
WRTP:	Western Regional Treatment Plant
WWF:	Warm Water Fishes

Appendix A CSO Regulator Structure Characteristics

Table A-1: CSO Outfall Characteristics Summary

Outfall No.	CSO Receiving Water	Invert at Regulator	Invert at Receiving Stream
002	Delaware River	7.00	-3.5
003	Delaware River	7.98	-3.5
004	Delaware River	8.80	-3.5
005	Delaware River	4.74	-4.5
007	Delaware River	0.81	0.21
008	Delaware River	2.79	0.01
009	Delaware River	2.61	-4
010*	Delaware River	22.5	*
011	Delaware River	7.09	-4
012	Chester Creek	1.46	-2
013	Delaware River	1.86	-4
014	Delaware River	-1.09	-4
015	Ridley Creek	0.52	-3
016	Ridley Creek	0.11	-5
017	Ridley Creek	0.09	0.09
018	Ridley Creek	6.28	-5.0
019	Chester Creek	18.00	12.28
020	Chester Creek	8.78	-4
021	Chester Creek	5.78	-1.5
022	Chester Creek	11.5	-3.5
023	Chester Creek	1.33	-3.0
024	Chester Creek	1.21	-4.0
025	Chester Creek	-1.08	-4.0
026	Chester Creek	9.00	-4.0
032	Delaware River	1.00	-4.0
033	Ridley Creek	N/A	N/A

Notes:
*CSO regulator 010 discharges at Outfall 009.
N/A: Not Applicable

Table A-2: Regulator Gates Characteristics

Regulator Gate ID No.	Dimensions		Invert EL (ft.)
	Height	Width	
002	5.0 in.	7.5 in.	6.29
003	7.5 in.	7.75 in	7.18
004	8.0 in. dia.	N/A	7.89
005	12.0 in.	12.0 in.	3.99
007	5.0 in.	6.00 in.	0.50
008	7.5 in.	12.375 in.	2.63
009	5.0 in.	7.5 in.	2.45
010*	7.5 in.	15.375 in.	21.50
011	5.0 in.	9.25 in.	6.99
012	2.50	9.25 in.	0.50
013	7.5 in.	7.75 in.	0.84
014	12.0 in.	15.00 in.	-2.50
015	5.0 in.	6.00 in.	0.46
016	7.5 in.	12.375 in.	-0.55
017	5.0 in.	6.00 in.	0.09
018	5.0 in.	6.00 in.	6.06
019	7.5 in.	15.38 in.	16.89
020	7.5 in.	7.75 in.	8.06
021	7.5 in.	7.75 in.	4.56
022	5.00 in.	6.00 in.	10.47
023	7.5 in.	7.75 in.	0.50
024	5.0 in.	9.25 in.	0.50
025	5.0 in.	6.00 in	-2.25
026	7.5 in.	12.375 in.	7.91
032	*	*	-0.20
033	N/A	N/A	N/A

*Gate removed; no data for gate opening dimensions. Regulator modeled as pipe with same diameter as upstream sewer

Table A-3: Orifice Characteristics

Orifice ID No.	Orifice Type	Dimensions		Invert EL (ft.)
		Height	Width	
002	Side	4 5/8 in.	6 in.	5.78
003	Side	6 ¼ in.	7 in.	6.68
004	None	N/A No Orifice Plate		N/A
005	Side	7 ½ in.	12 in.	3.49
007	Side	3 ½ in.	5 in.	0
008	Side	6 7/8 in.	18 in.	2.13
009	Side	3 ½ in.	8 in.	1.95
010*	Side	10.563 in.	15 in.	21.09
011	Side	5 7/8 in.	8 in.	6.49
012	Side	4 5/8 in.	14 in.	0.00
013	Side	4 ½ in.	16 in.	0.34
014	Side	7 ½ in.	16 in	-3
015	None	N/A No Orifice Plate		N/A
016	Side	9 1/8 in.	30 in.	-1.05
017	None	N/A No Orifice Plate		N/A
018	None	N/A No Orifice Plate		N/A
019	None	N/A No Orifice Plate		N/A
020	Side	12.15 in.	8 in.	7.41
021	Side	11.33 in.	15 in.	4.47
022	Side	2.9 in.	8 in.	9.97
023	Side	5.75 in.	14 in.	0.00
024	Side	7.5 in.	16 in.	-2.75
025	Side	4.61 in.	5 in.	7.41
026	Side	7.69 in.	30 in.	
032	None	N/A No Orifice Plate		N/A

Orifice ID No.	Orifice Type	Dimensions	Invert EL
033	N/A	N/A No longer connected to CSS	N/A

Table A-4: Weir Characteristics

Weir ID No.	Dimensions		
	Height	Length	Crest Height
002	2.50 ft.	2.24 ft.	1.21 in.
003	2.50 ft.	2.24 ft.	1.30 in.
004	2.74 ft.	1.69 ft.	1.17 in.
005	3.50 ft.	2.65 ft.	1.25 in.
007	3.50 ft.	2.65 ft.	0.81 in.
008	4.98 ft.	3.54 ft.	1.23 in.
009	3.25 ft.	3.12 ft.	0.94 in.
010*	2.50 ft.	2.24 ft.	1.50 in.
011	2.44 ft.	3.9 ft.	1.76 in.
012	1.58 ft.	1.73 ft.	1.46 in.
013	3.40 ft.	2.65 ft.	1.62 in.
014	2.75 ft.	2.52 ft.	2.33 in.
015	2.79 ft.	1.53 ft.	0.27 in.
016	3.58 ft.	4.51 ft.	2.08 in.
017	2.17 ft.	2.63 ft.	0.96 in.
018	4.33 ft.	2.58 ft.	0.25 in.
019	3.17 ft.	2.05 ft.	1.44 in.
020	2.50 ft.	2.24 ft.	1.44 in.
021	0.63 ft.	1.48 ft.	1.72 in.
022	2.53 ft.	2.24 ft.	1.53 in.
023	1.50 ft.	2.24 ft.	1.25 in.
024	3.00 ft.	2.45 ft.	1.13 in
025	2.50 ft.	2.24 ft.	1.67 in.
026	0.95 ft.	2.43 ft.	2.64 in.
032	2.75 ft.	1.66 ft.	1.54 in.
033	N/A	N/A	N/A

*Height (H) measured from weir crest to pipe crown; Crest Height (H) measured from invert of upstream node to weir crest

Table A-5: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Regulator/Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River(2)	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W

Name of Receiving Stream	CSO Regulator/Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Ridley Creek(2)	033	Elkington Boulevard and Ridley Creek	39°52'22"N	75°22'29"W

Notes:
(1) CSO Regulator #010 discharges to the Delaware River through CSO Outfall #009.
(2) No mechanical regulator used for this outfall.

Appendix B H&H Model Calibration and Validation Results

H&H MODEL CALIBRATION AND VALIDATION RESULTS
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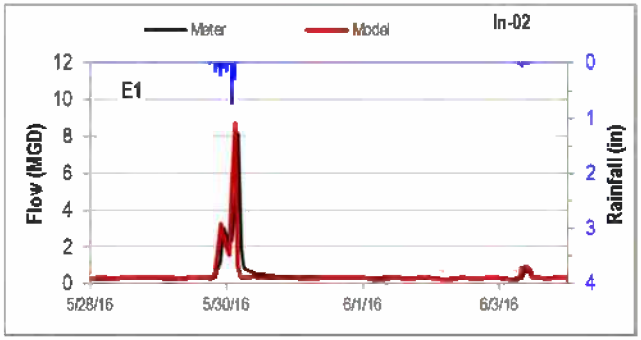
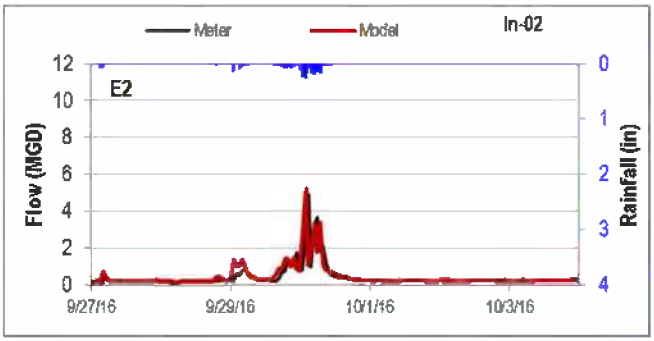
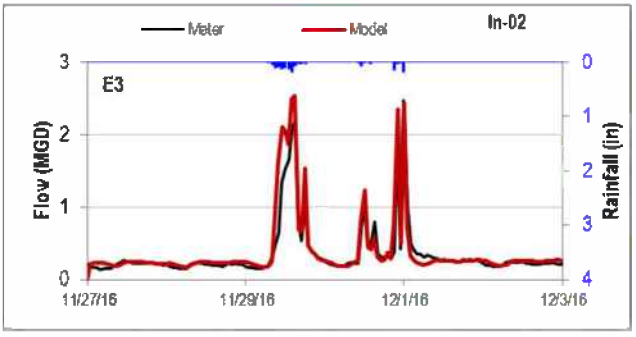
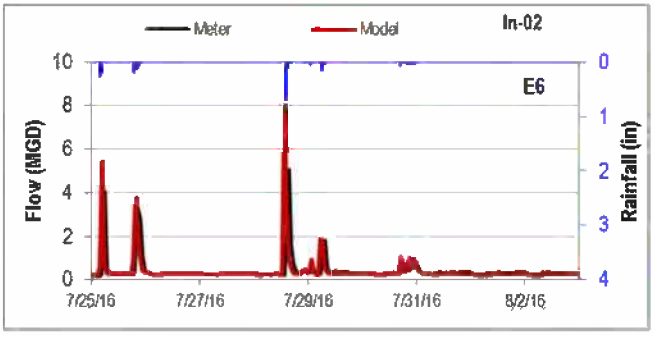
FLOW METER IN-02 MODEL CALIBRATION AND VALIDATION RESULTS

In-02 Model Calibration Results (Metered and Modeled Flow)

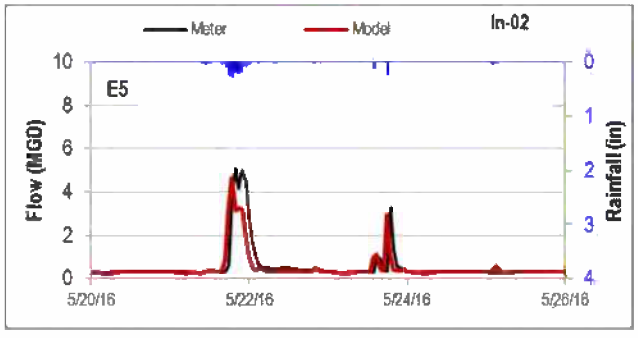


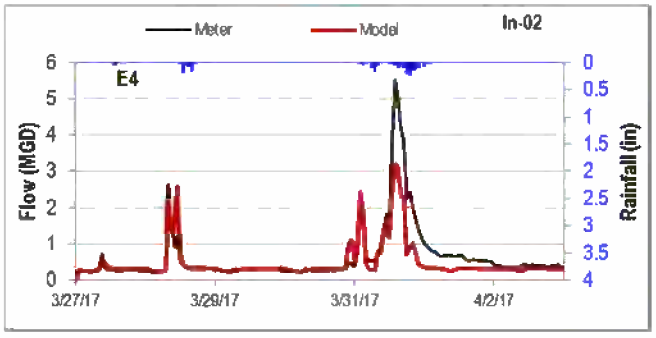




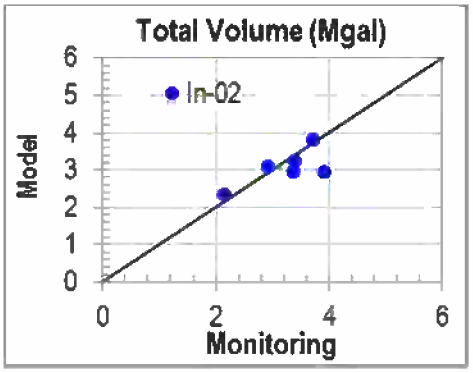


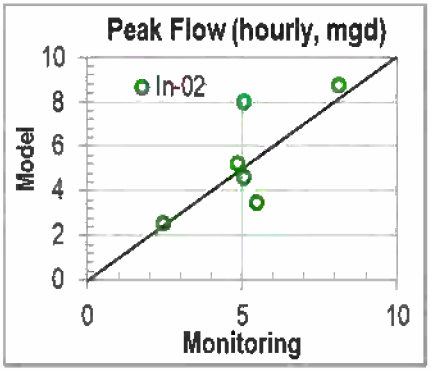
In-02 Model Validation Results (Metered and Modeled Flow)





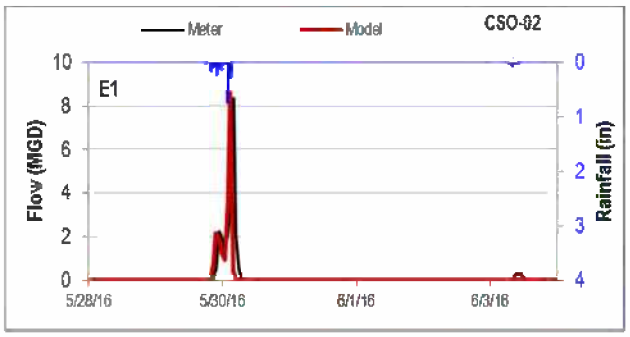
In-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

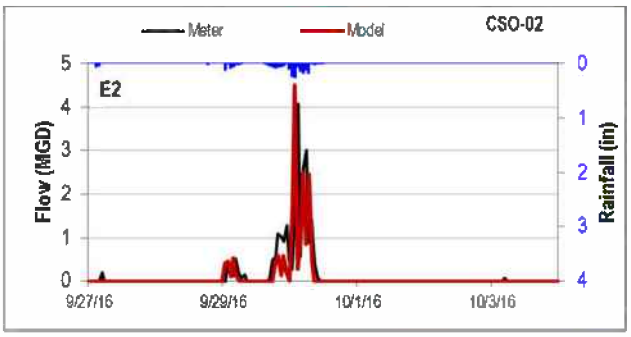


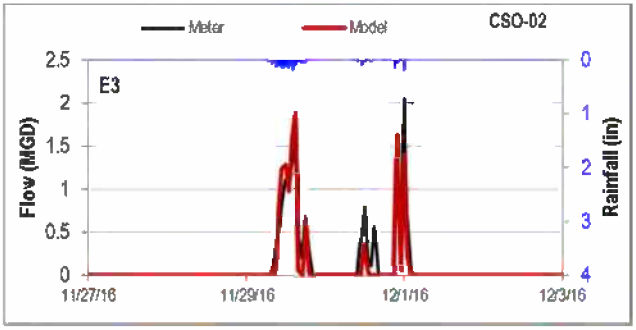


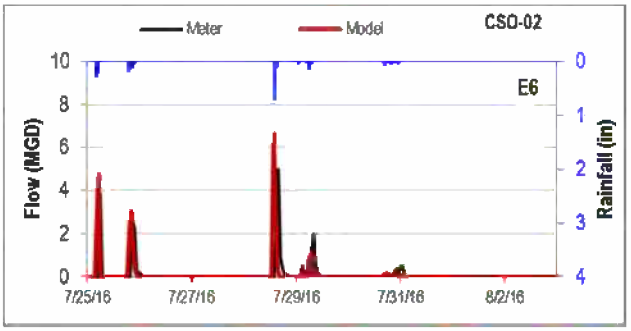
FLOW METER CSO-02 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-02 Model Calibration Results (Metered and Modeled Flow)

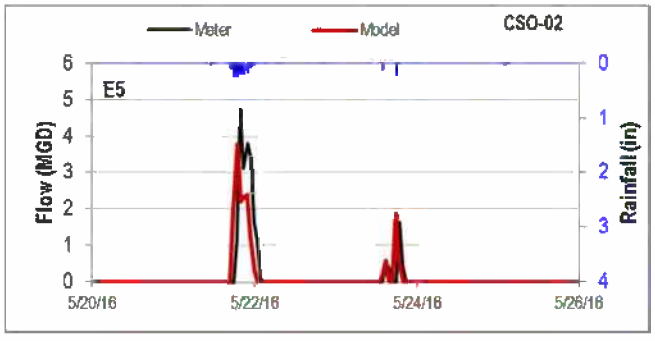


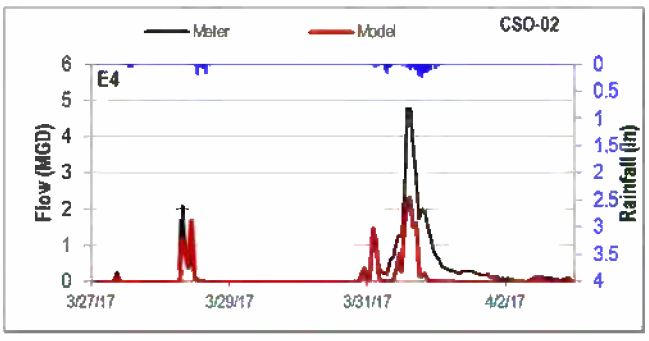




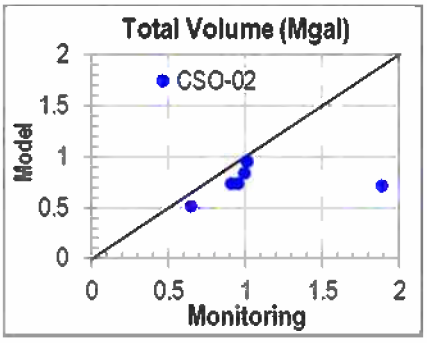


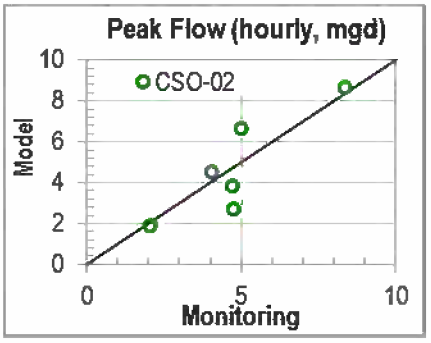
CSO-02 Model Validation Results (Metered and Modeled Flow)





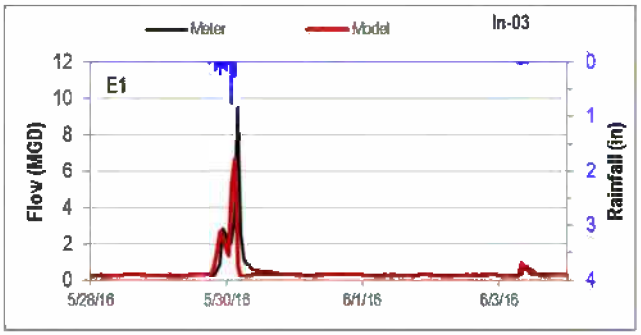
CSO-02 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

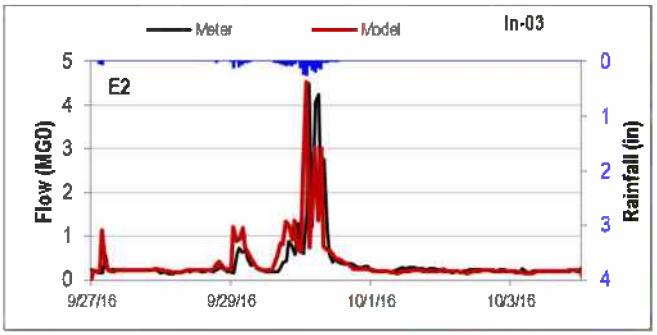


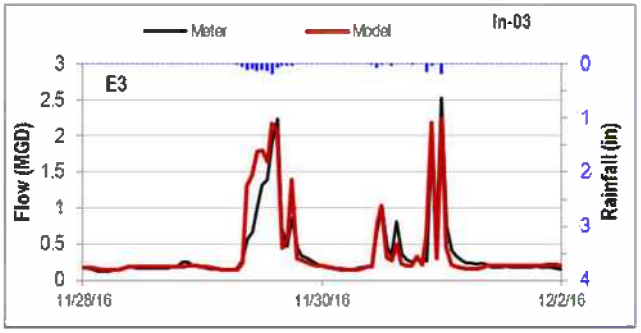


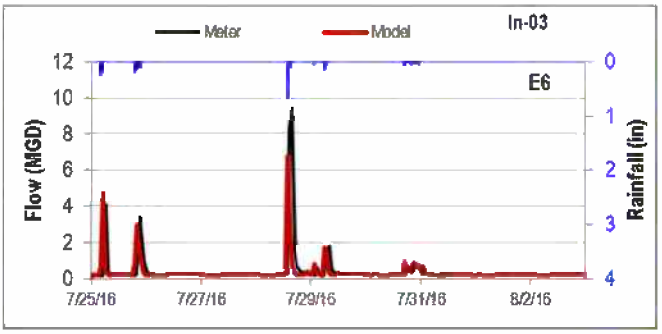
FLOW METER IN-03 MODEL CALIBRATION AND VALIDATION RESULTS

In-03 Model Calibration Results (Metered and Modeled Flow)

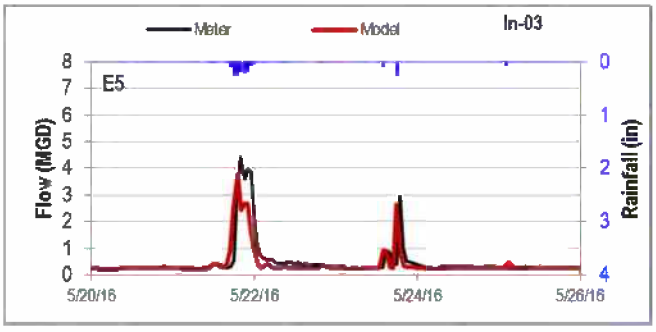


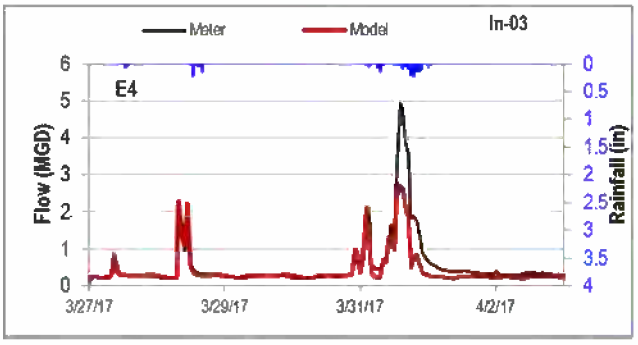




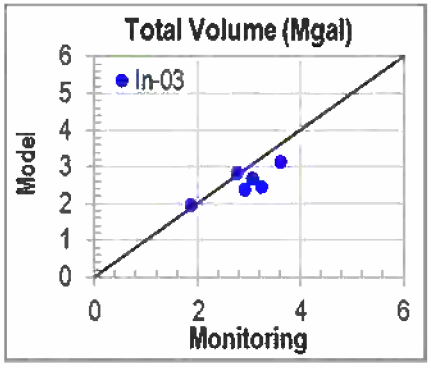


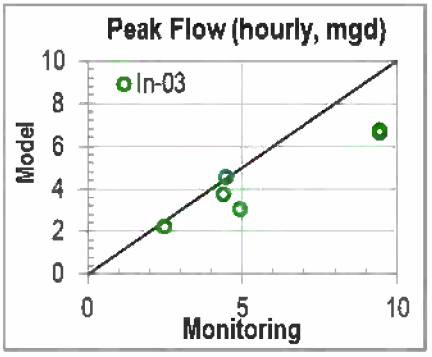
In-03 Model Validation Results (Metered and Modeled Flow)





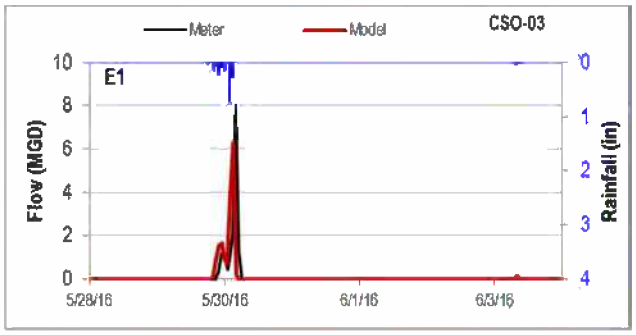
In-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

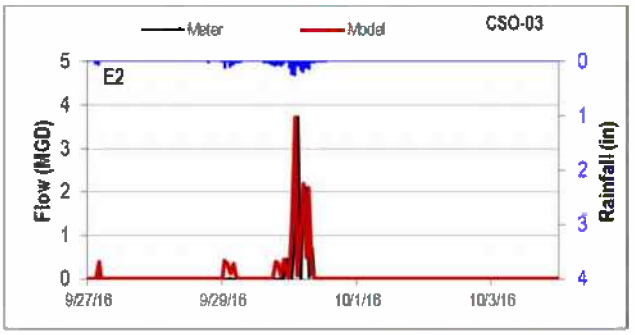


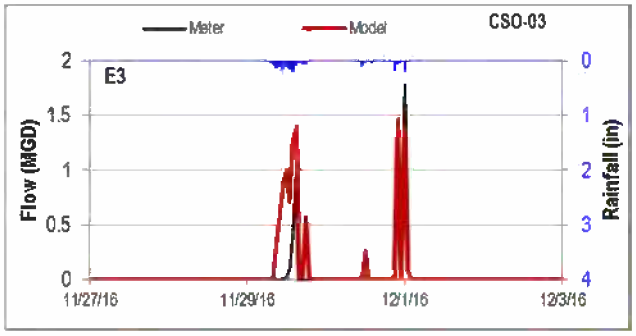


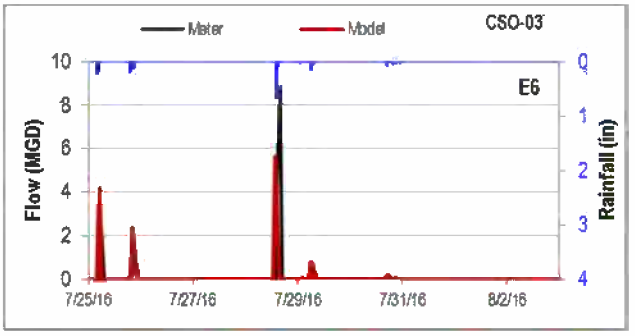
FLOW METER CSO-03 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-03 Model Calibration Results (Metered and Modeled Flow)

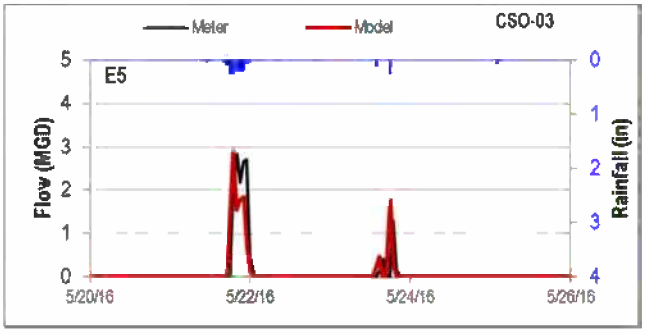


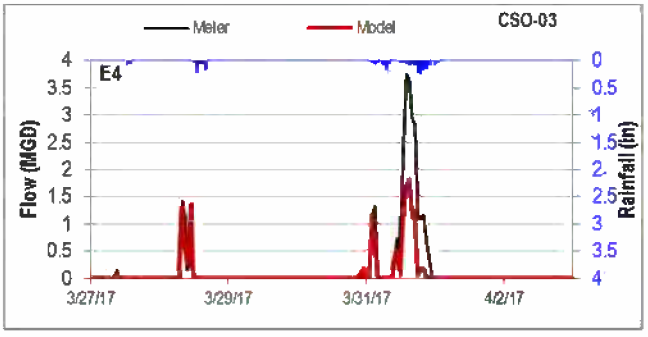




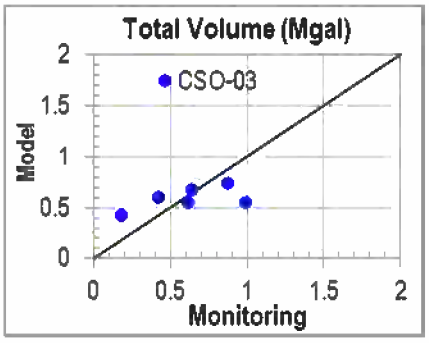


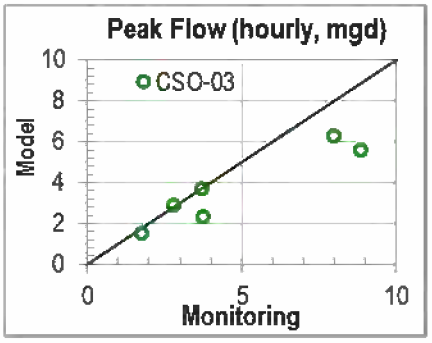
CSO-03 Model Validation Results (Metered and Modeled Flow)





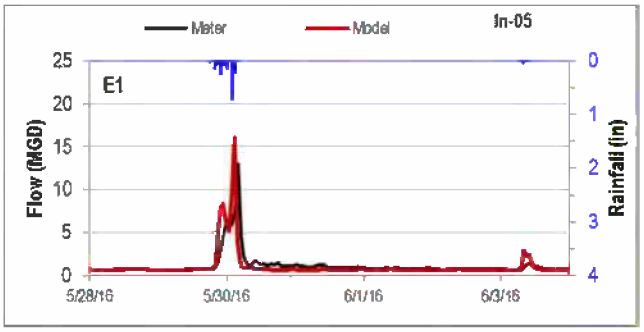
CSO-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

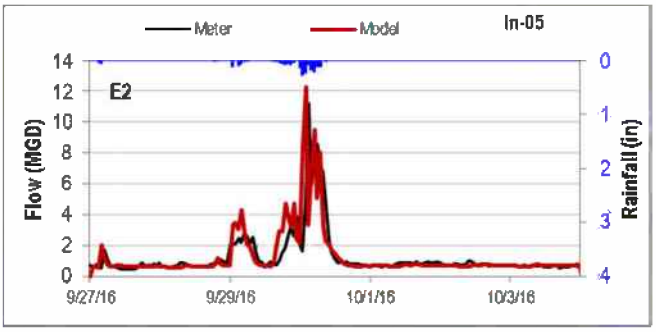


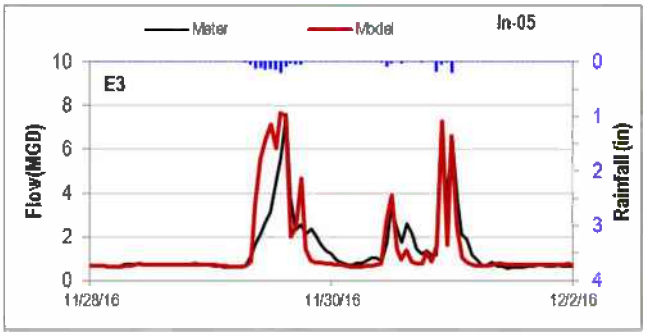


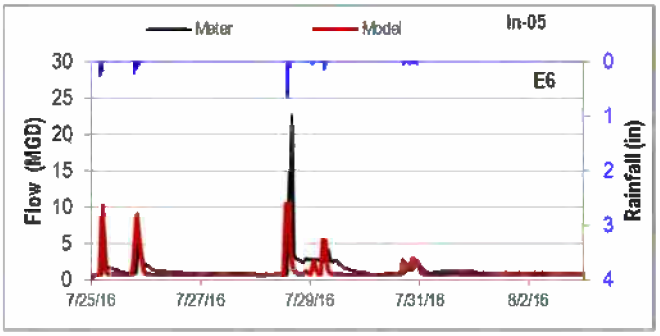
FLOW METER IN-05 MODEL CALIBRATION AND VALIDATION RESULTS

In-05 Model Calibration Results (Metered and Modeled Flow)

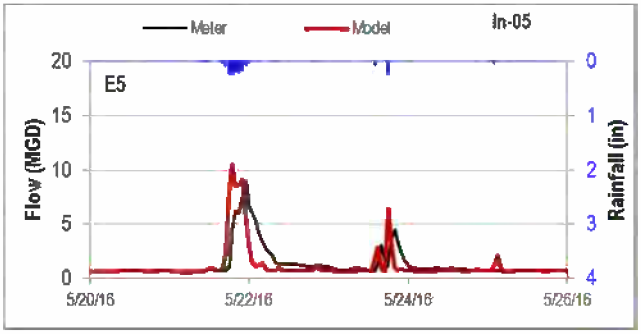


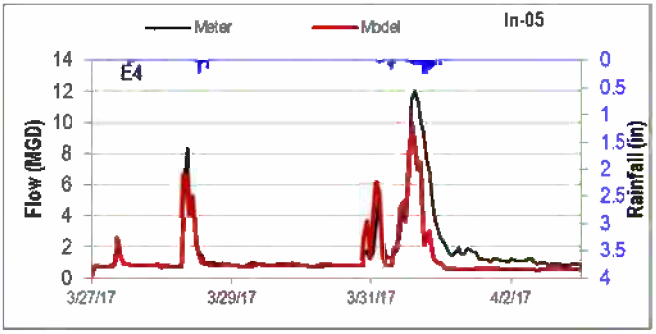




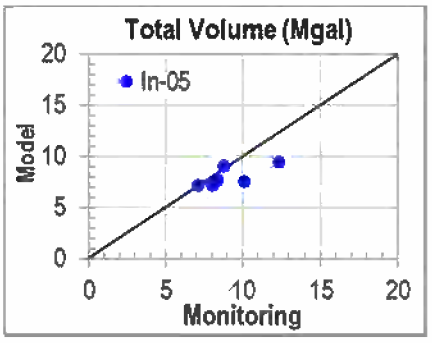


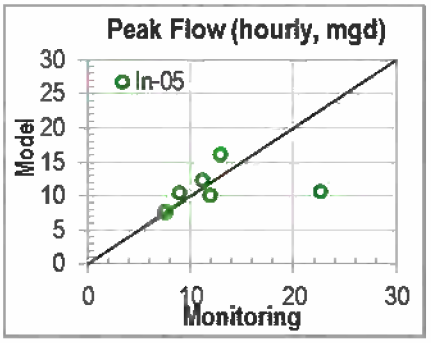
In-05 Model Validation Results (Metered and Modeled Flow)





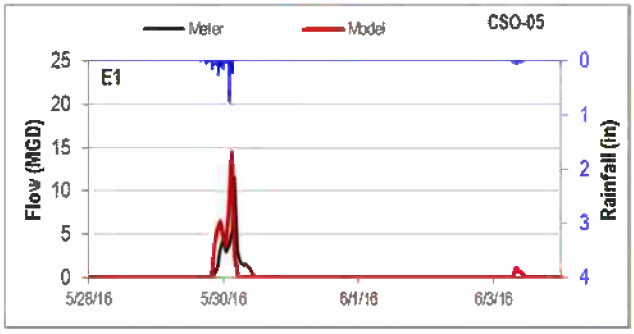
In-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

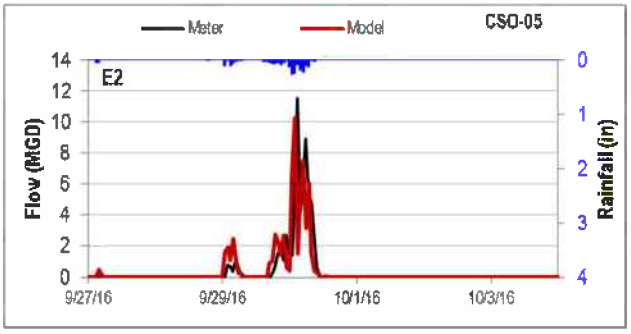


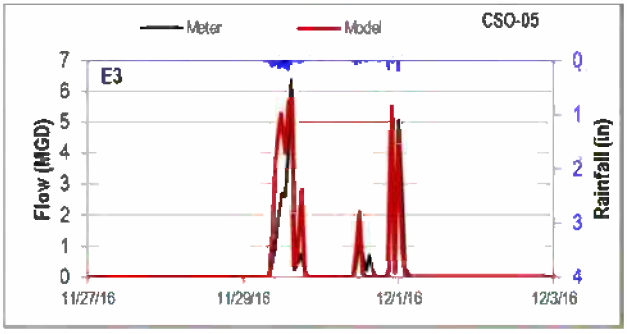


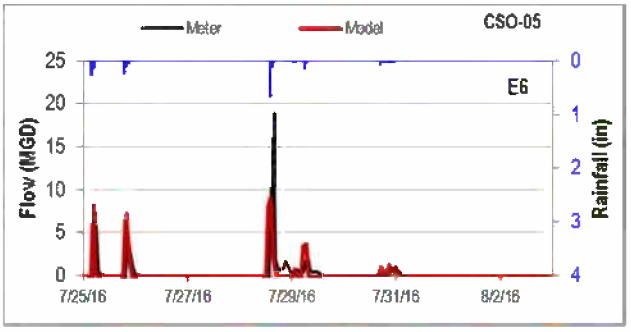
FLOW METER CSO-05 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-05 Model Calibration Results (Metered and Modeled Flow)

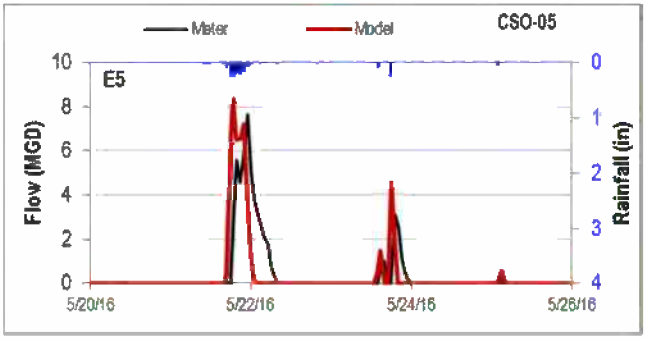


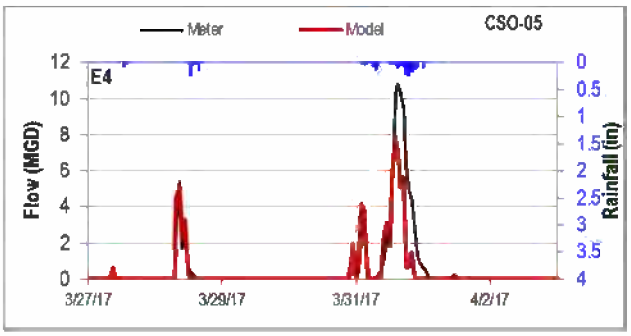




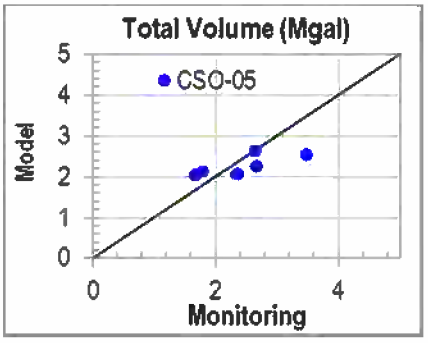


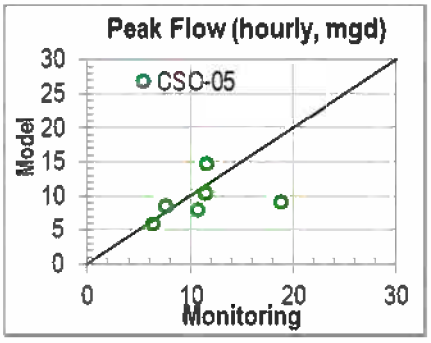
CSO-05 Model Validation Results (Metered and Modeled Flow)





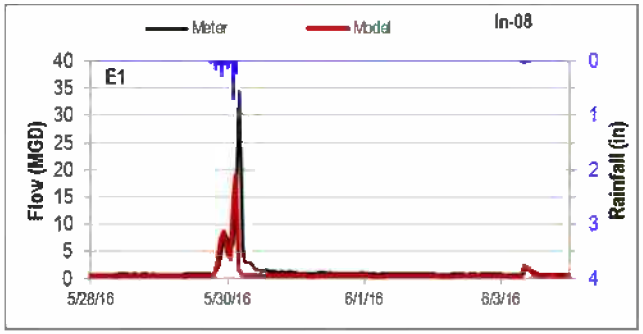
CSO-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

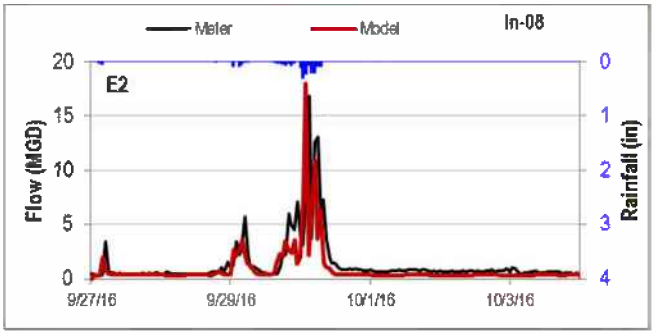


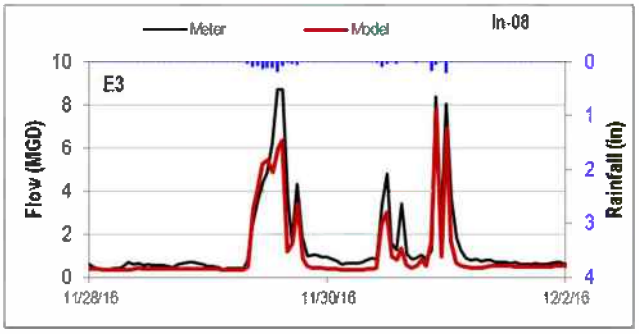


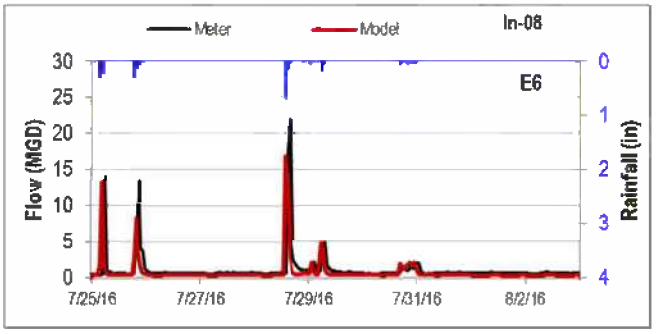
FLOW METER IN-08 MODEL CALIBRATION AND VALIDATION RESULTS

In-08 Model Calibration Results (Metered and Modeled Flow)

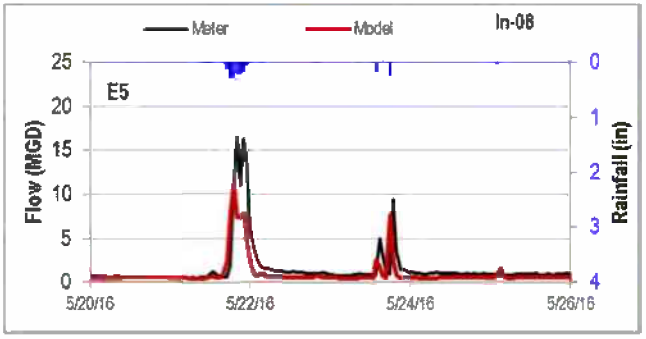


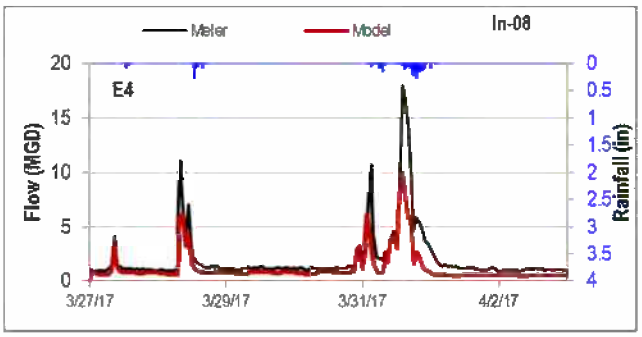




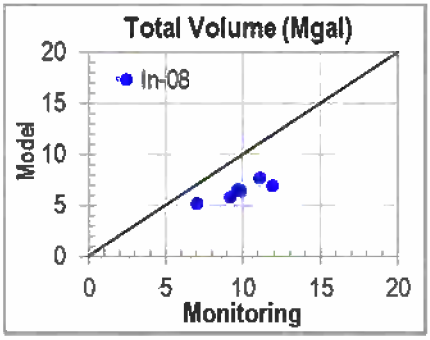


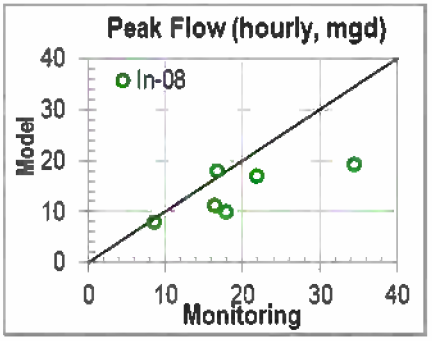
In-08 Model Validation Results (Metered and Modeled Flow)





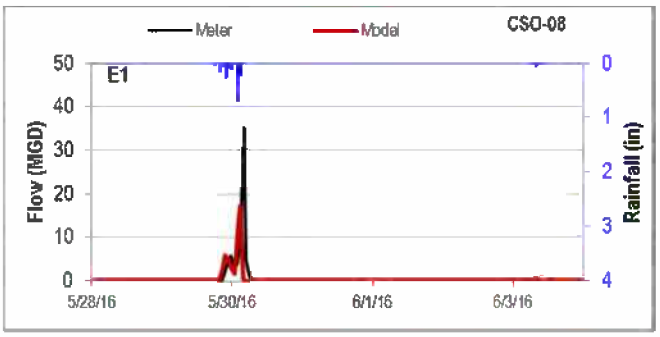
In-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

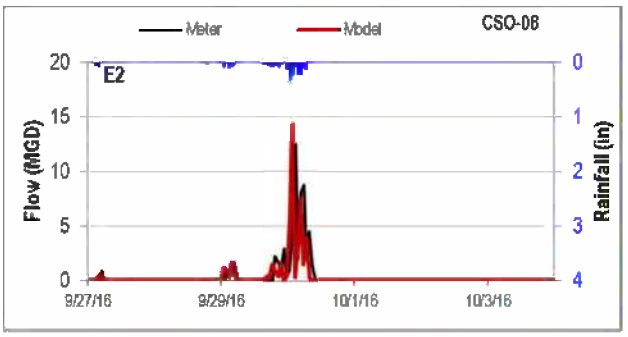


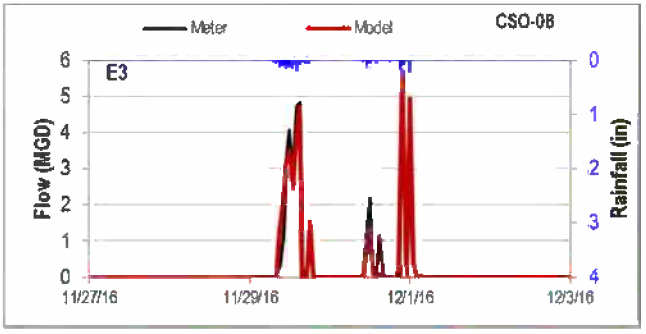


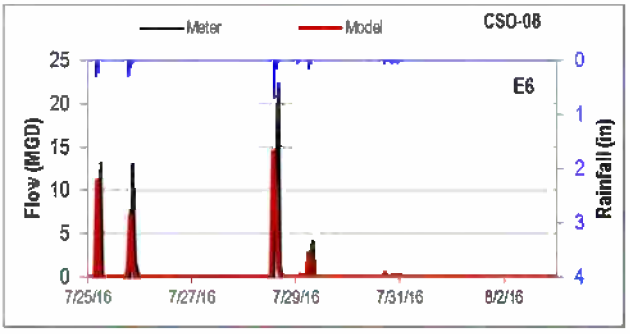
FLOW METER CSO-08 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-08 Model Calibration Results (Metered and Modeled Flow)

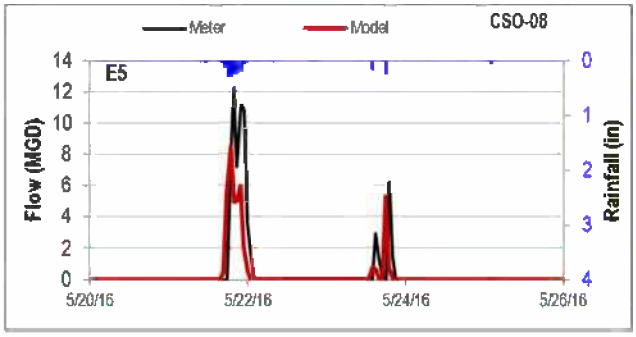


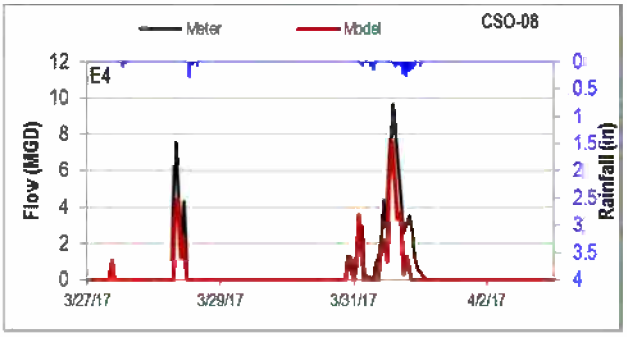




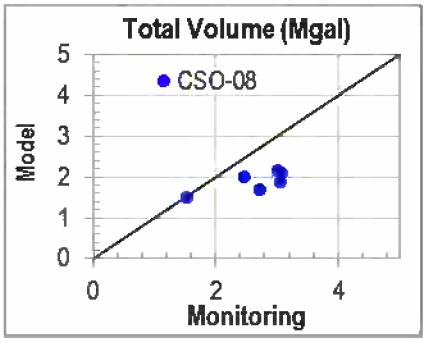


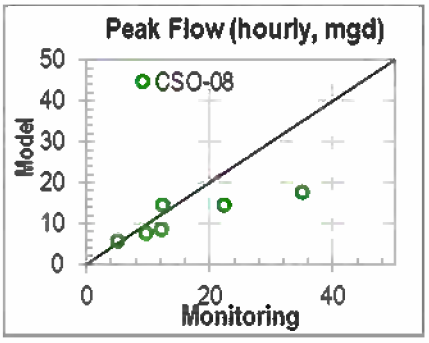
CSO-08 Model Validation Results (Metered and Modeled Flow)





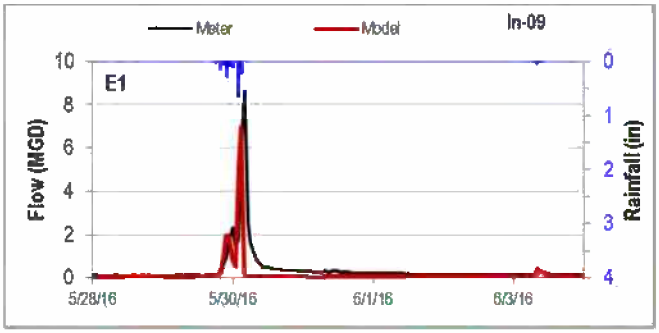
CSO-08 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

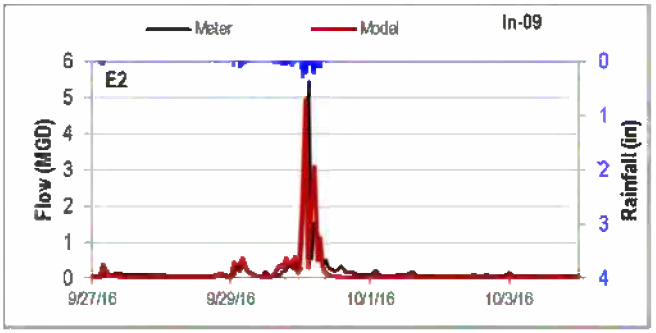


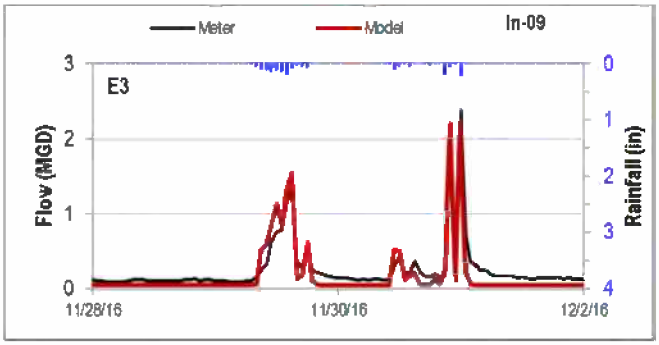


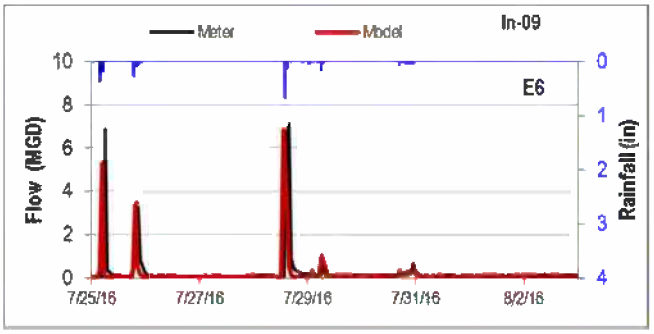
FLOW METER IN-09 MODEL CALIBRATION AND VALIDATION RESULTS

In-09 Model Calibration Results (Metered and Modeled Flow)

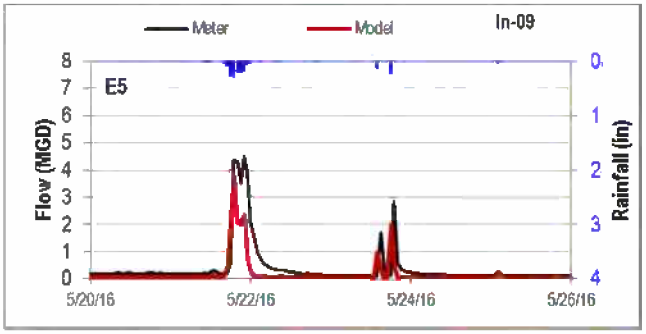


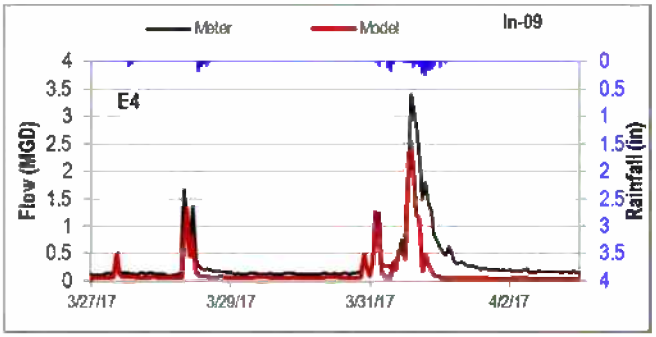




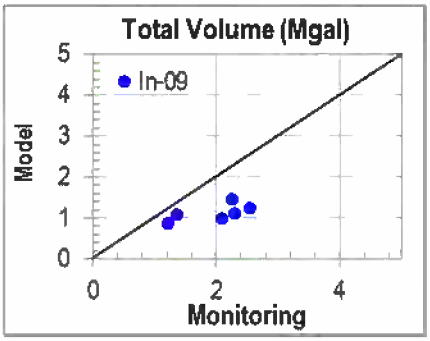


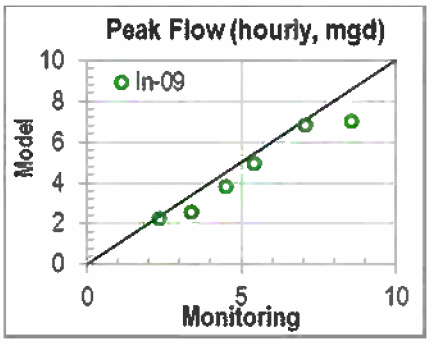
In-09 Model Validation Results (Metered and Modeled Flow)





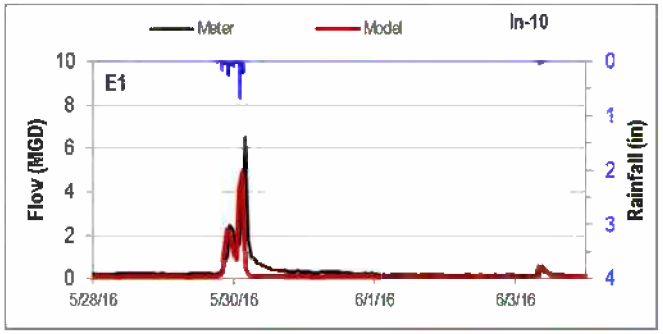
In-09 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

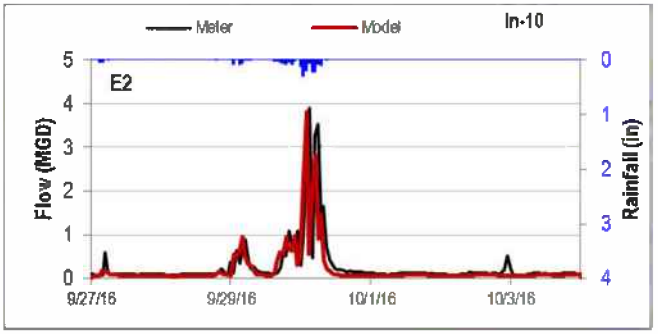


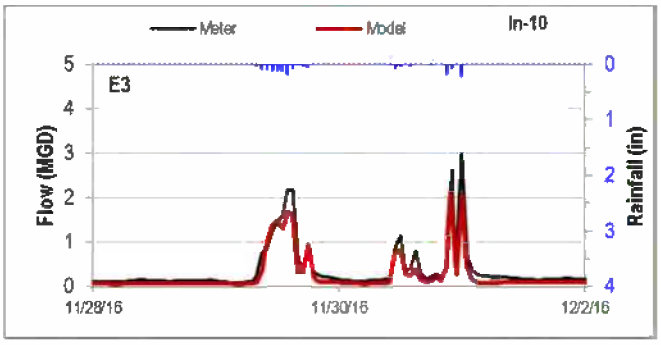


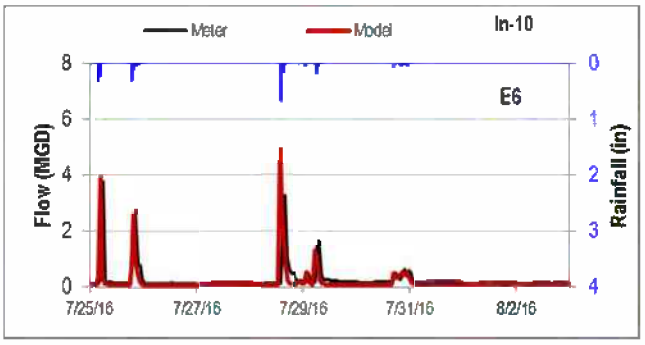
FLOW METER IN-10 MODEL CALIBRATION AND VALIDATION RESULTS

In-10 Model Calibration Results (Metered and Modeled Flow)

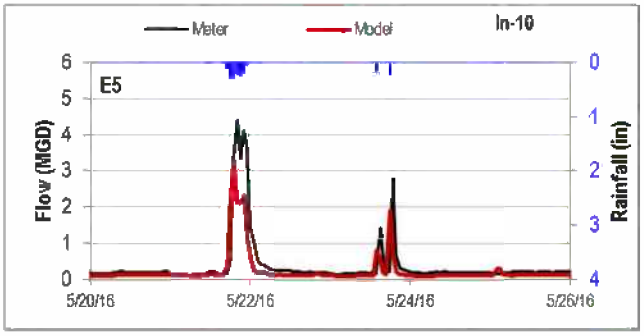


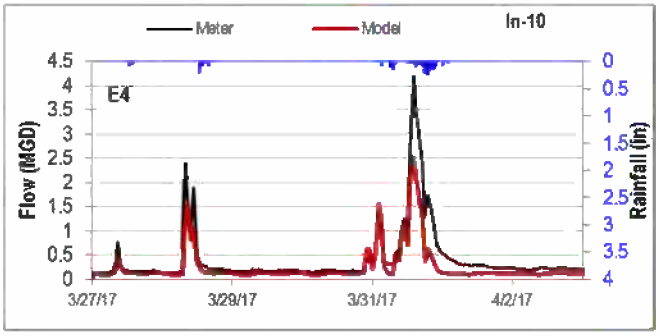




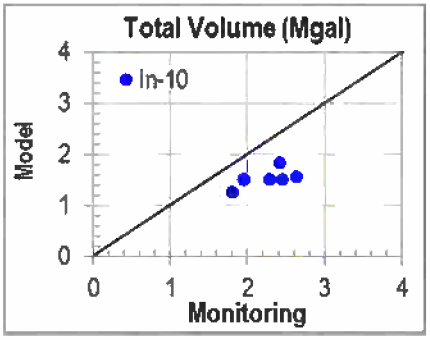


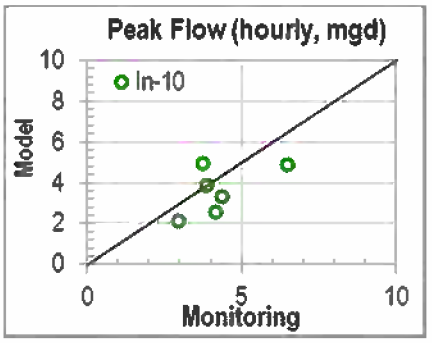
In-10 Model Validation Results (Metered and Modeled Flow)





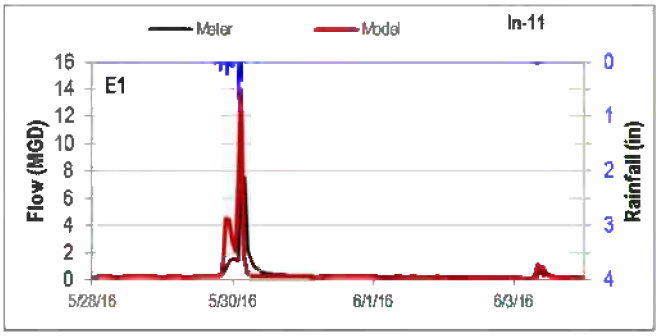
In-10 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

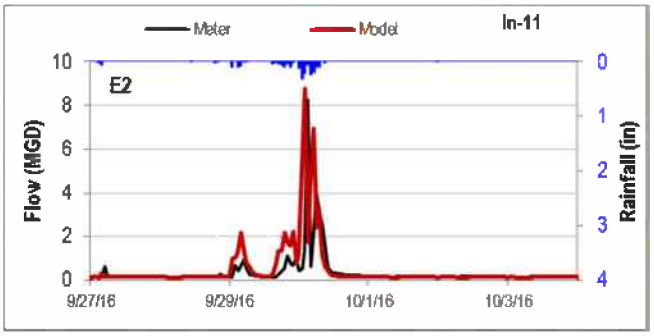


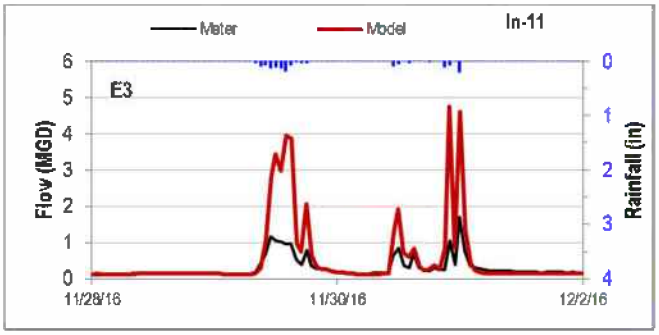


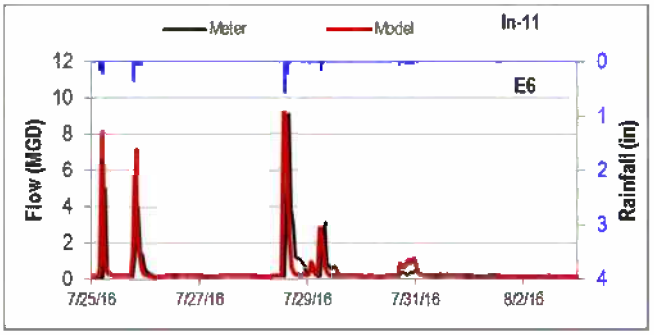
FLOW METER IN-11 MODEL CALIBRATION AND VALIDATION RESULTS

In-11 Model Calibration Results (Metered and Modeled Flow)

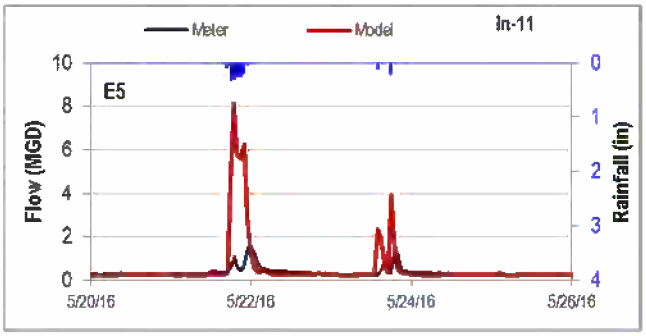


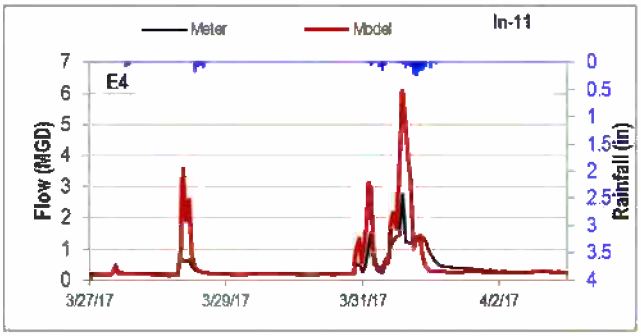




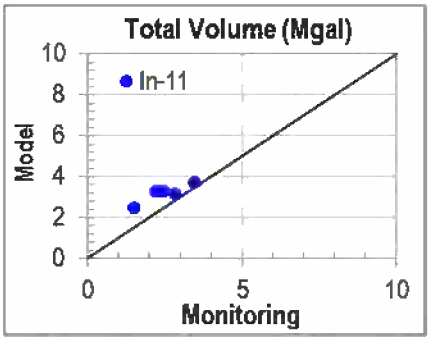


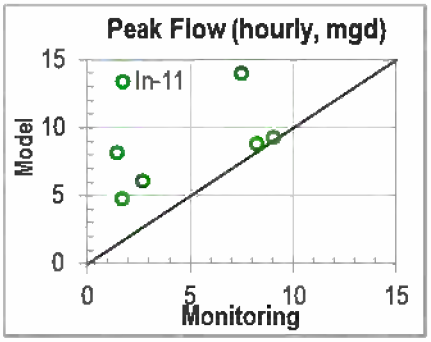
In-11 Model Validation Results (Metered and Modeled Flow)





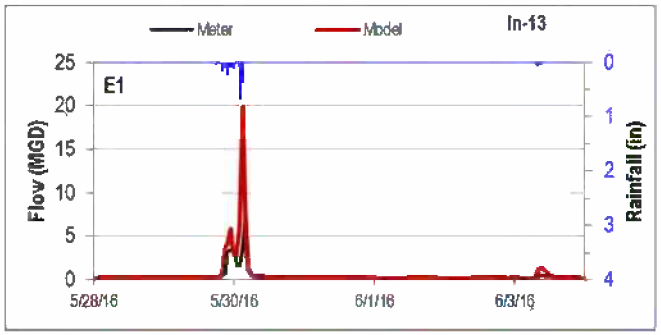
In-11 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

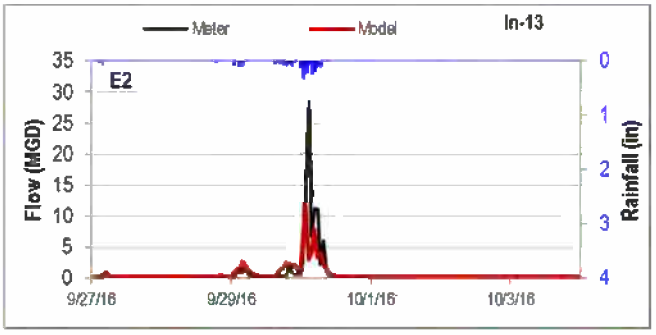


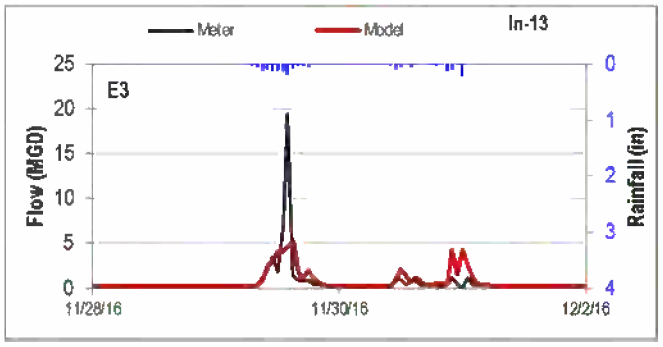


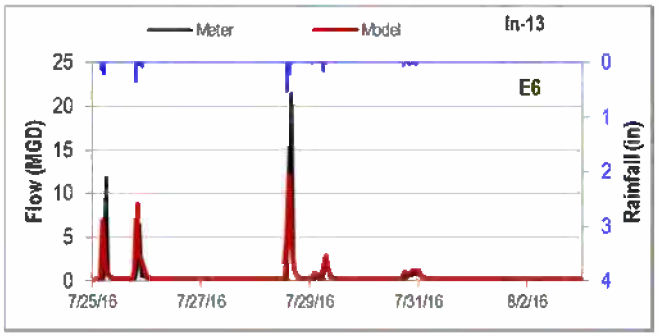
FLOW METER IN-13 MODEL CALIBRATION AND VALIDATION RESULTS

In-13 Model Calibration Results (Metered and Modeled Flow)

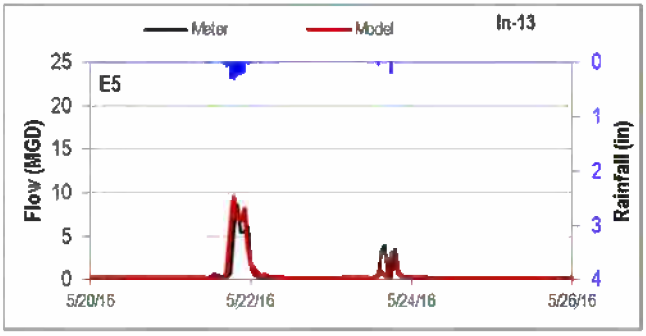


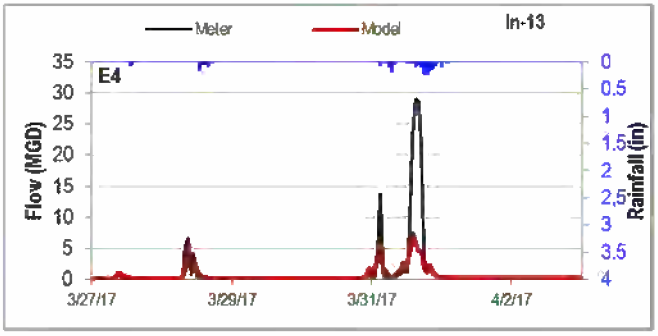




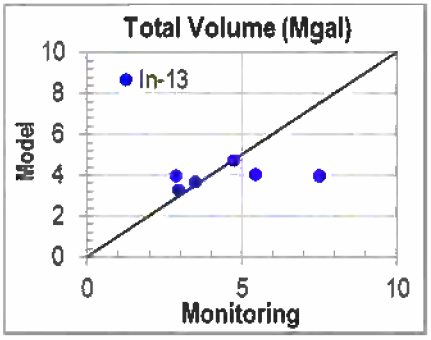


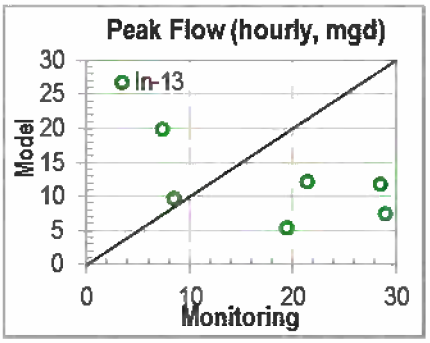
In-13 Model Validation Results (Metered and Modeled Flow)





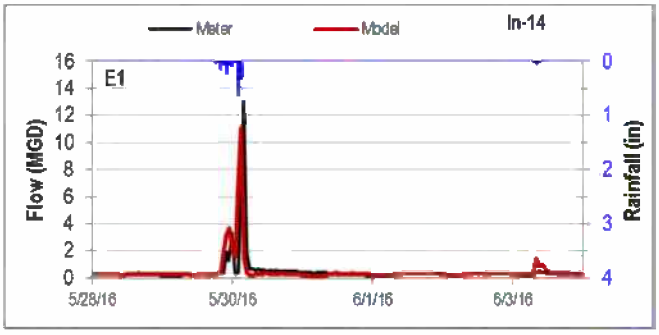
In-13 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

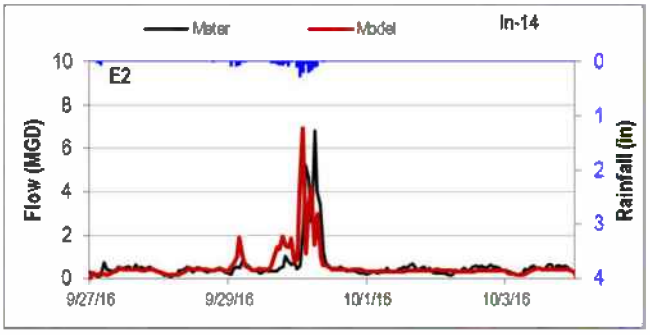


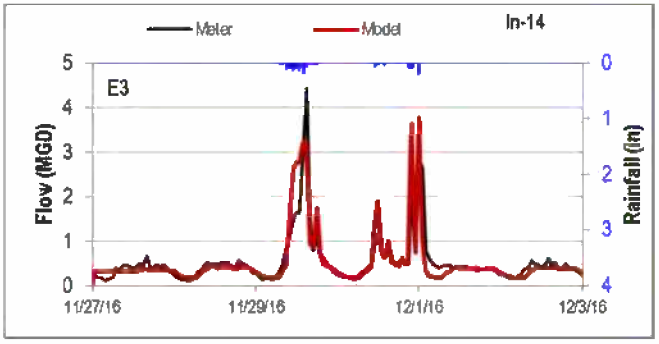


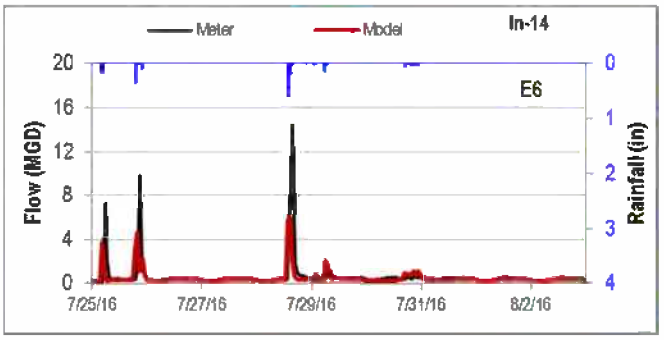
FLOW METER IN-14 MODEL CALIBRATION AND VALIDATION RESULTS

In-14 Model Calibration Results (Metered and Modeled Flow)

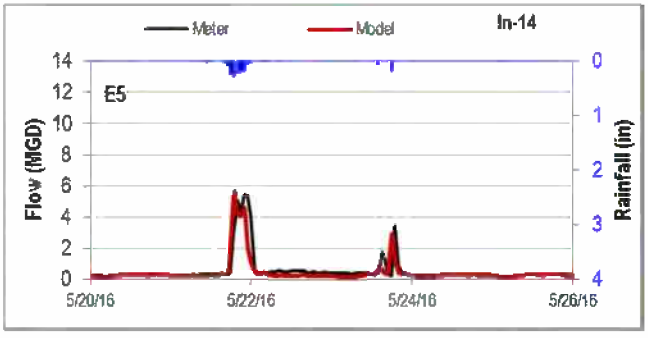


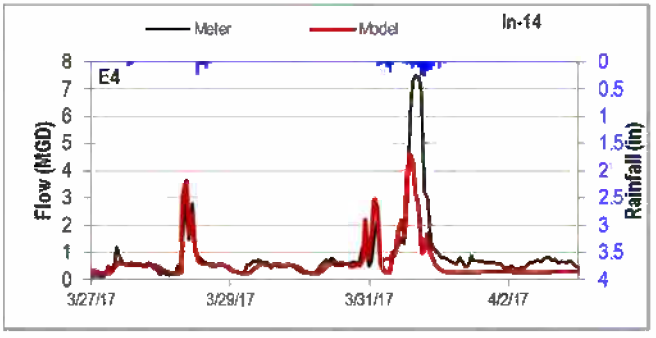




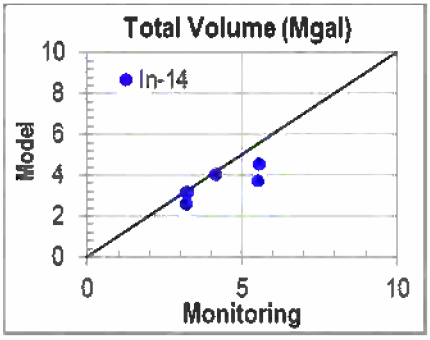


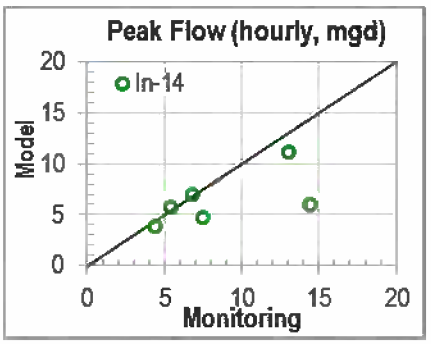
In-14 Model Validation Results (Metered and Modeled Flow)





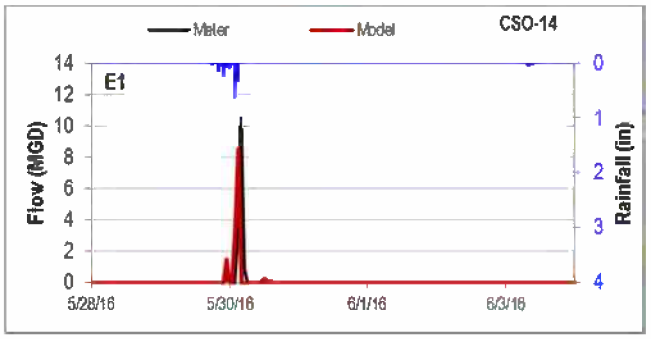
In-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

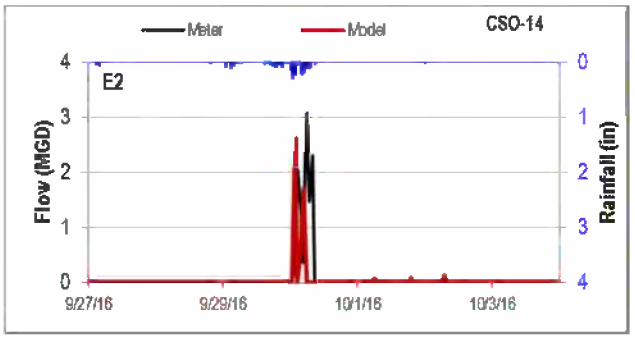


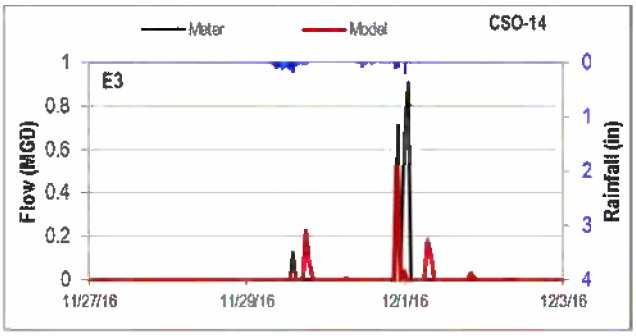


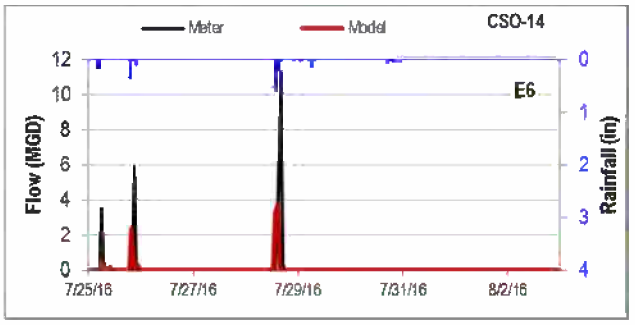
FLOW METER CSO-14 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-14 Model Calibration Results (Metered and Modeled Flow)

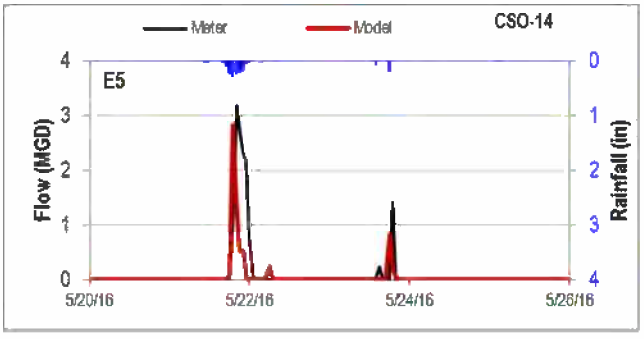


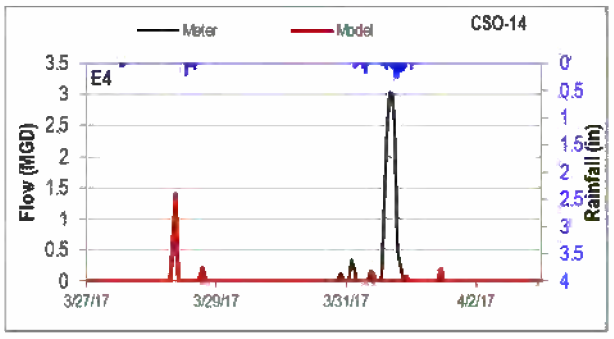




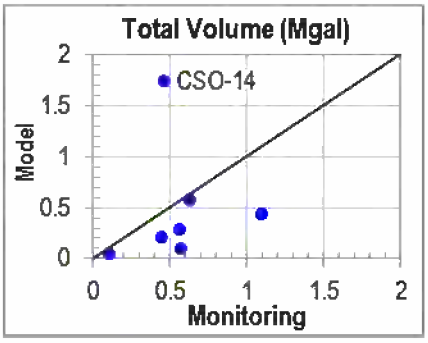


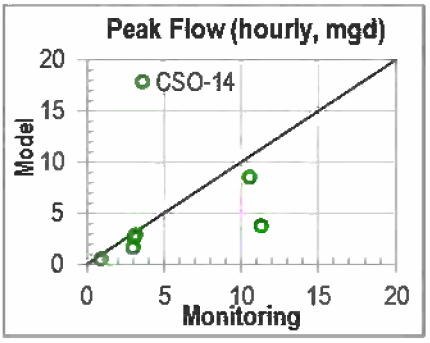
CSO-14 Model Validation Results (Metered and Modeled Flow)





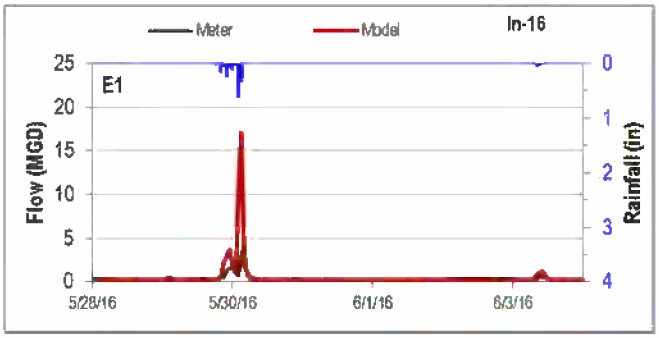
CSO-14 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

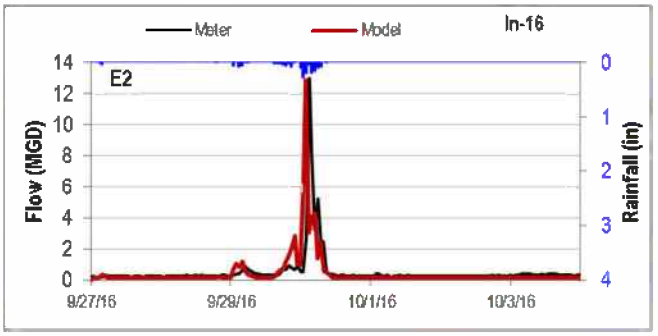


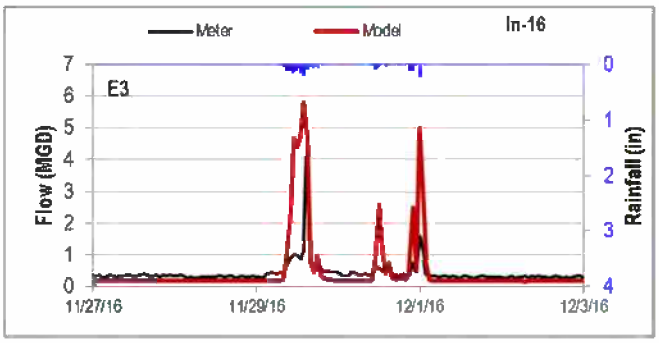


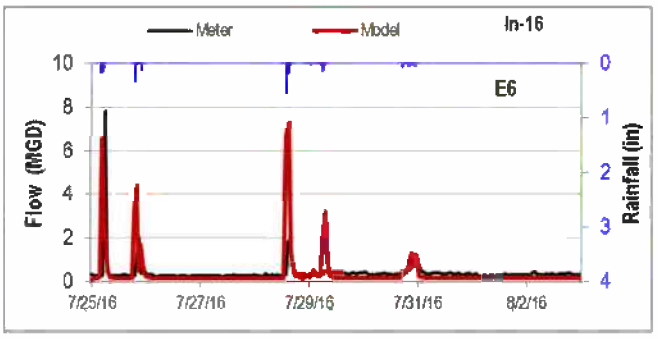
FLOW METER IN-16 MODEL CALIBRATION AND VALIDATION RESULTS

In-16 Model Calibration Results (Metered and Modeled Flow)

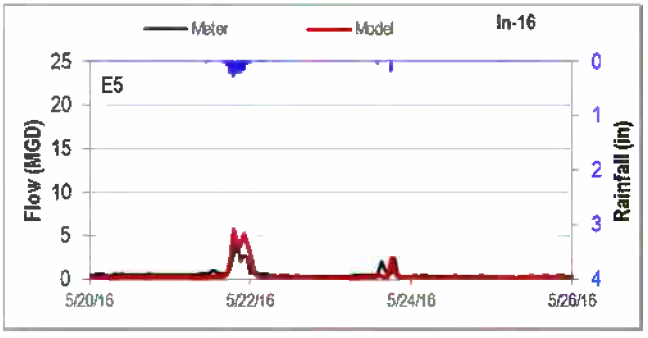


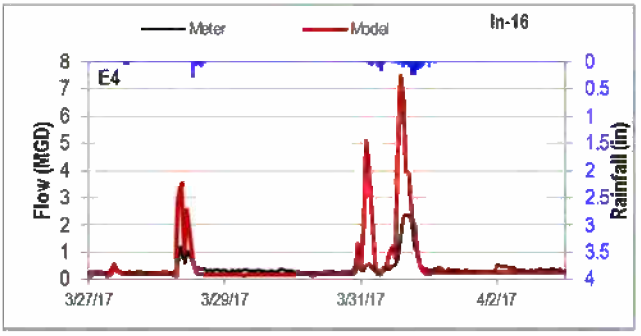




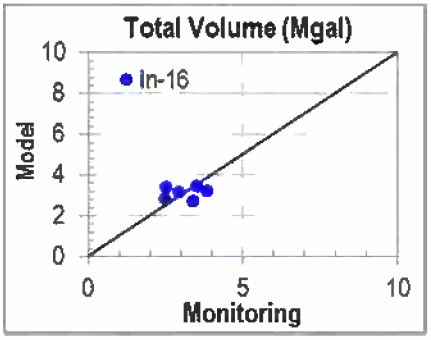


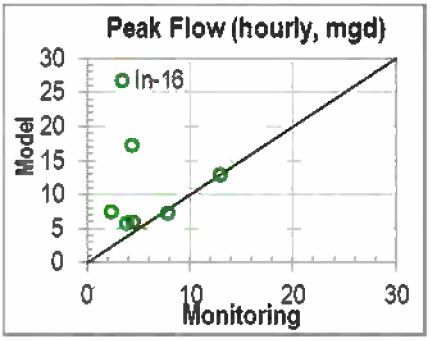
In-16 Model Validation Results (Metered and Modeled Flow)





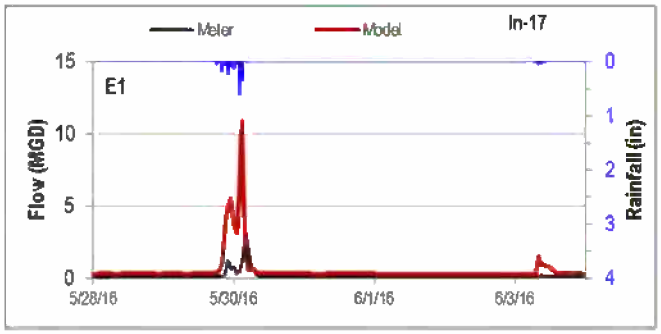
In-16 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

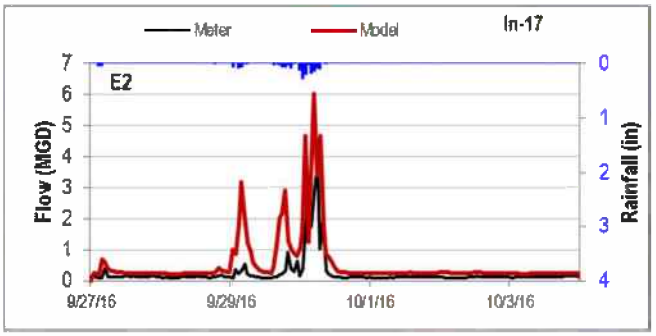


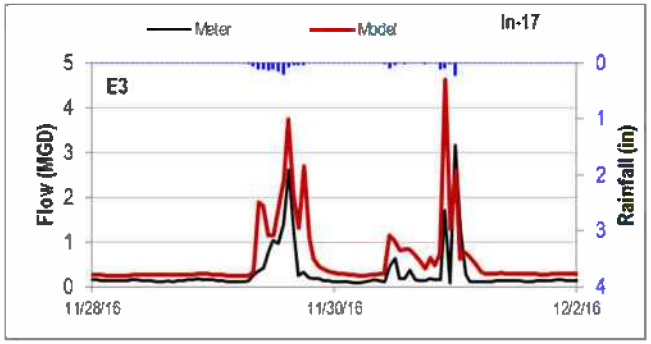


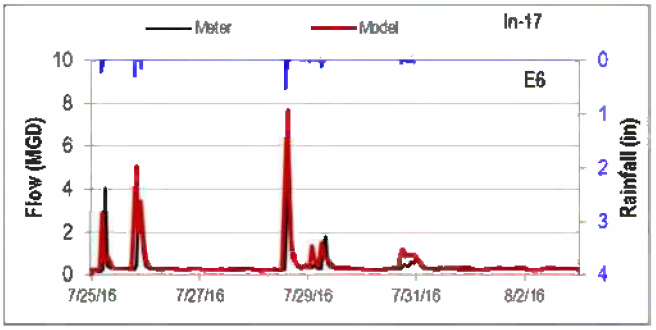
FLOW METER IN-17 MODEL CALIBRATION AND VALIDATION RESULTS

In-17 Model Calibration Results (Metered and Modeled Flow)

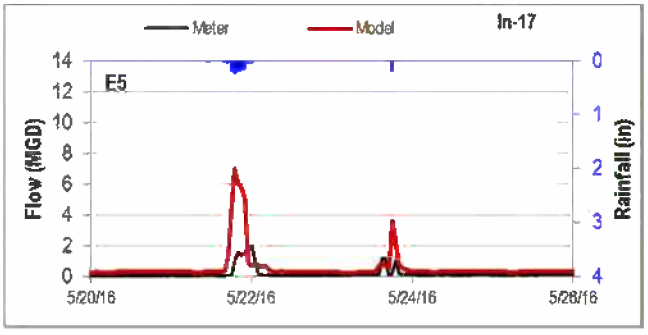


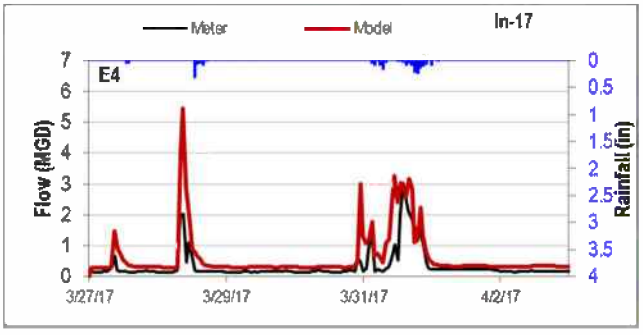




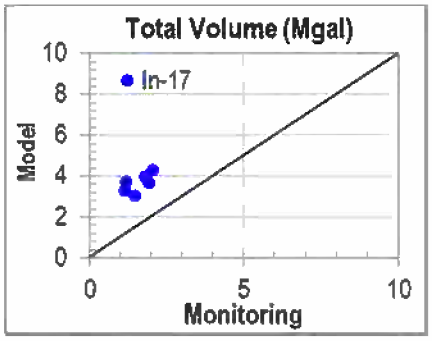


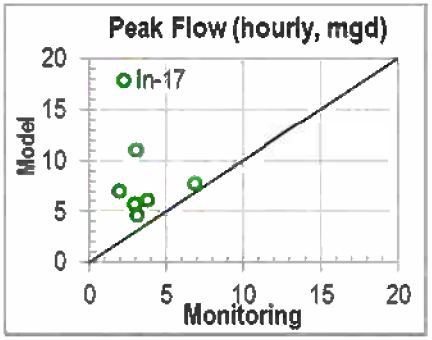
In-17 Model Validation Results (Metered and Modeled Flow)





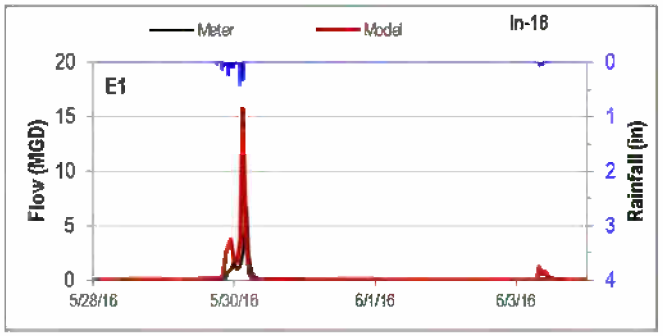
In-17 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

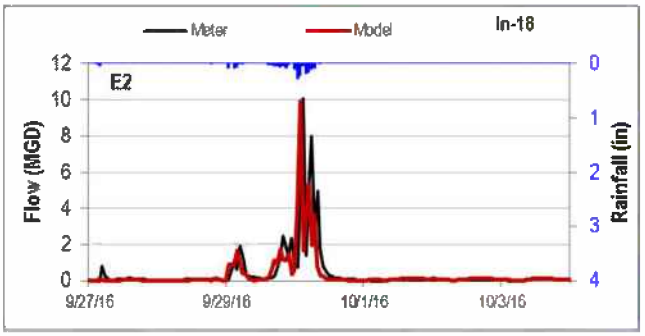


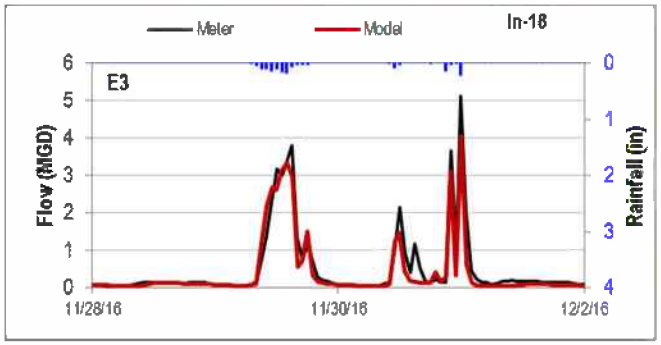


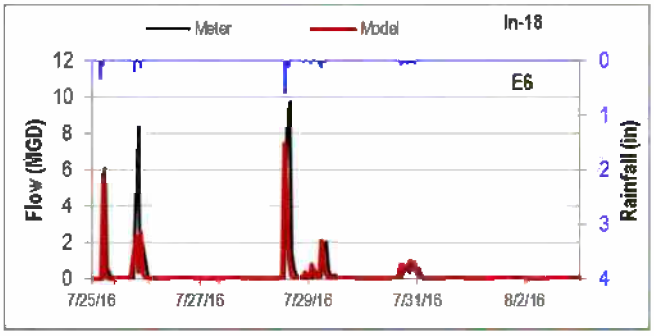
FLOW METER IN-18 MODEL CALIBRATION AND VALIDATION RESULTS

In-18 Model Calibration Results (Metered and Modeled Flow)

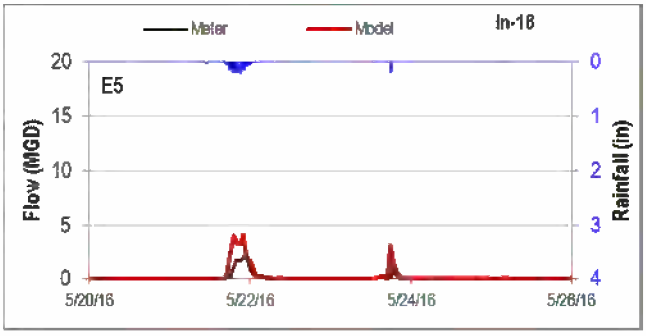


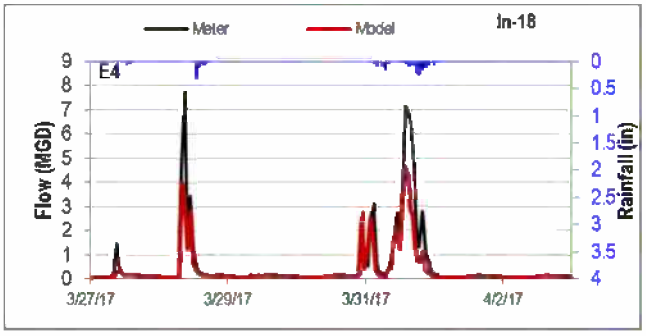




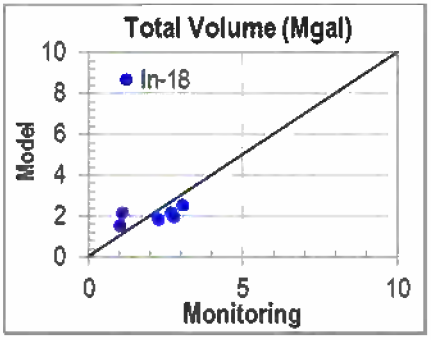


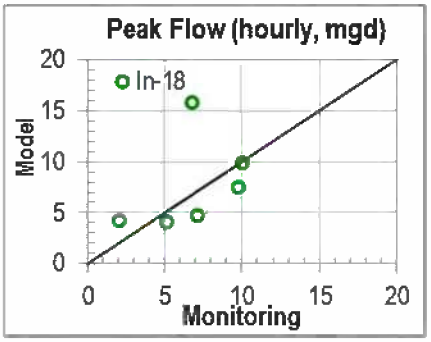
In-18 Model Validation Results (Metered and Modeled Flow)





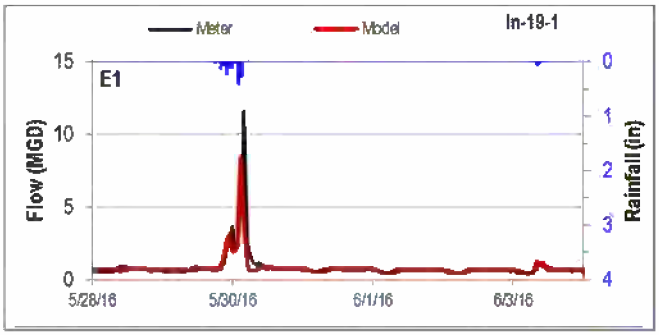
In-18 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

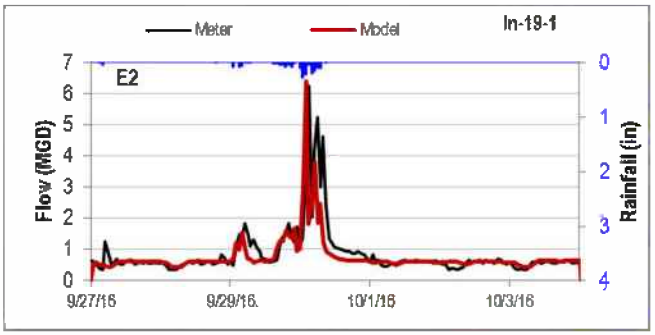


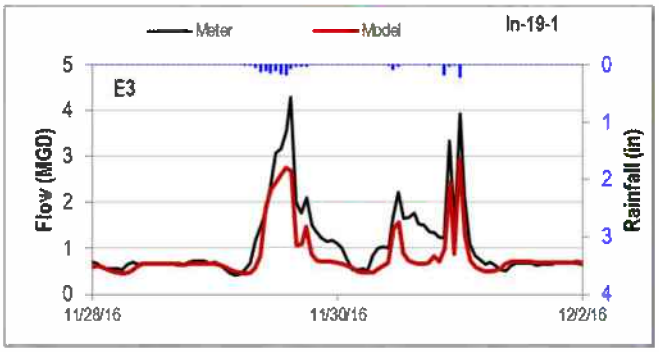


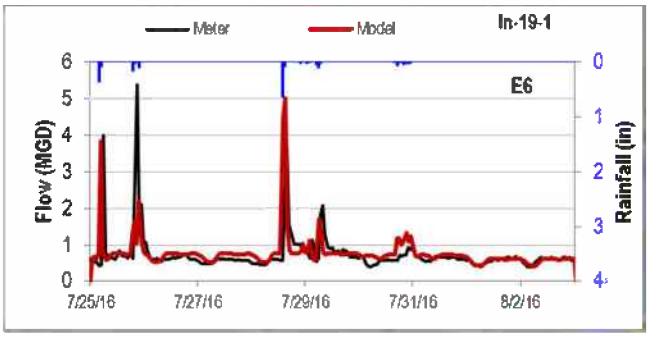
FLOW METER IN-19-1 MODEL CALIBRATION AND VALIDATION RESULTS

In-19-1 Model Calibration Results (Metered and Modeled Flow)

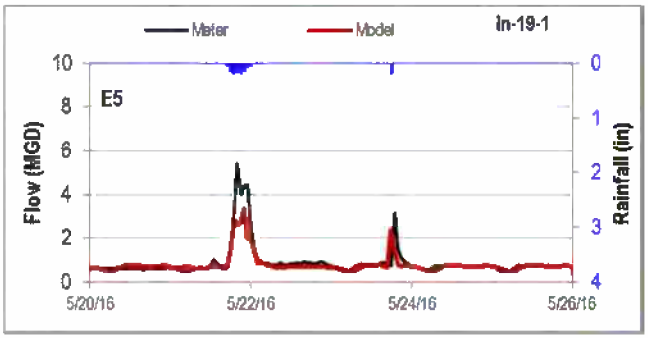


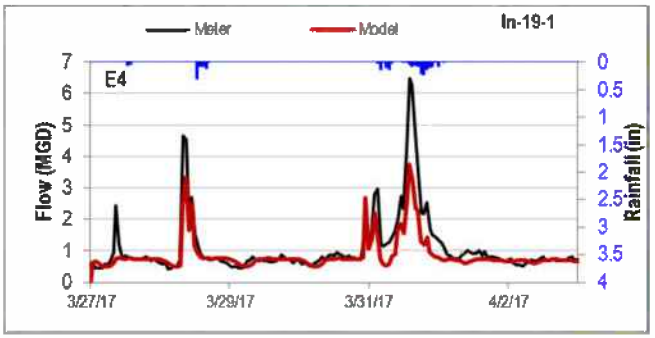




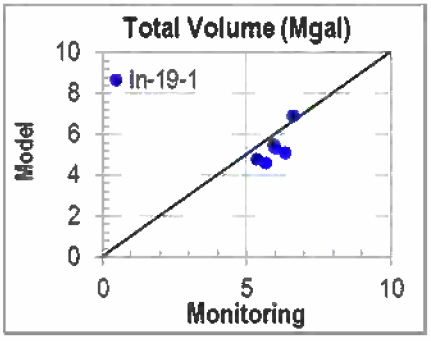


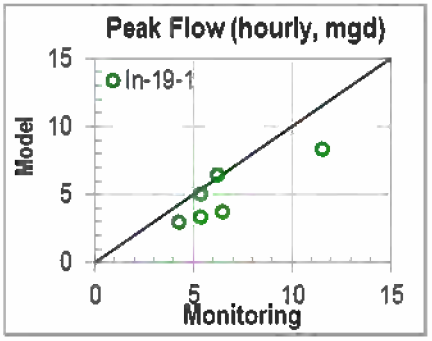
In-19-1 Model Validation Results (Metered and Modeled Flow)





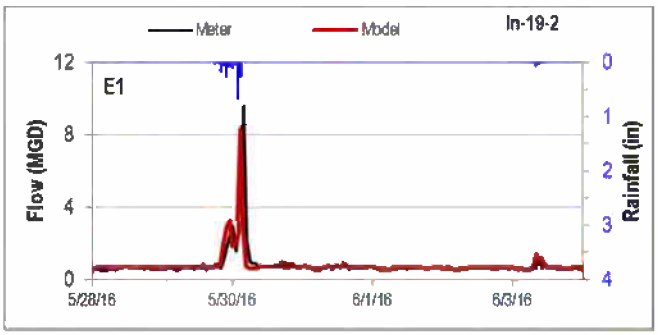
In-19-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

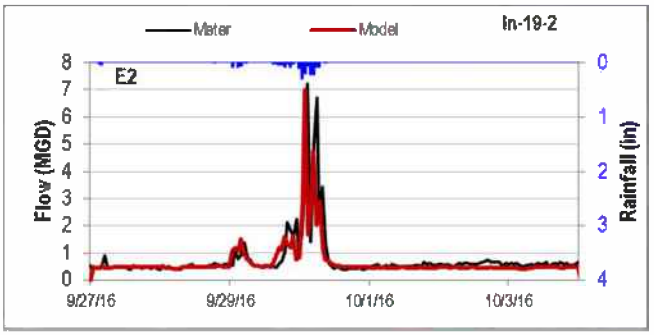


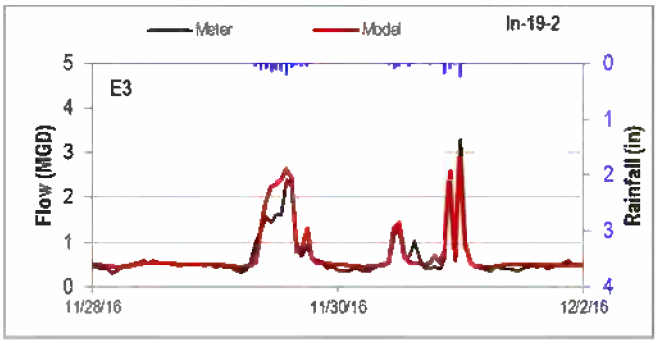


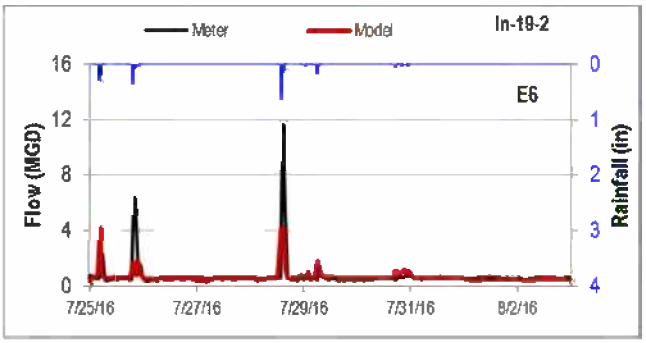
FLOW METER IN-19-2 MODEL CALIBRATION AND VALIDATION RESULTS

In-19-2 Model Calibration Results (Metered and Modeled Flow)

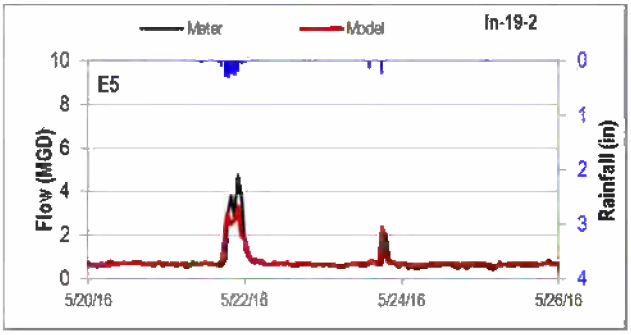


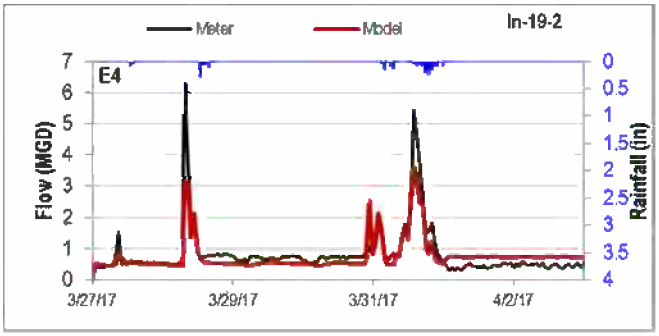




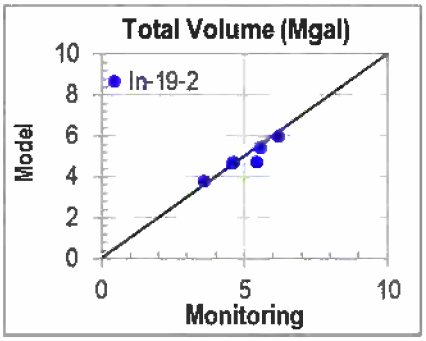


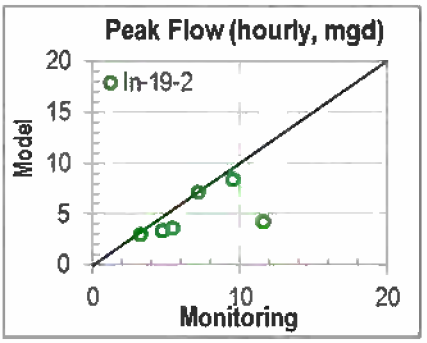
In-19-2 Model Validation Results (Metered and Modeled Flow)





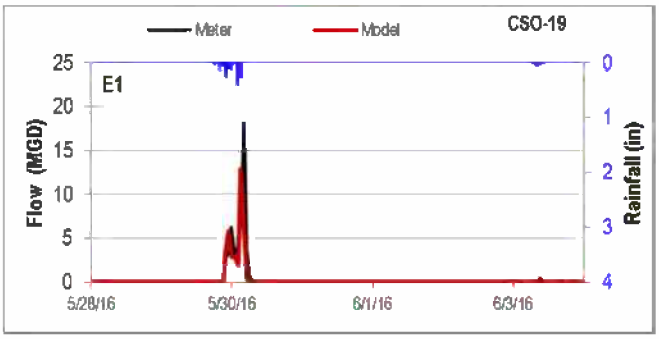
In-19-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

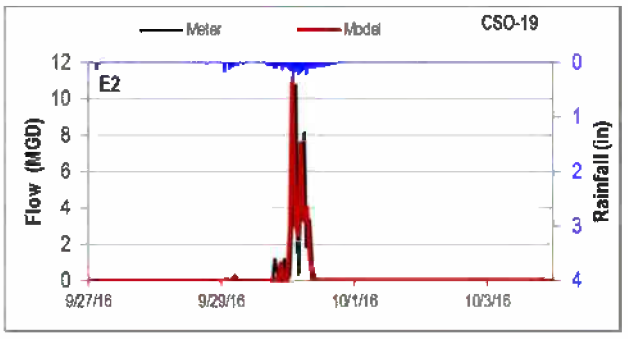


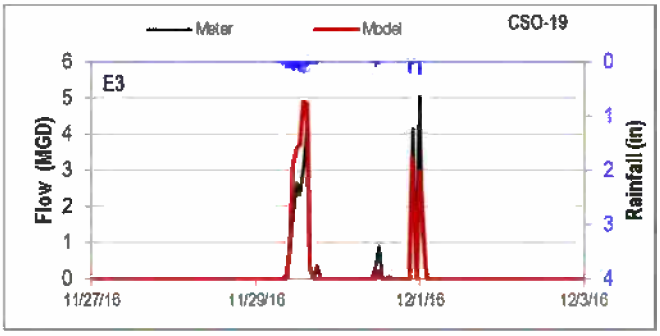


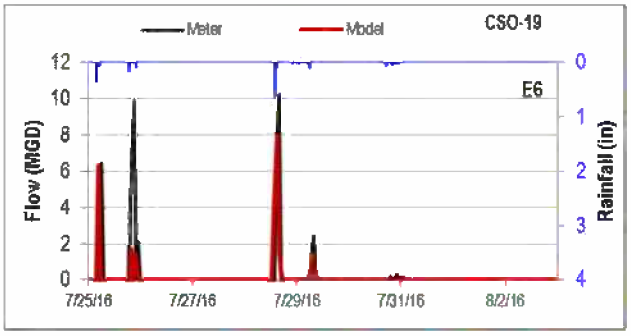
FLOW METER CSO-19 MODEL CALIBRATION AND VALIDATION RESULTS

CSO-19 Model Calibration Results (Metered and Modeled Flow)

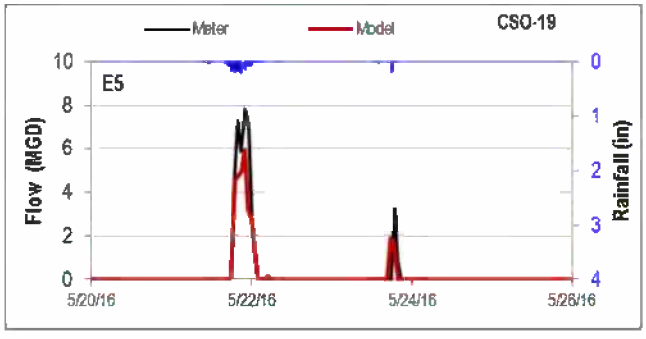


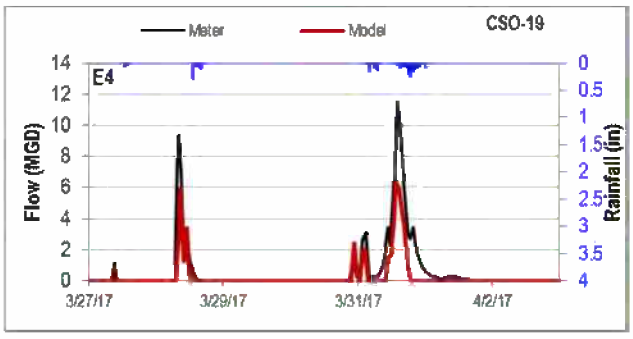




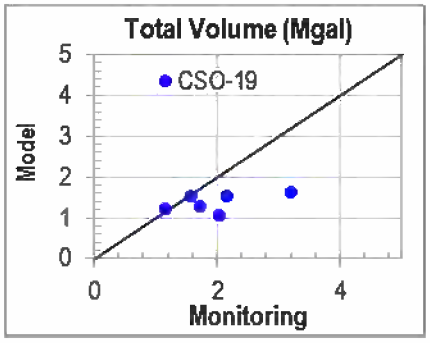


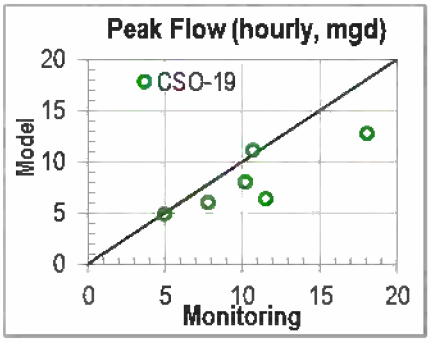
CSO-19 Model Validation Results (Metered and Modeled Flow)





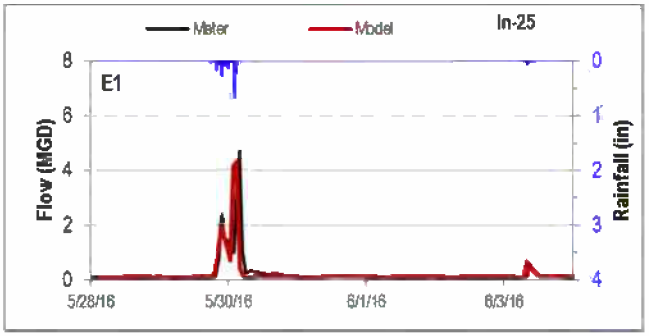
CSO-19 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

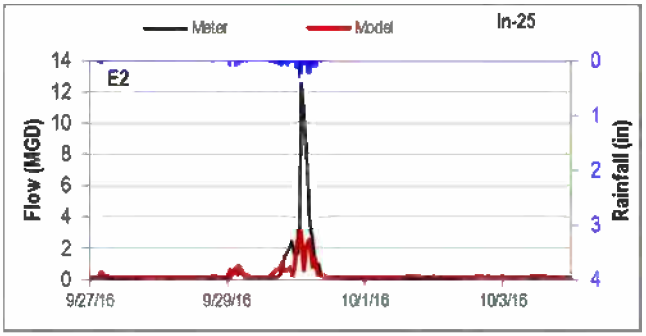


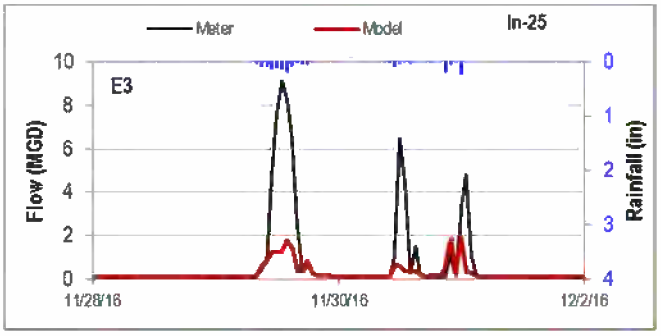


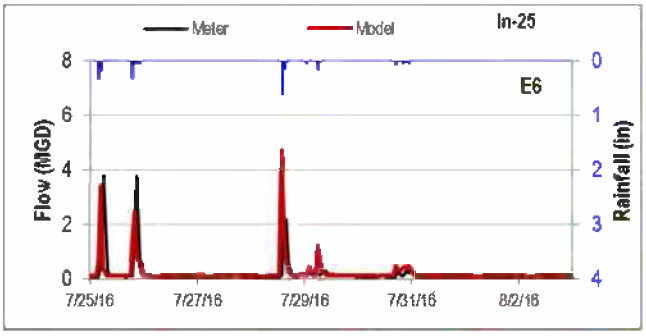
FLOW METER IN-25 MODEL CALIBRATION AND VALIDATION RESULTS

In-25 Model Calibration Results (Metered and Modeled Flow)

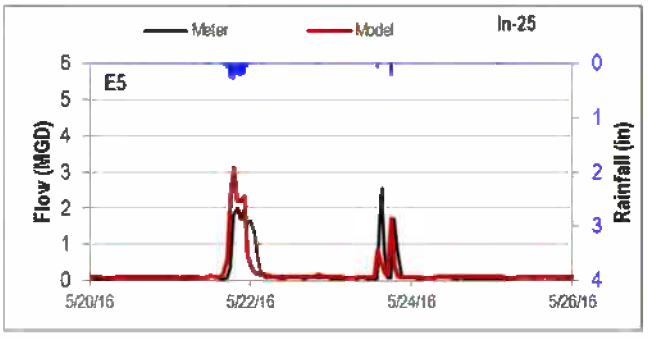


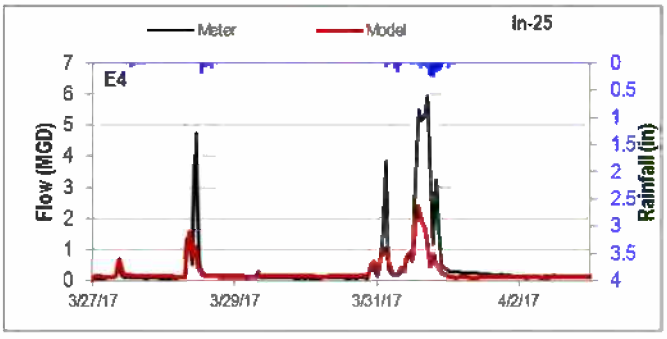




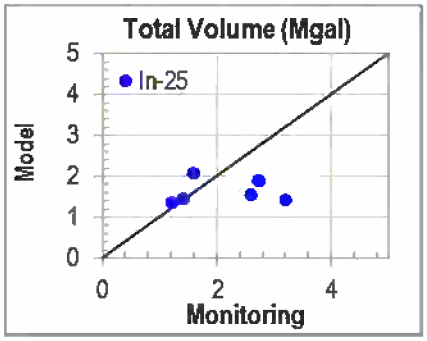


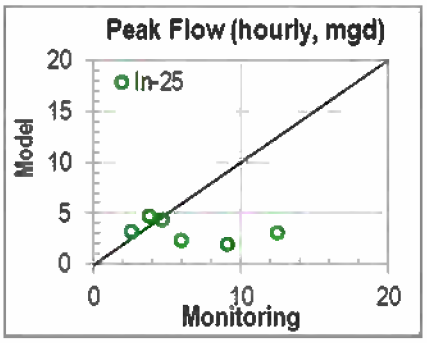
In-25 Model Validation Results (Metered and Modeled Flow)





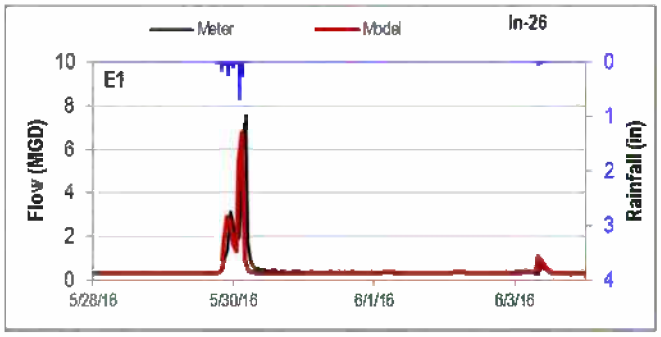
In-25 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

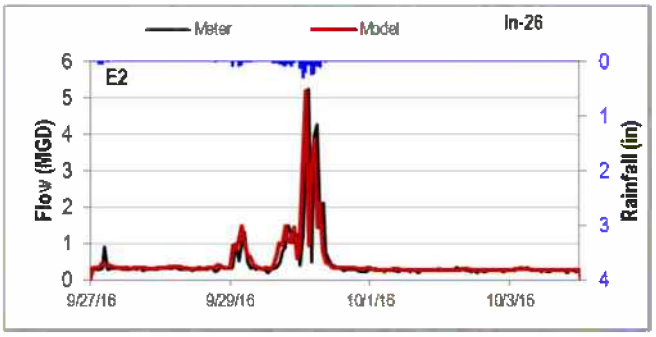


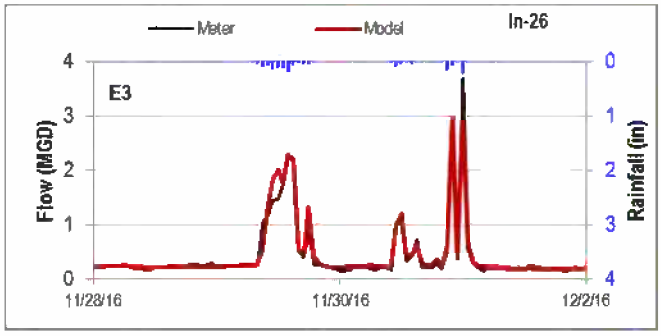


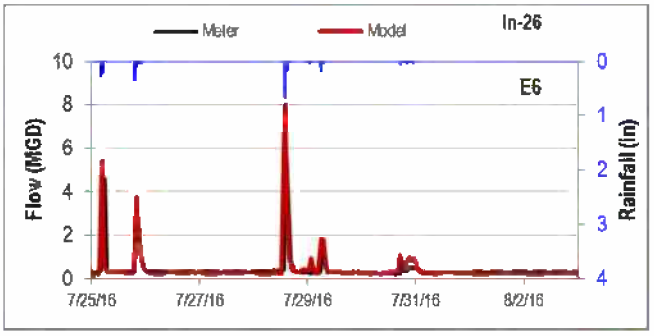
FLOW METER IN-26 MODEL CALIBRATION AND VALIDATION RESULTS

In-26 Model Calibration Results (Metered and Modeled Flow)

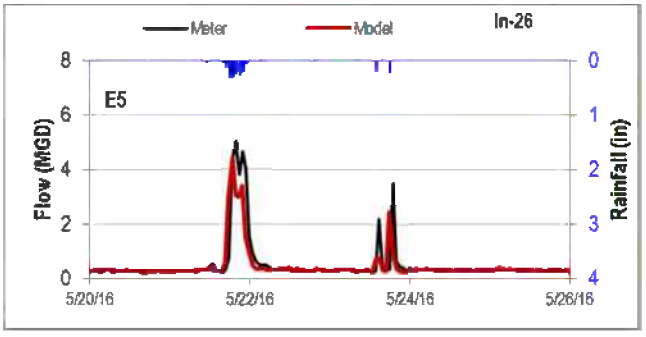


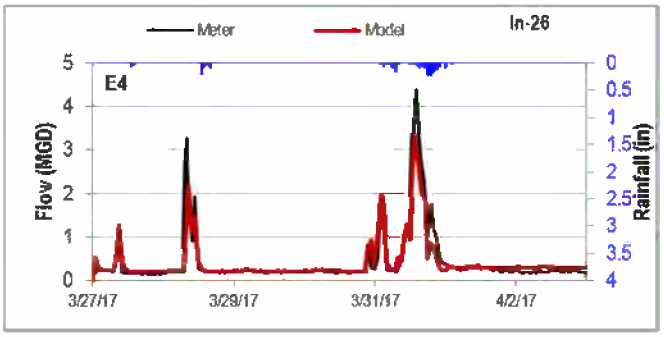




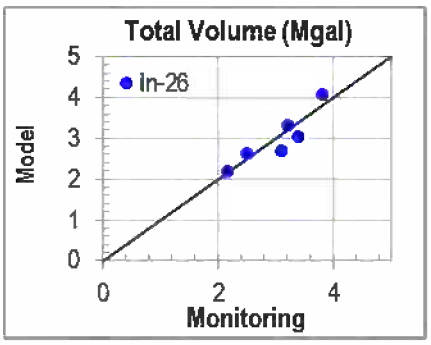


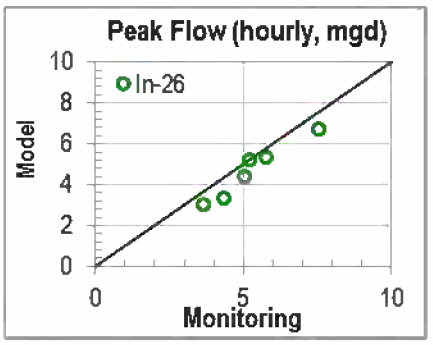
In-26 Model Validation Results (Metered and Modeled Flow)





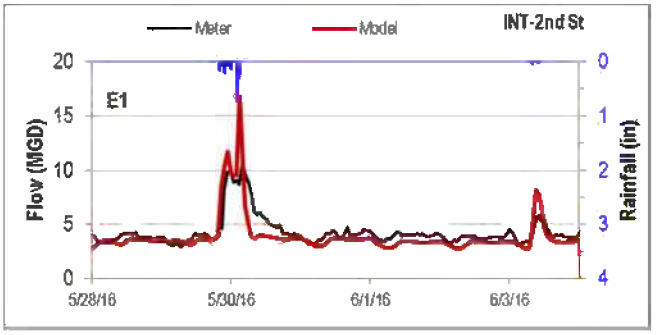
In-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

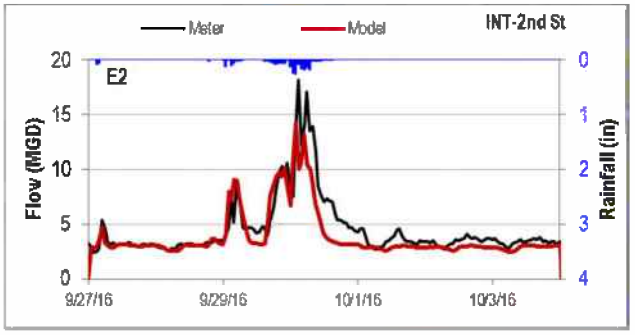


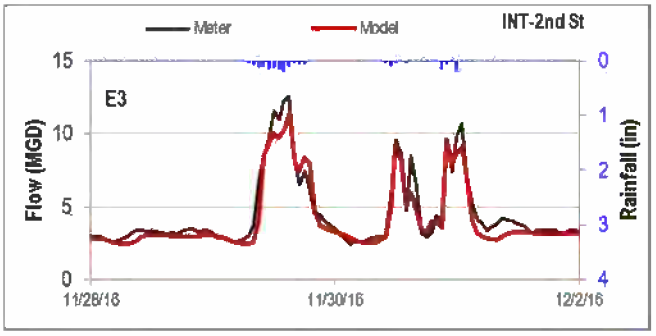


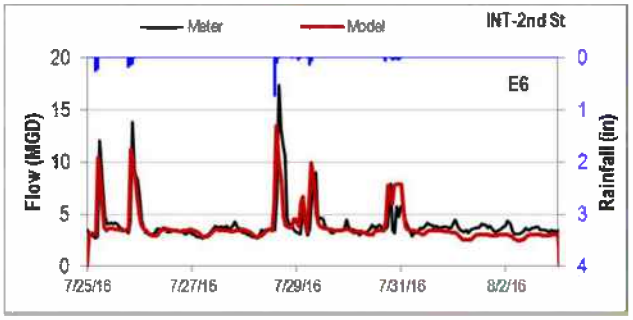
FLOW METER INT-2nd St MODEL CALIBRATION AND VALIDATION RESULTS

INT-2nd St Model Calibration Results (Metered and Modeled Flow)

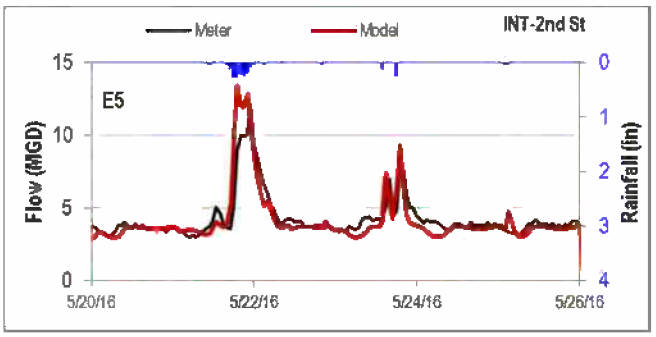


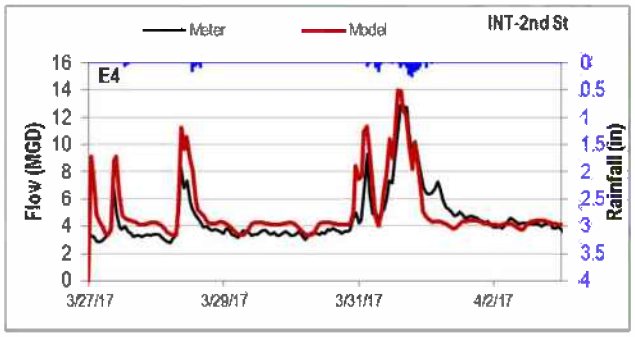




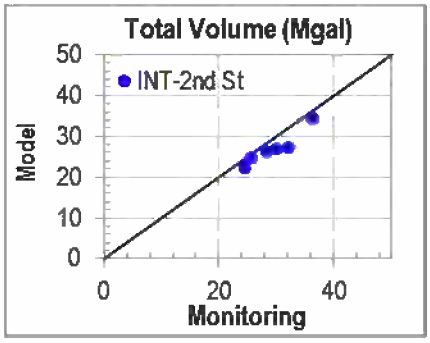


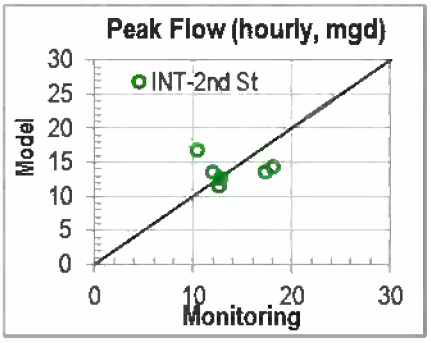
INT-2nd St Model Validation Results (Metered and Modeled Flow)





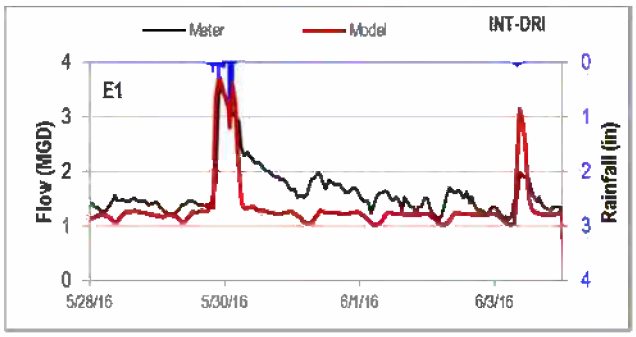
INT-2nd St Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

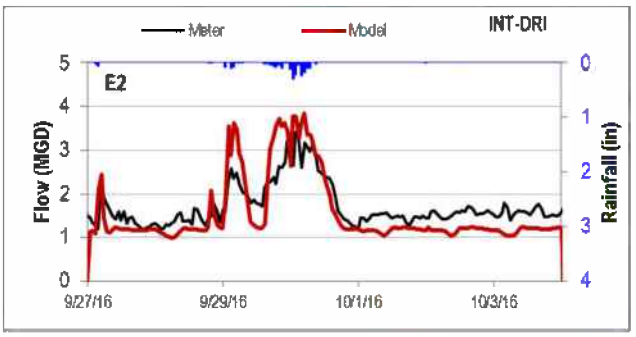


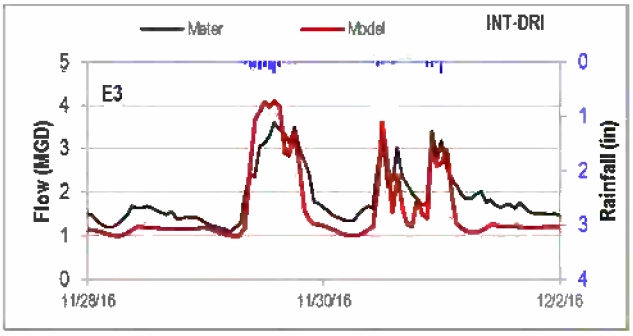


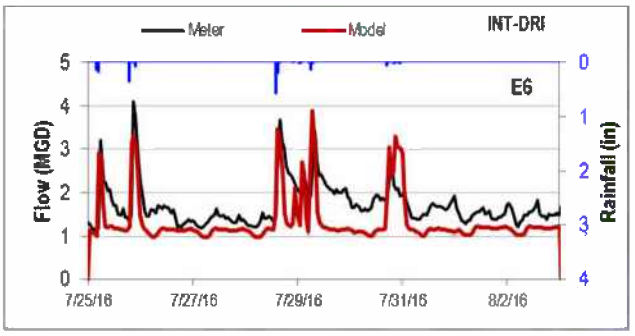
FLOW METER INT-DRI MODEL CALIBRATION AND VALIDATION RESULTS

INT-DRI Model Calibration Results (Metered and Modeled Flow)

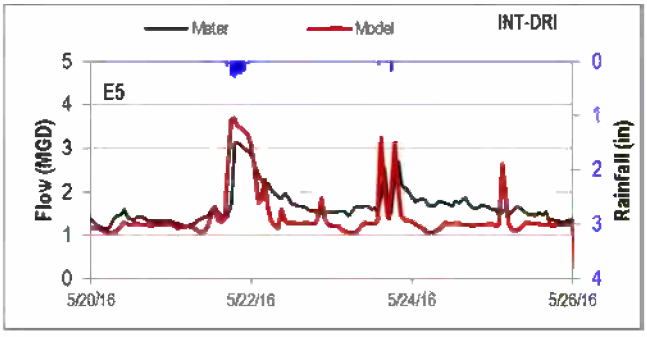


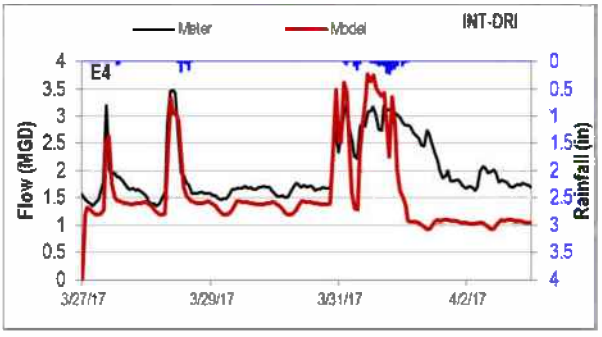




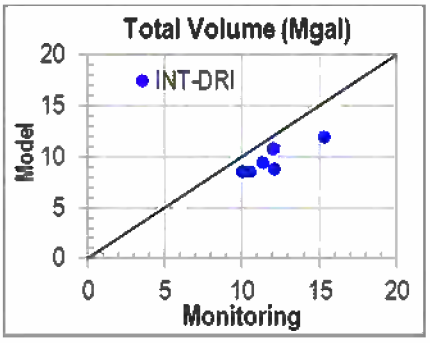


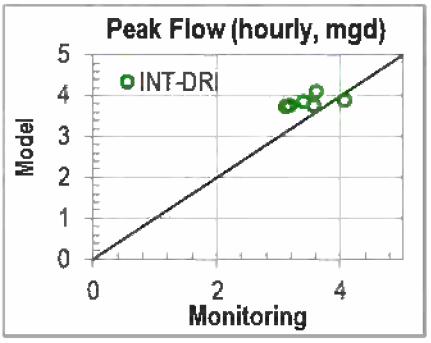
INT-DRI Model Validation Results (Metered and Modeled Flow)





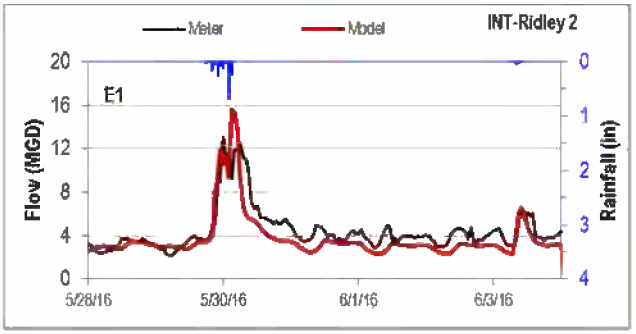
INT-DRI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

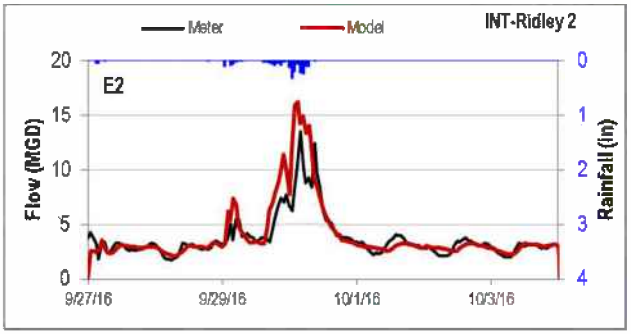


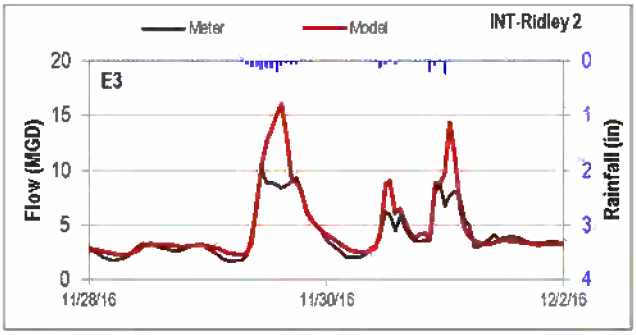


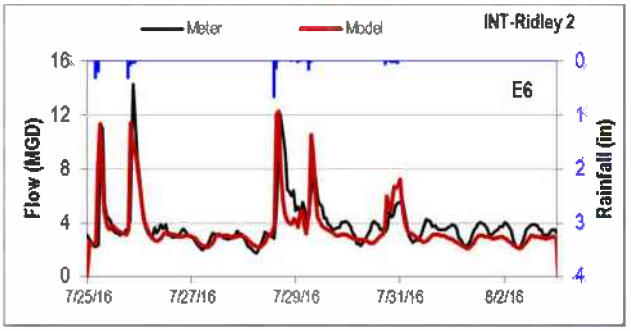
FLOW METER INT-Ridley 2 MODEL CALIBRATION AND VALIDATION RESULTS

INT-Ridley 2 Model Calibration Results (Metered and Modeled Flow)

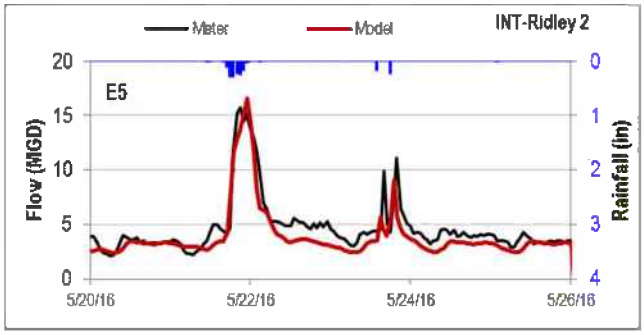


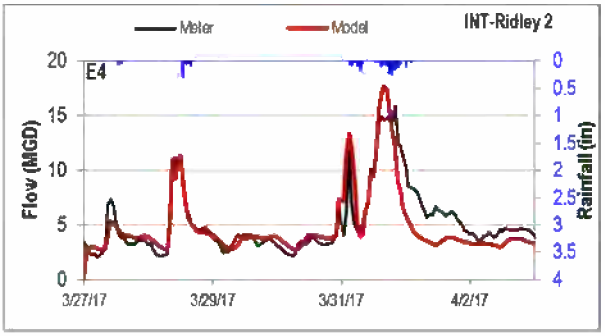




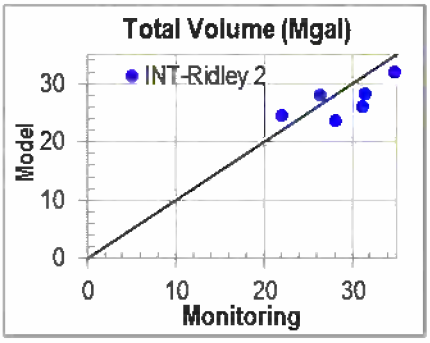


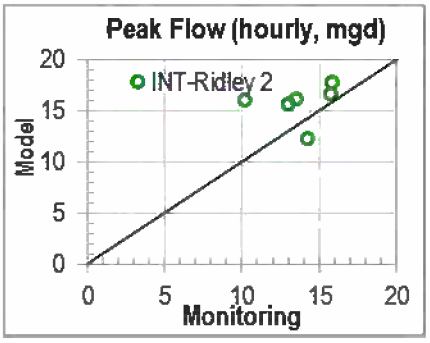
INT-Ridley 2 Model Validation Results (Metered and Modeled Flow)





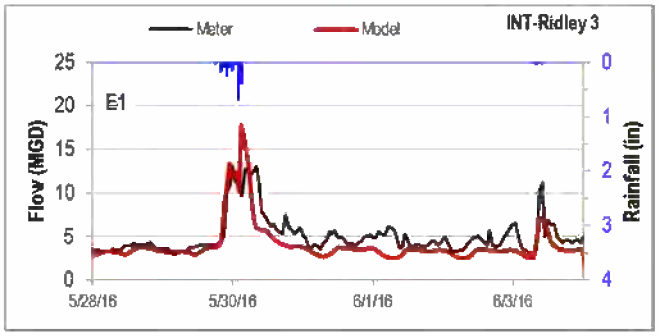
INT-Ridley-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

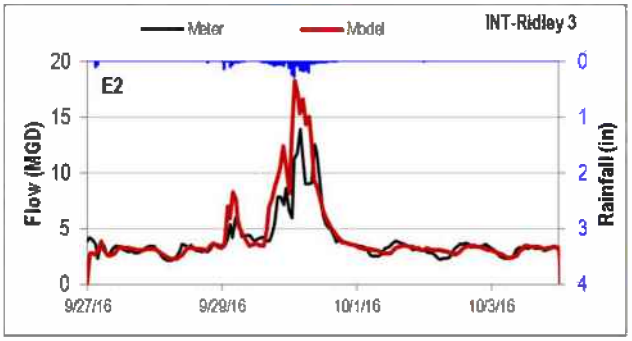


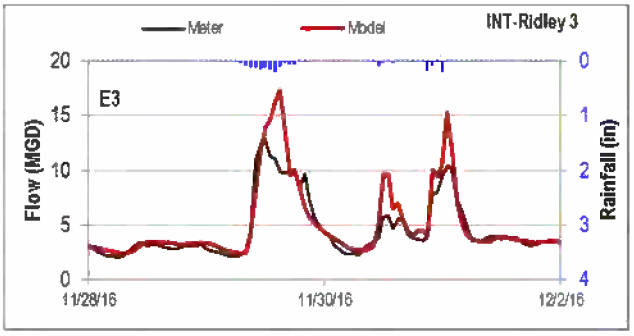


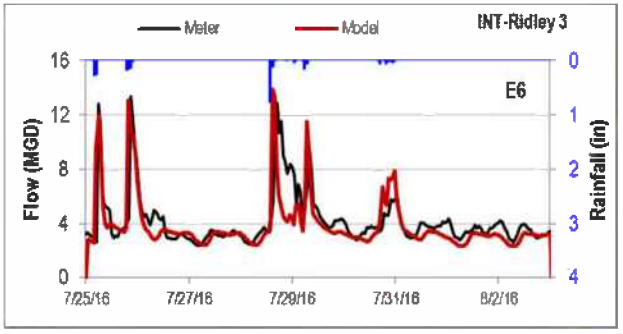
FLOW METER INT-Ridley 3 MODEL CALIBRATION AND VALIDATION RESULTS

INT-Ridley 3 Model Calibration Results (Metered and Modeled Flow)

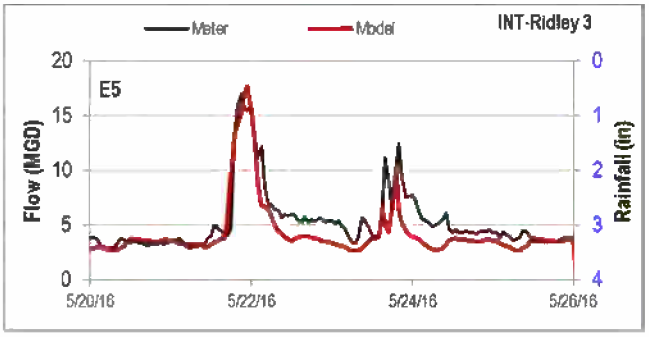


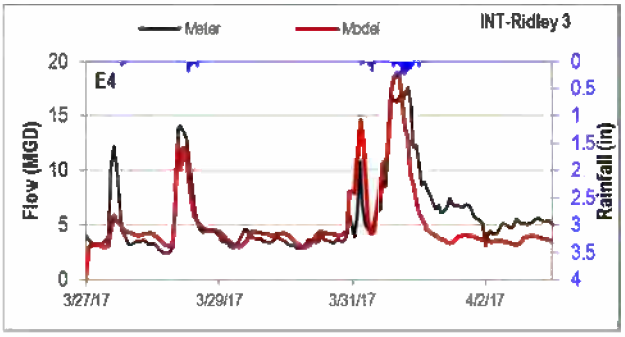




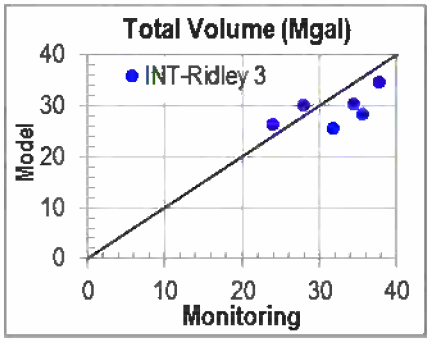


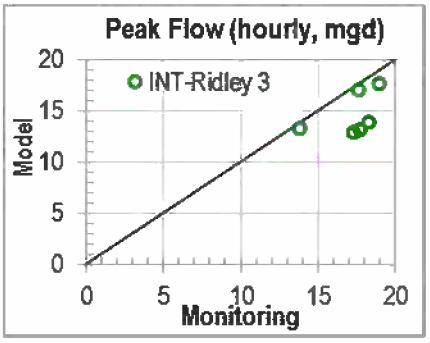
INT-Ridley 3 Model Validation Results (Metered and Modeled Flow)





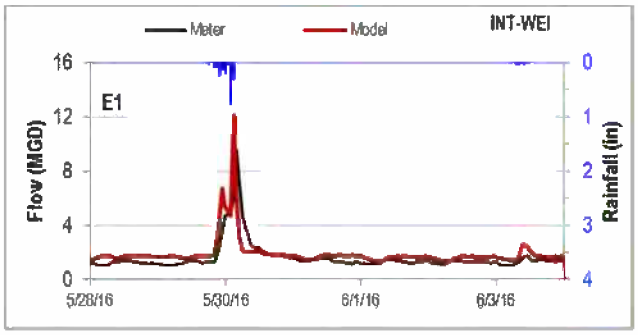
INT-Ridley 3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

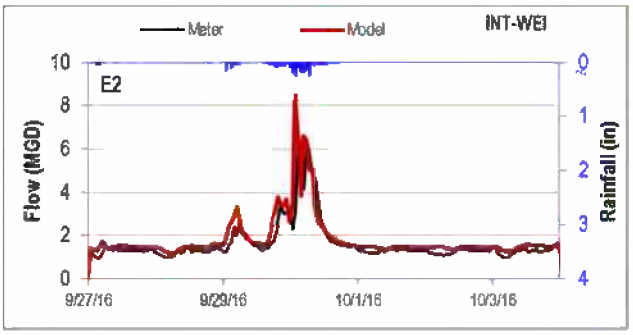


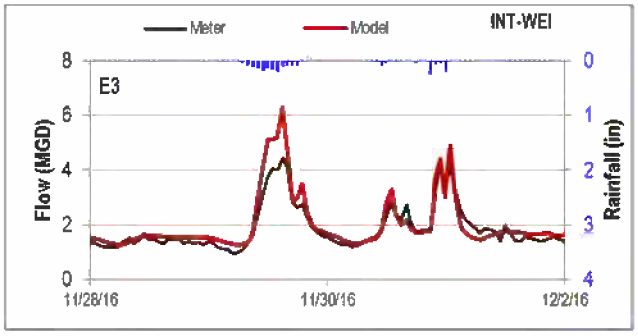


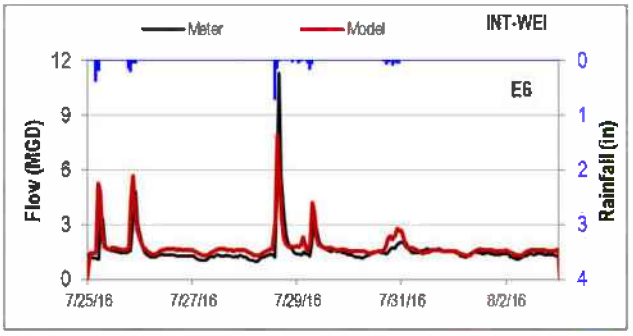
FLOW METER INT-WEI MODEL CALIBRATION AND VALIDATION RESULTS

INT-WEI Model Calibration Results (Metered and Modeled Flow)

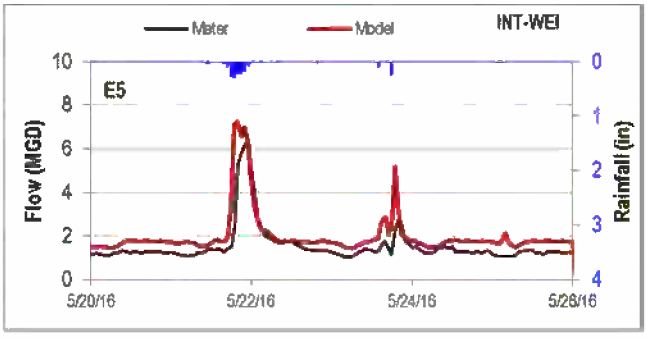


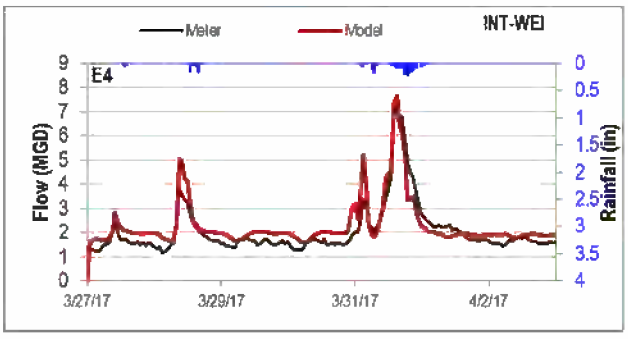




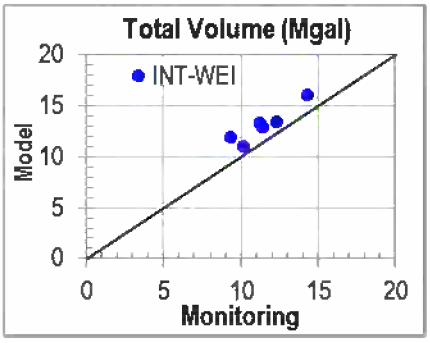


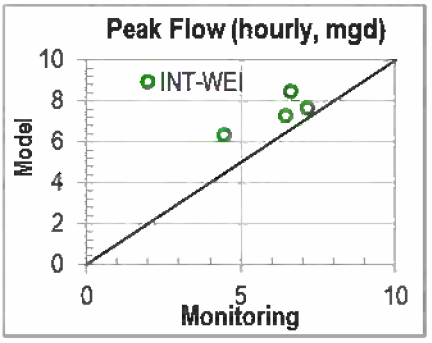
INT-WEI Model Validation Results (Metered and Modeled Flow)





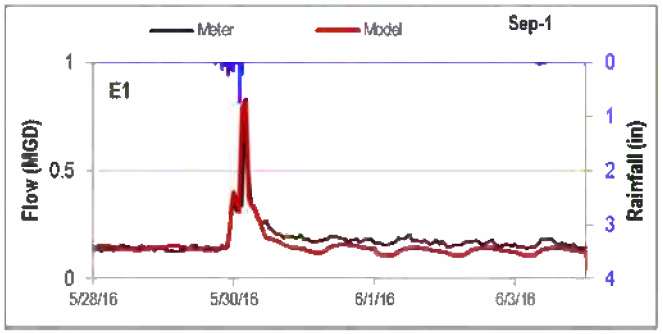
INT-WEI Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

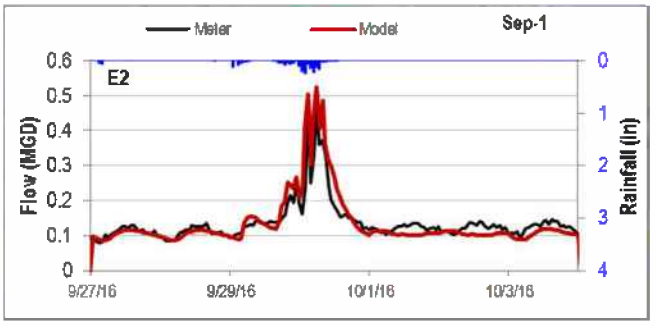


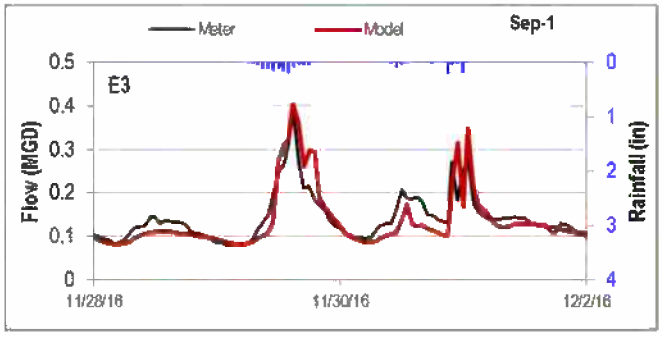


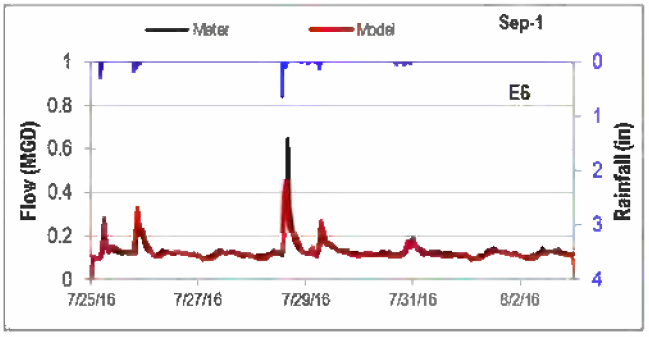
FLOW METER Sep-1 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-1 Model Calibration Results (Metered and Modeled Flow)

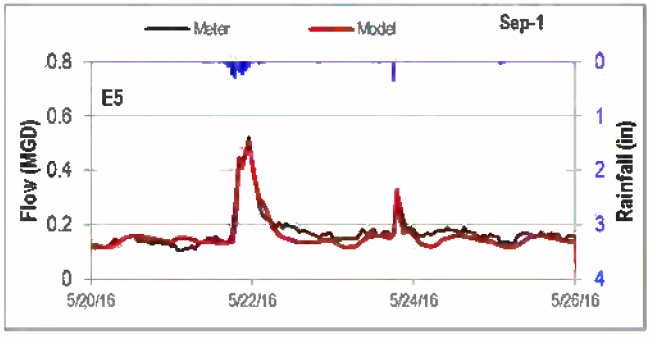


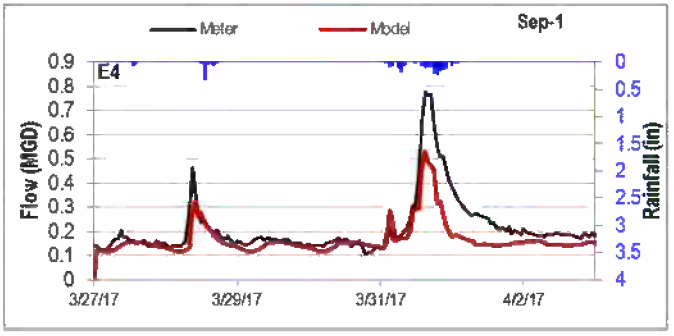




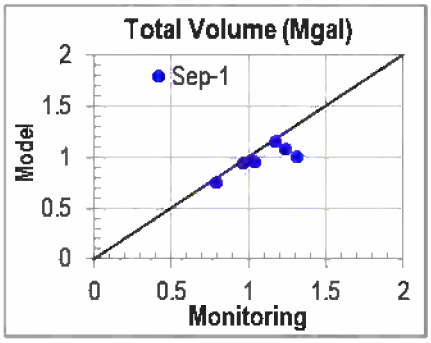


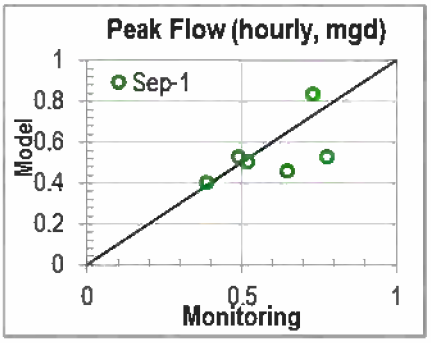
Sep-1 Model Validation Results (Metered and Modeled Flow)





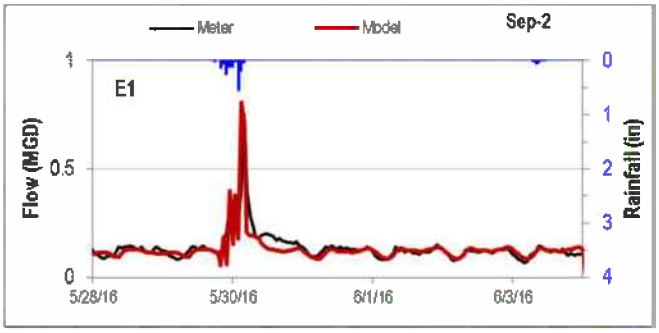
Sep-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

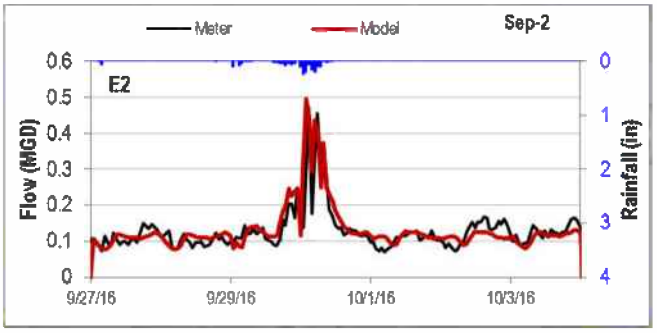


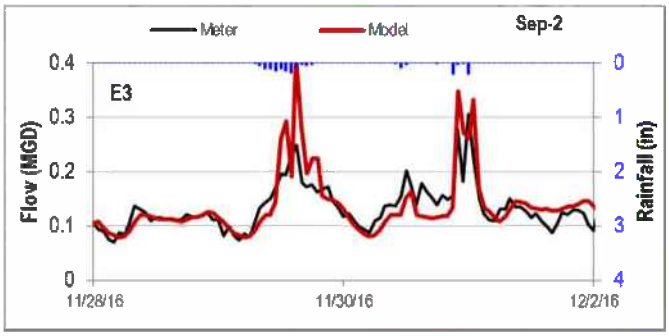


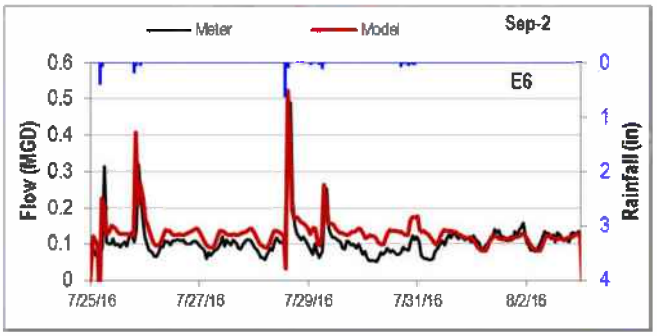
FLOW METER Sep-2 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-2 Model Calibration Results (Metered and Modeled Flow)

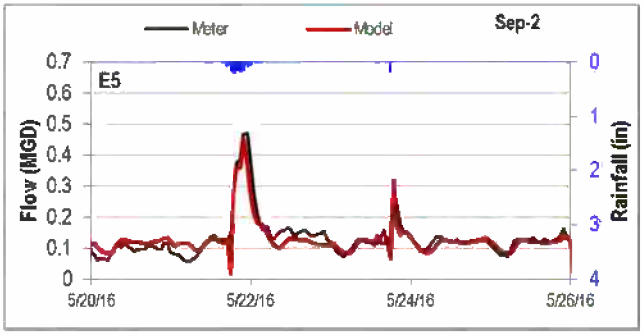


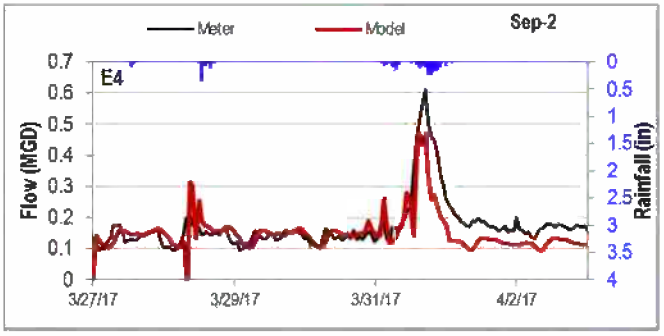




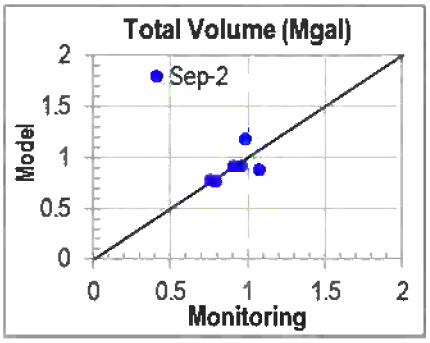


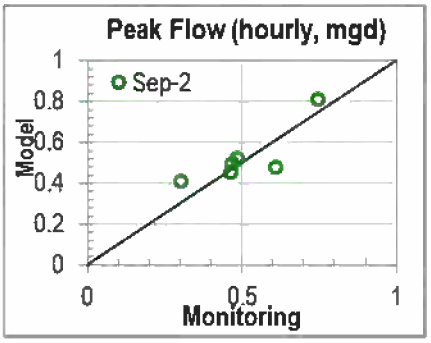
Sep-2 Model Validation Results (Metered and Modeled Flow)





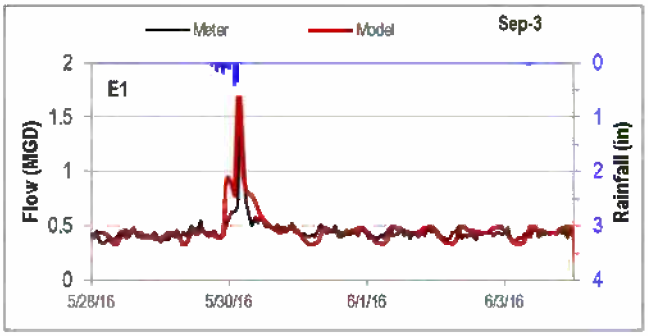
Sep-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

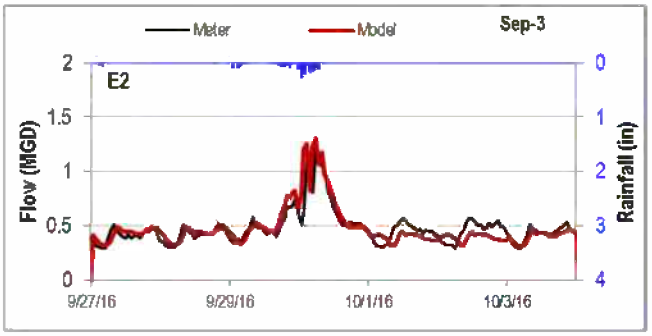


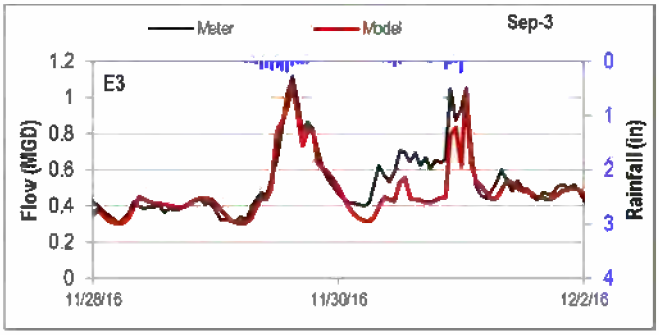


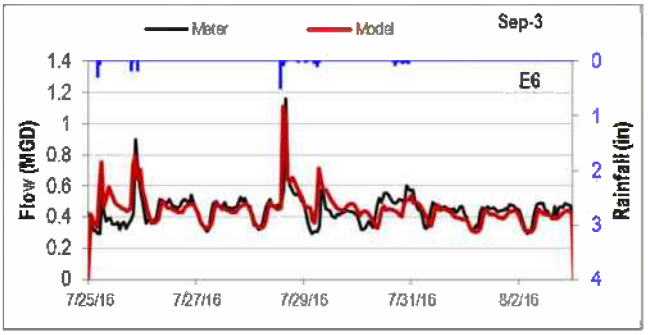
FLOW METER Sep-3 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-3 Model Calibration Results (Metered and Modeled Flow)

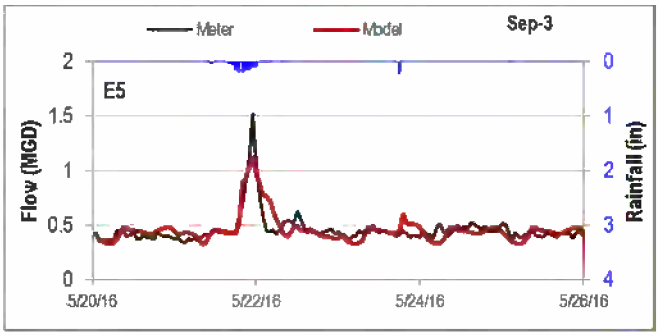


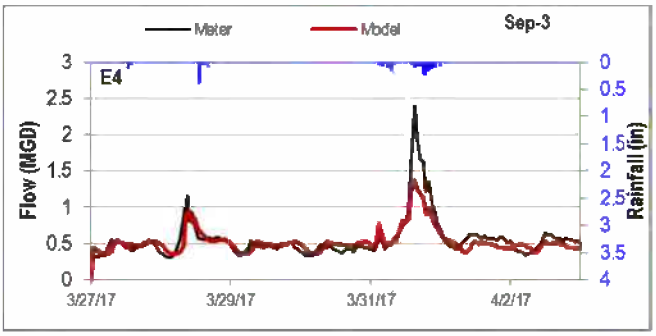




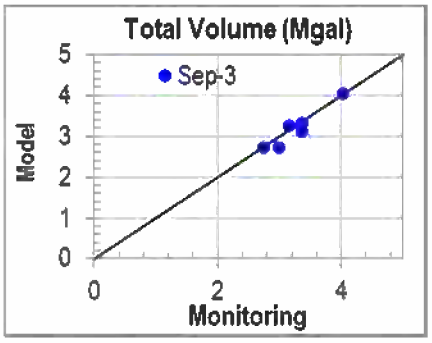


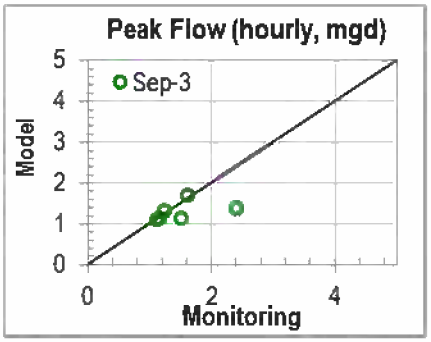
Sep-3 Model Validation Results (Metered and Modeled Flow)





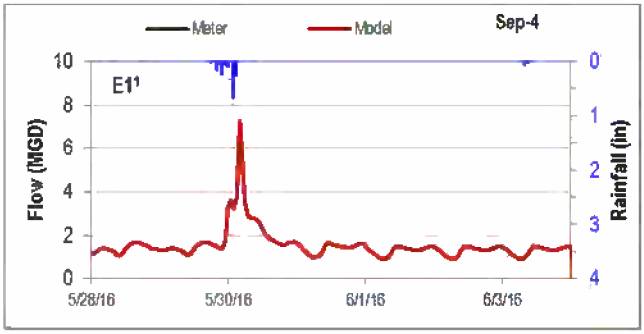
Sep-3 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

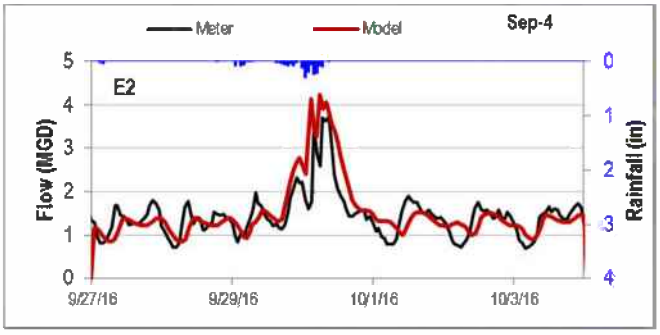


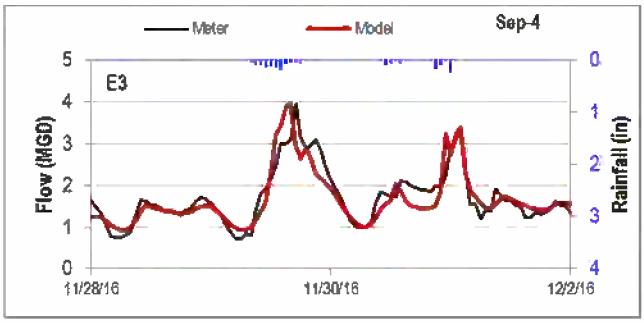


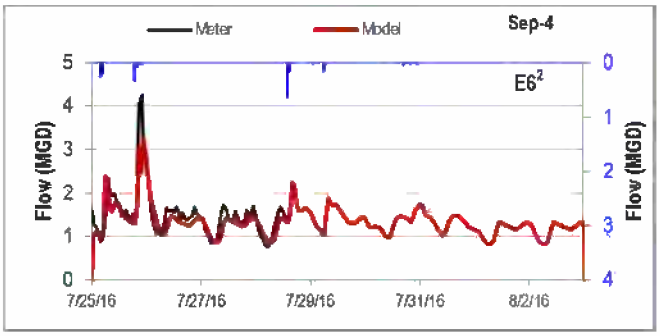
FLOW METER Sep-4 MODEL CALIBRATION AND VALIDATION RESULTS

Sep-4 Model Calibration Results (Metered and Modeled Flow)

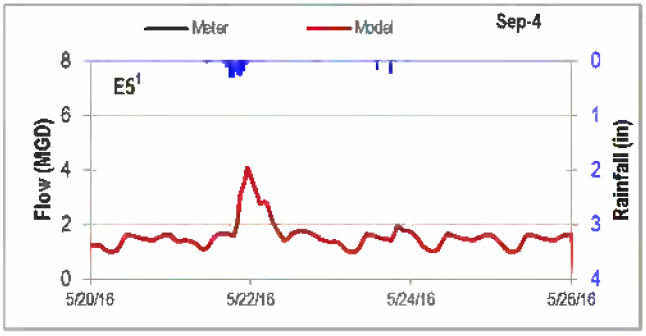


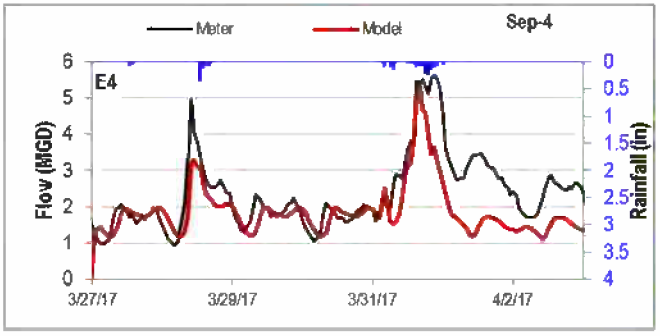






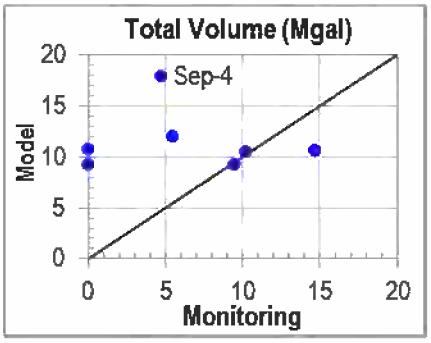
Sep-4 Model Validation Results (Metered and Modeled Flow)

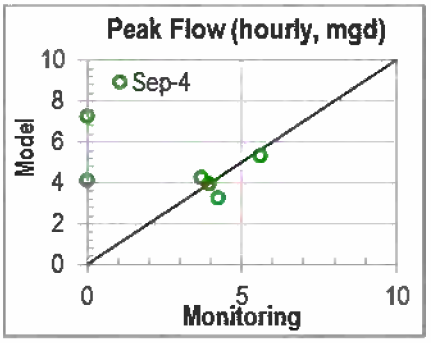




NOTE:
[1] Flow Meter installed June 2016.
[2] Flow Meter was taken out of service for maintenance.

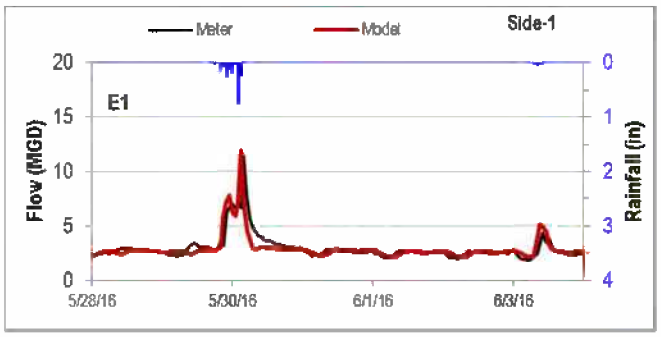
Sep-4 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

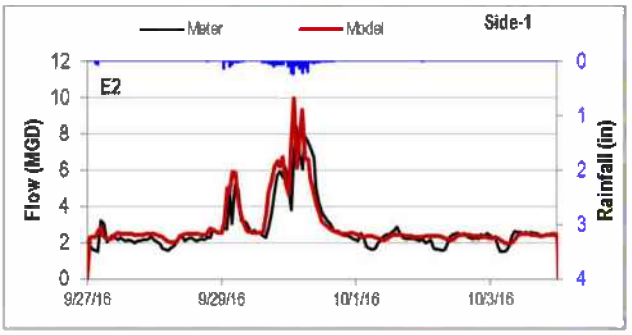


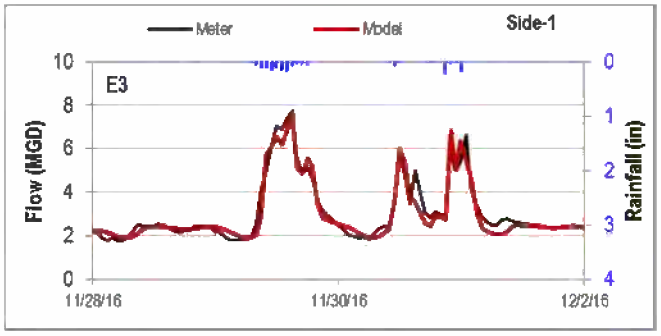


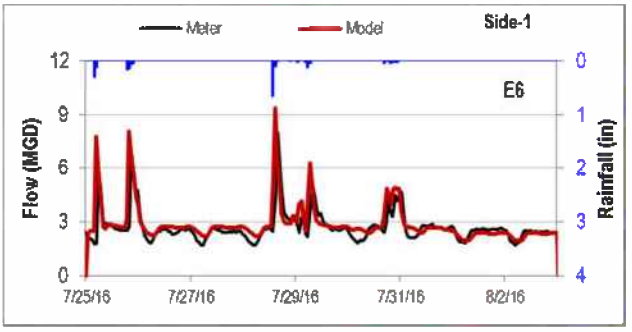
FLOW METER Side-1 MODEL CALIBRATION AND VALIDATION RESULTS

Side-1 Model Calibration Results (Metered and Modeled Flow)

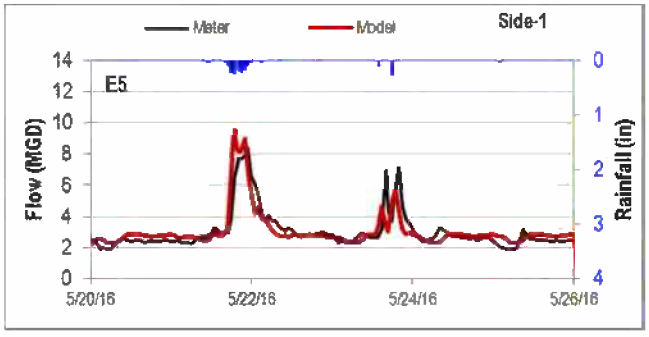


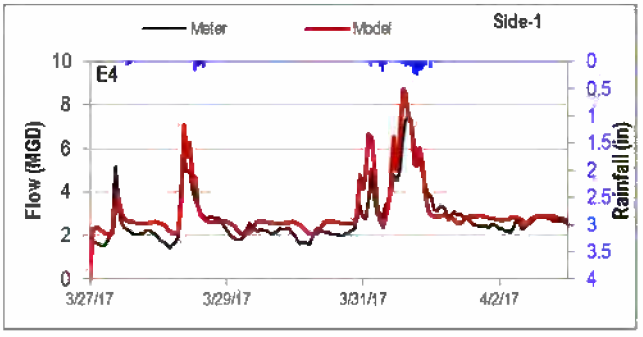




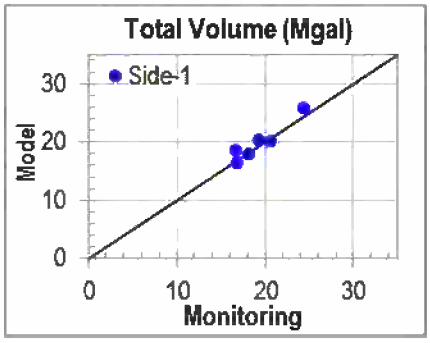


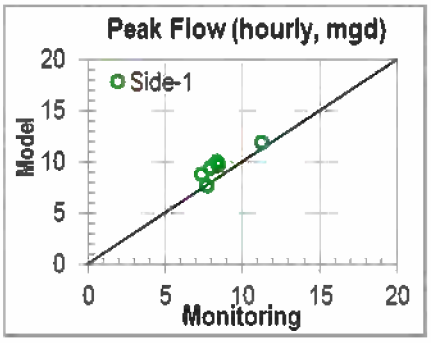
Side-1 Model Validation Results (Metered and Modeled Flow)





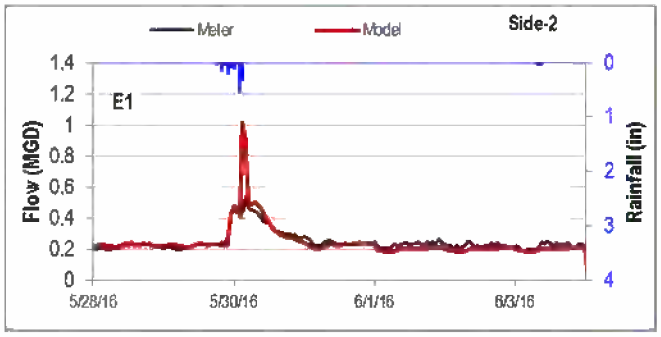
Side-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

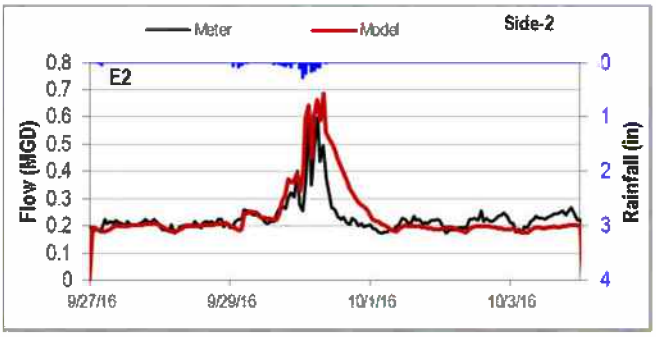


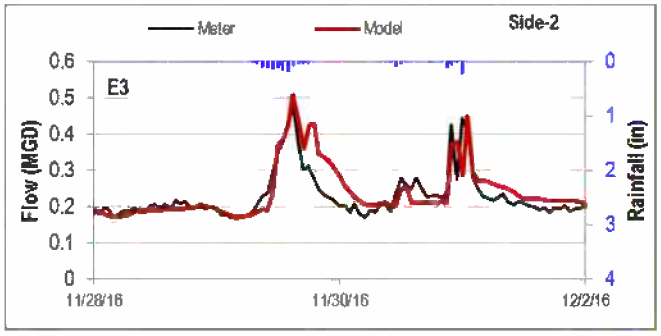


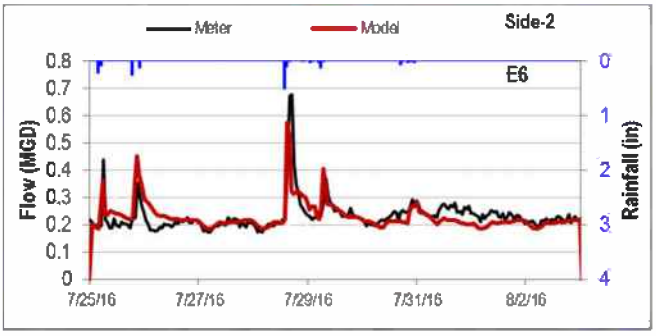
FLOW METER Side-2 MODEL CALIBRATION AND VALIDATION RESULTS

Side-2 Model Calibration Results (Metered and Modeled Flow)

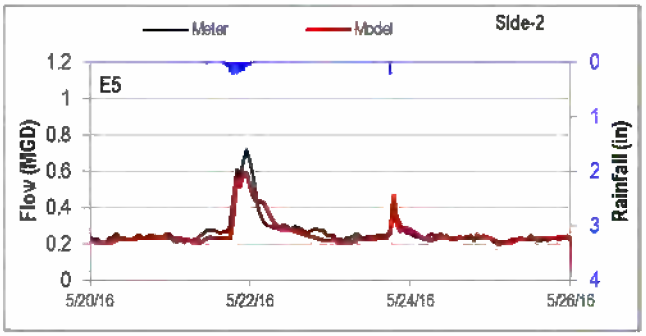


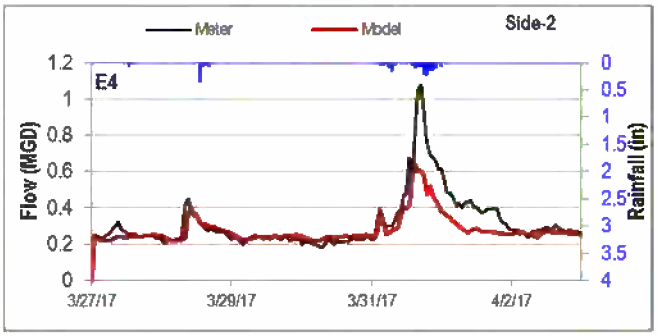




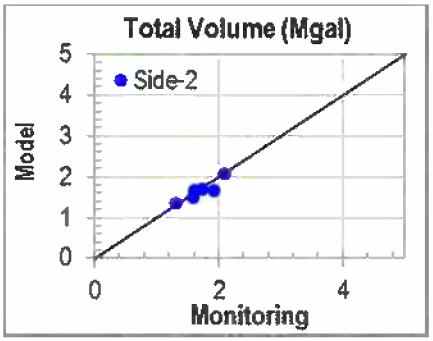


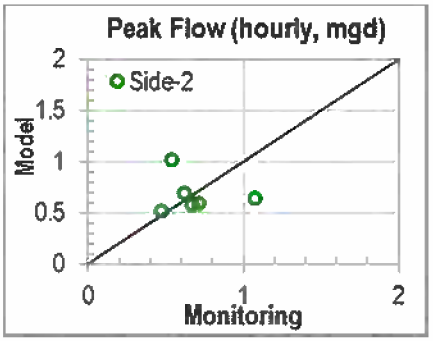
Side-2 Model Validation Results (Metered and Modeled Flow)





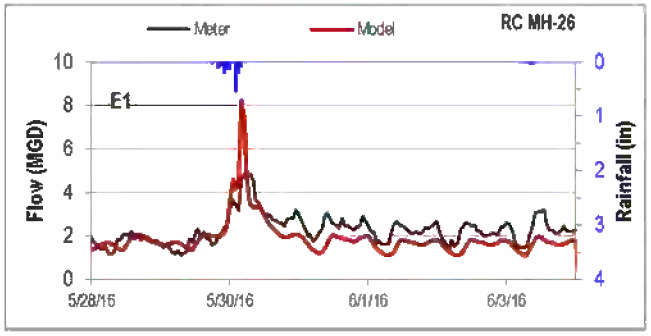
Side-2 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

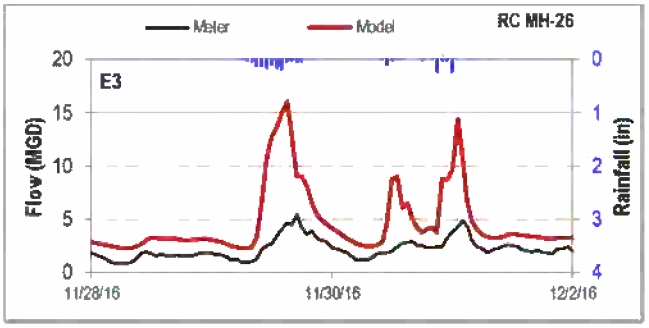


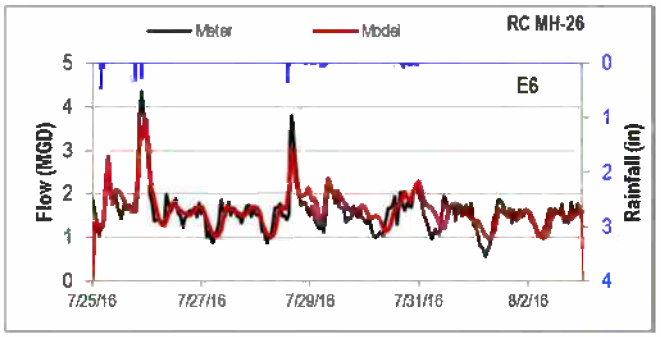


FLOW METER RC MH-26 MODEL CALIBRATION AND VALIDATION RESULTS

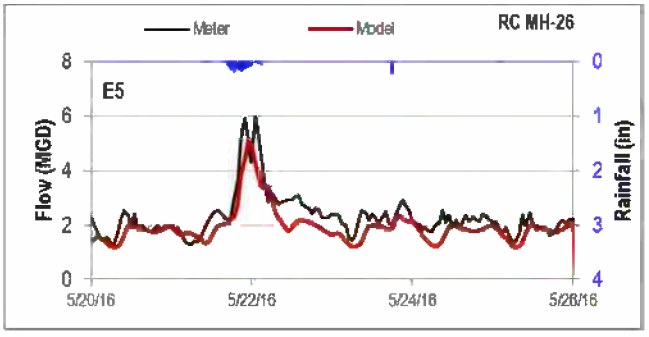
RC MH-26 Model Calibration Results (Metered and Modeled Flow)

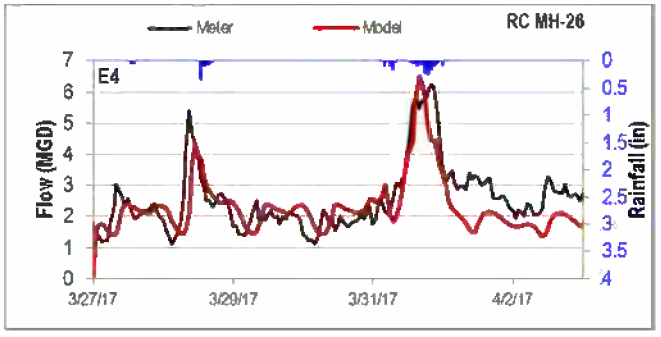




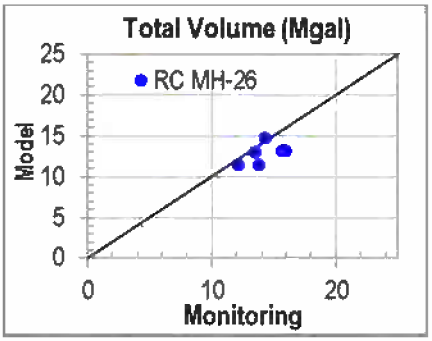


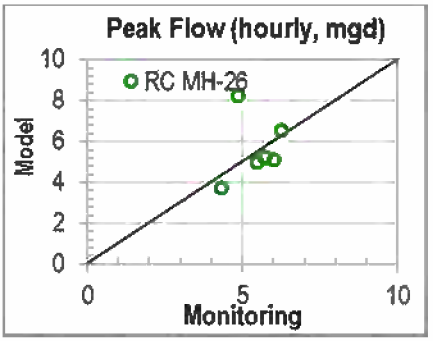
RC MH-26 Model Validation Results (Metered and Modeled Flow)





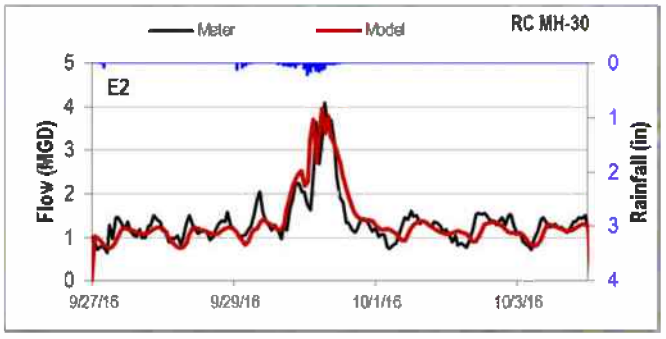
RC MH-26 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

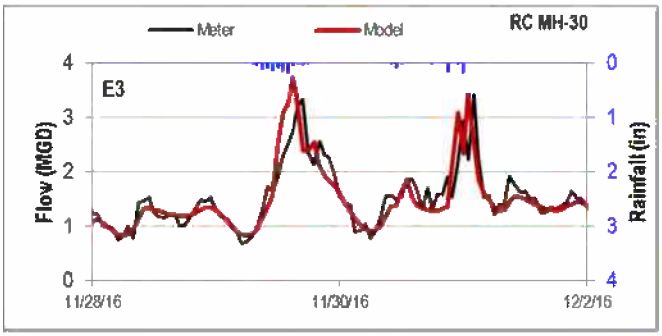


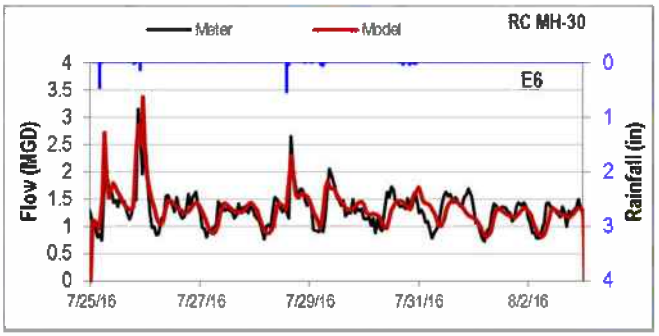


FLOW METER RC MH-30 MODEL CALIBRATION AND VALIDATION RESULTS

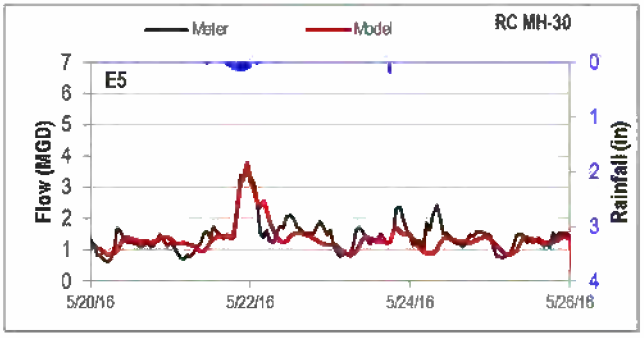
RC MH-30 Model Calibration Results (Metered and Modeled Flow)

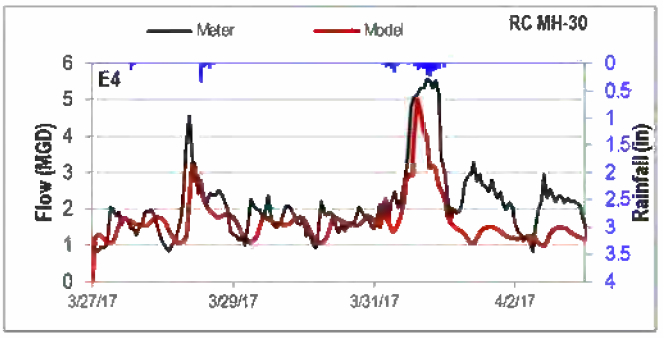




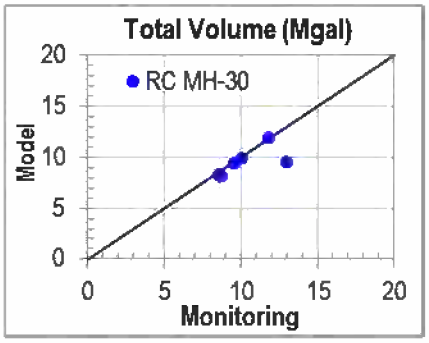


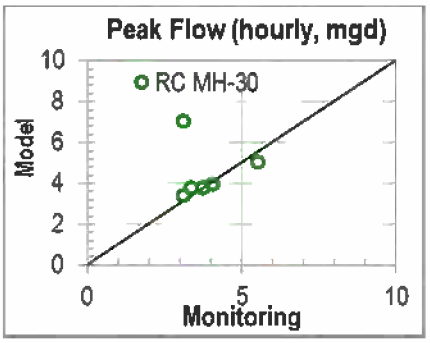
RC MH-30 Model Validation Results (Metered and Modeled Flow)





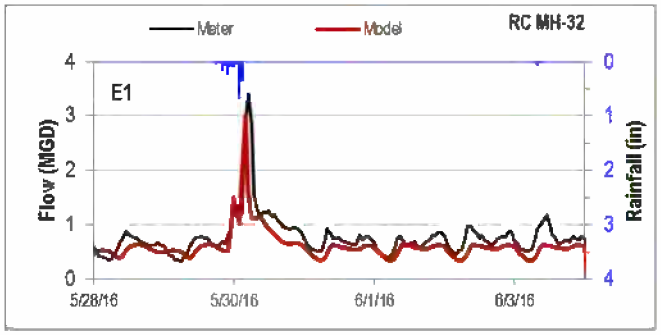
RC MH-30 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

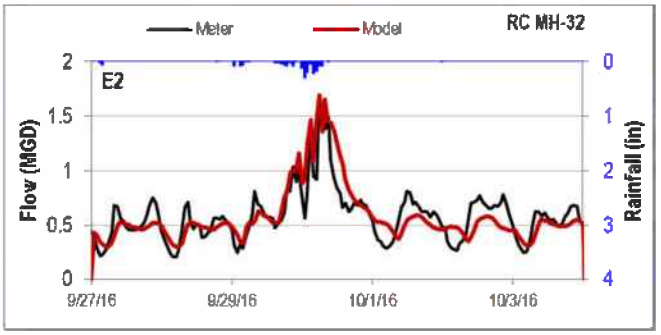


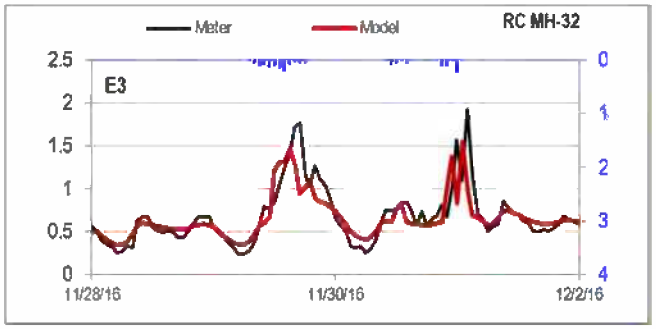


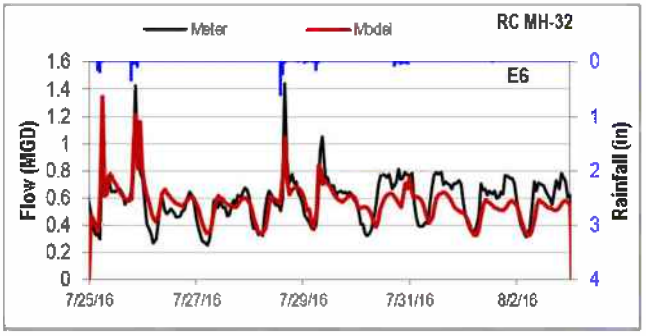
FLOW METER RC MH-32 MODEL CALIBRATION AND VALIDATION RESULTS

RC MH-32 Model Calibration Results (Metered and Modeled Flow)

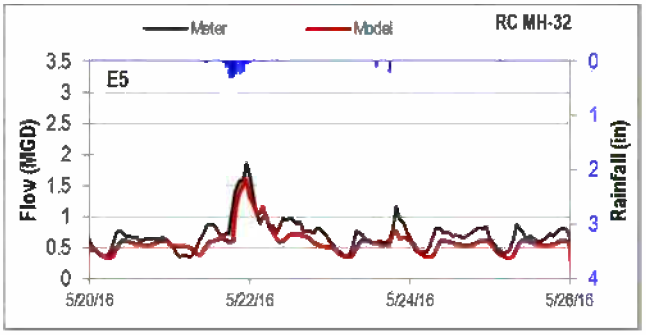


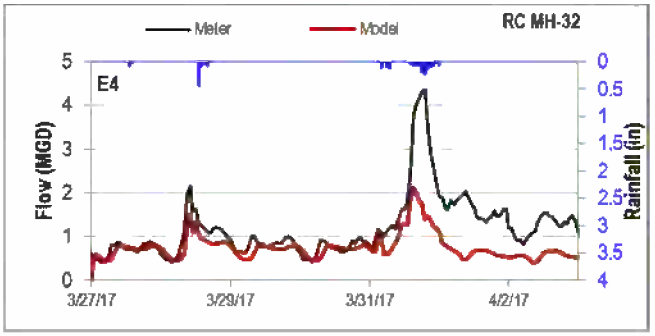




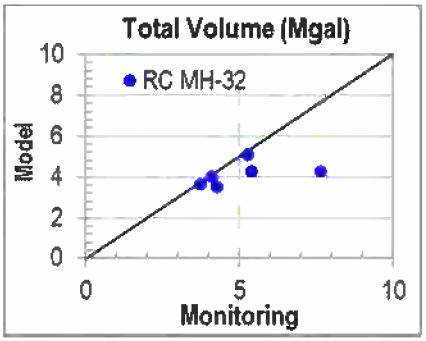


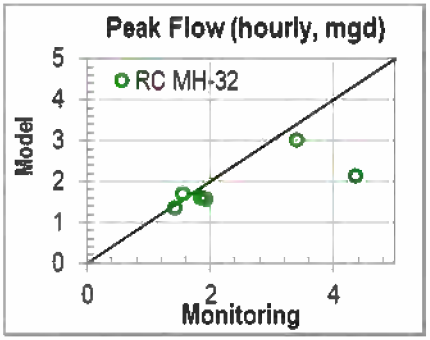
RC MH-32 Model Validation Results (Metered and Modeled Flow)





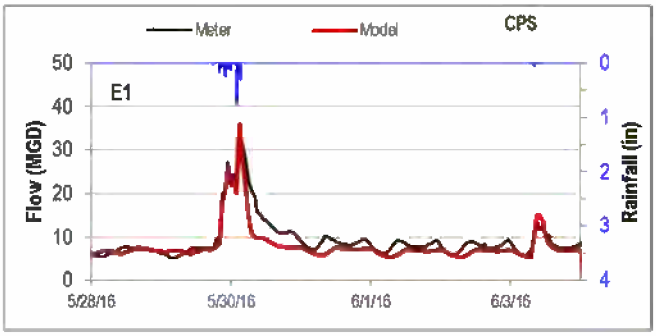
RC MH-32 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

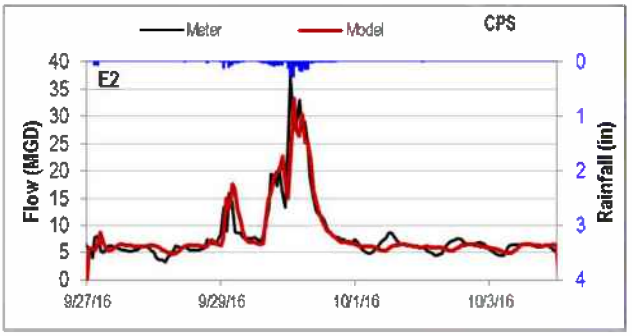


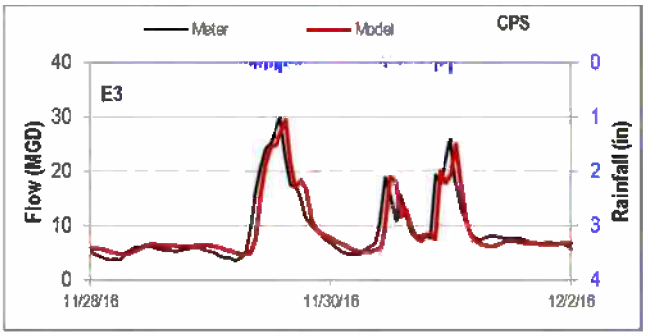


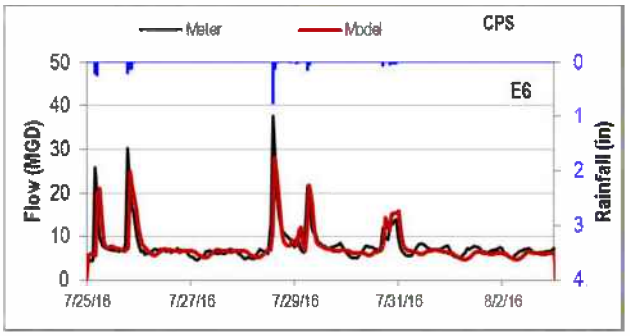
FLOW METER CPS MODEL CALIBRATION AND VALIDATION RESULTS

CPS Model Calibration Results (Metered and Modeled Flow)

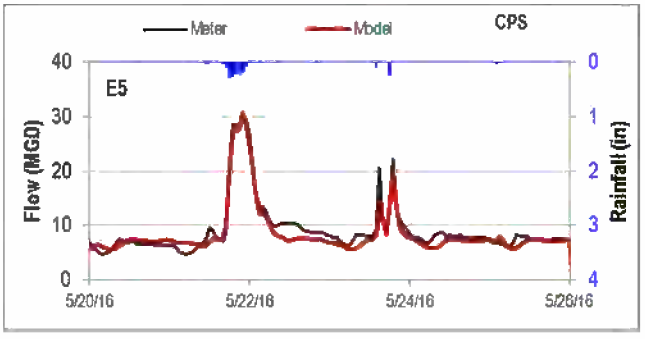


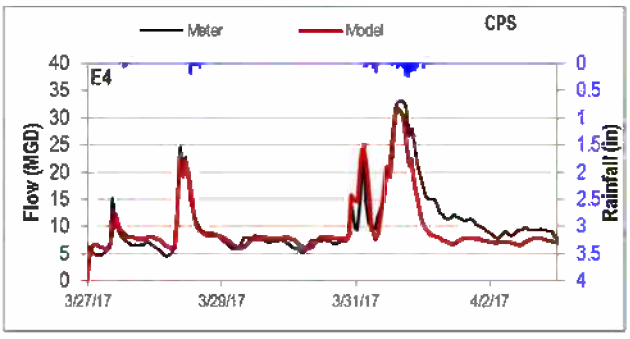




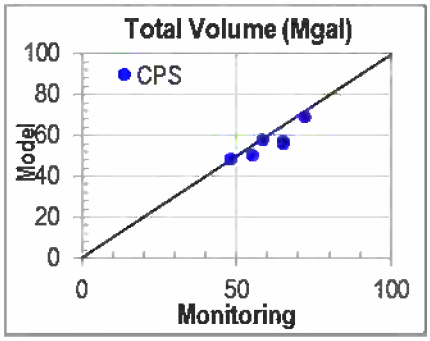


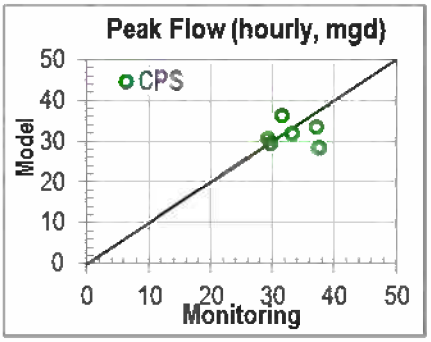
CPS Model Validation Results (Metered and Modeled Flow)





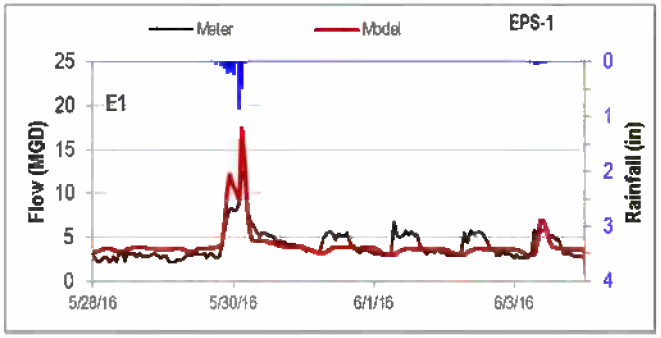
CPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

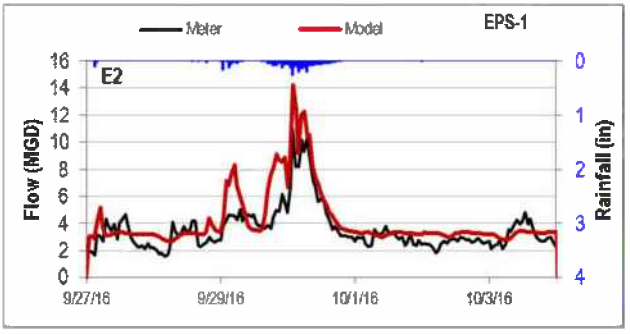


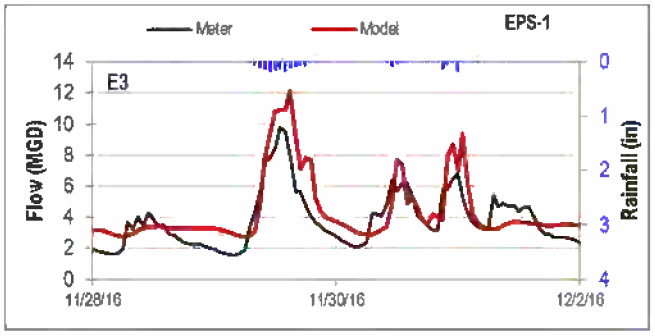


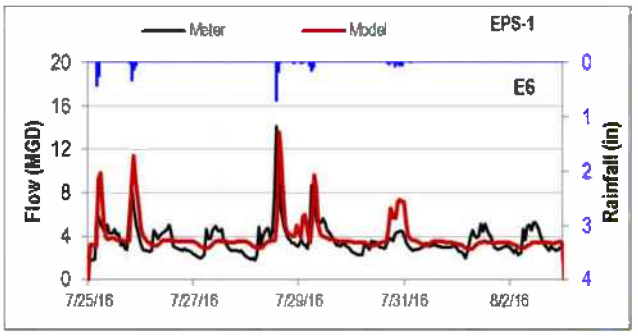
FLOW METER EPS-1 MODEL CALIBRATION AND VALIDATION RESULTS

EPS-1 Model Calibration Results (Metered and Modeled Flow)

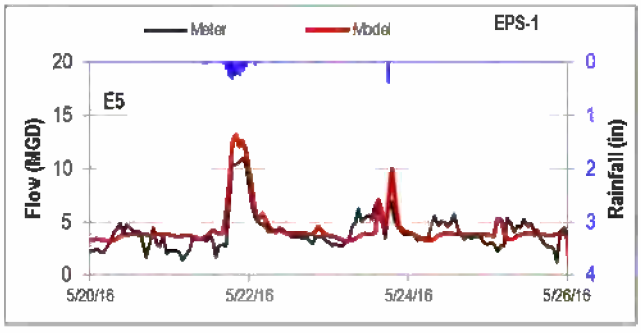


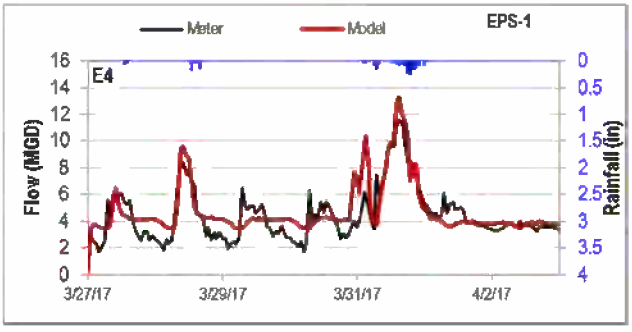




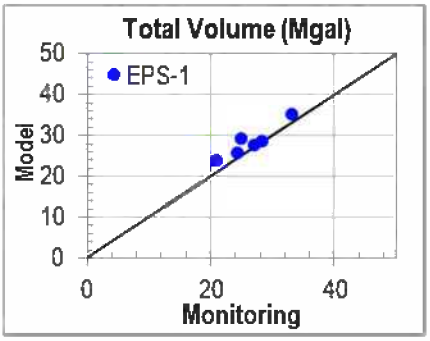


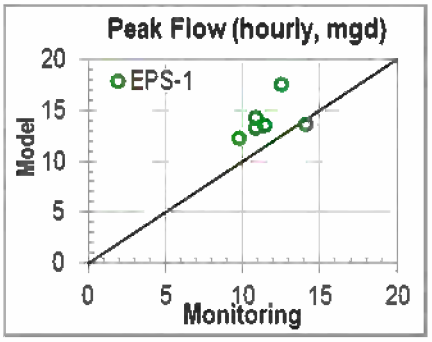
EPS-1 Model Validation Results (Metered and Modeled Flow)





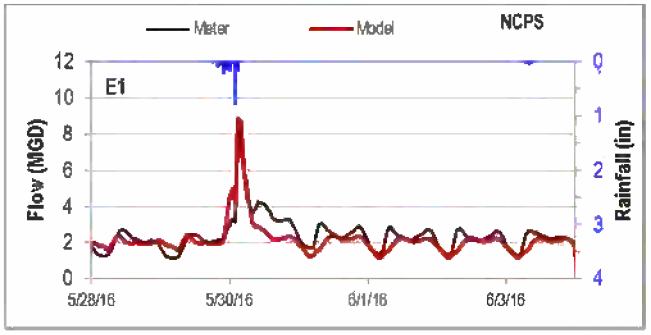
EPS-1 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

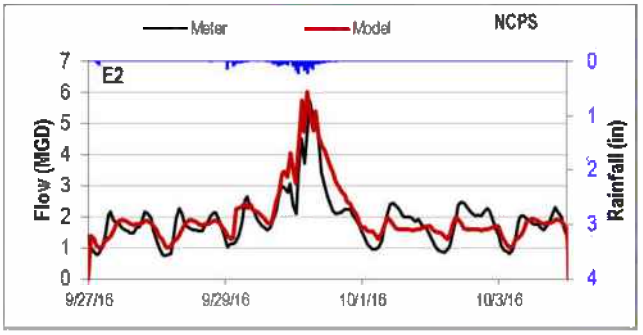


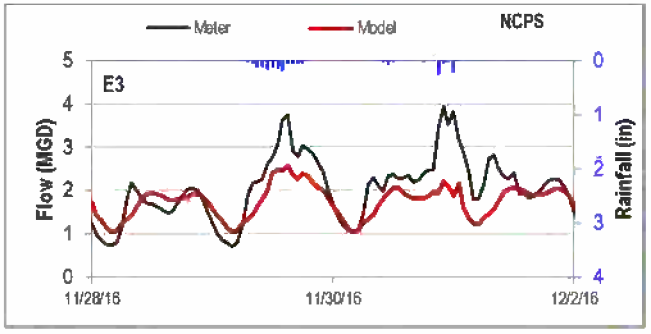


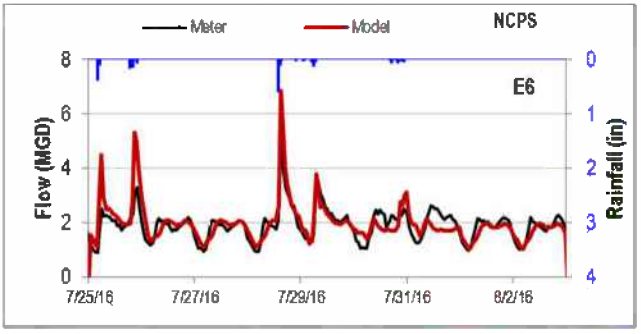
FLOW METER NCPS MODEL CALIBRATION AND VALIDATION RESULTS

NCPS Model Calibration Results (Metered and Modeled Flow)

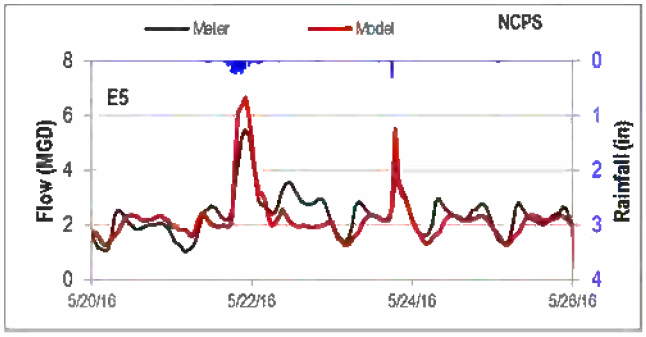


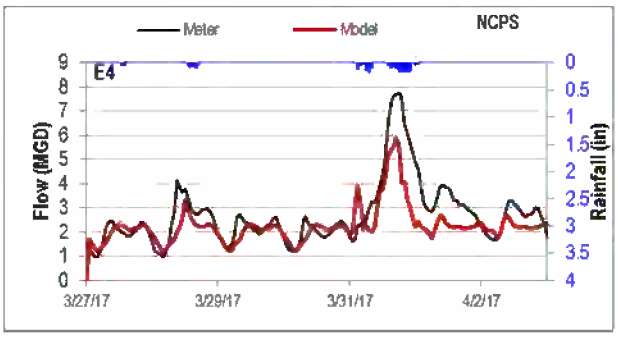




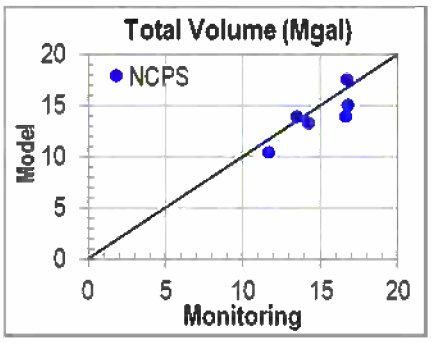


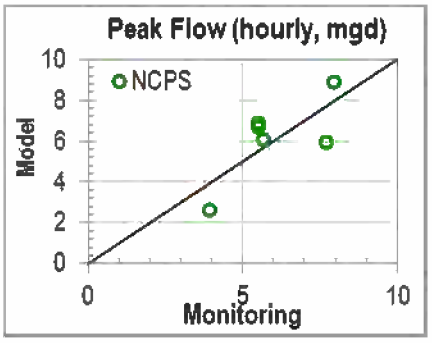
NCPS Model Validation Results (Metered and Modeled Flow)





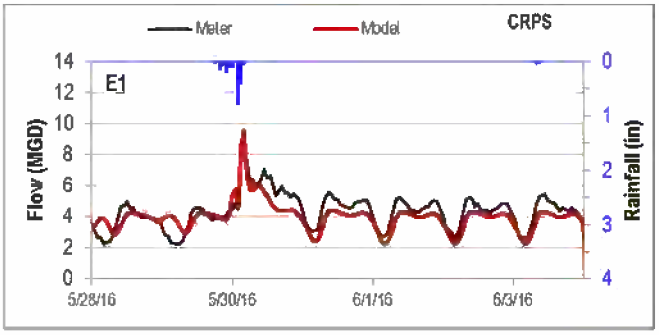
NCPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

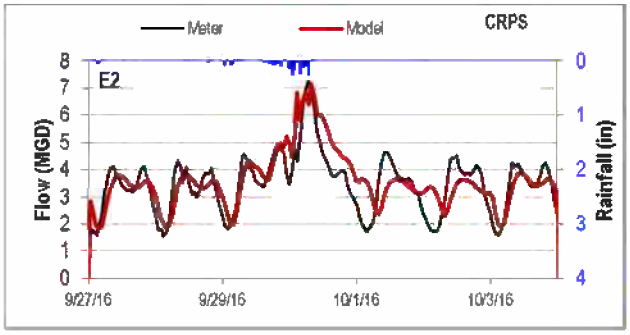


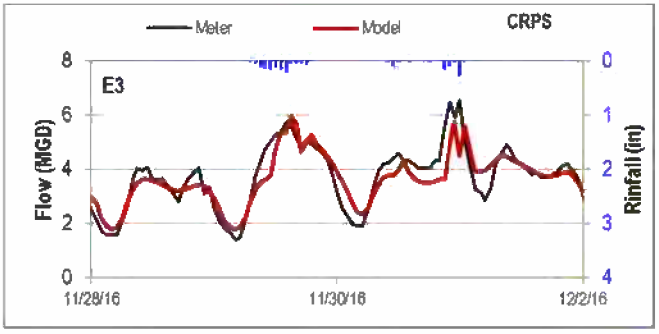


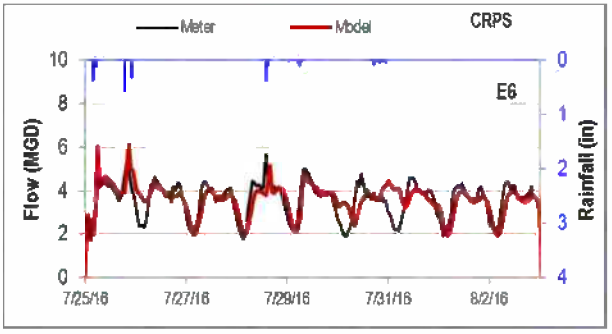
FLOW METER CRPS MODEL CALIBRATION AND VALIDATION RESULTS

CRPS Model Calibration Results (Metered and Modeled Flow)

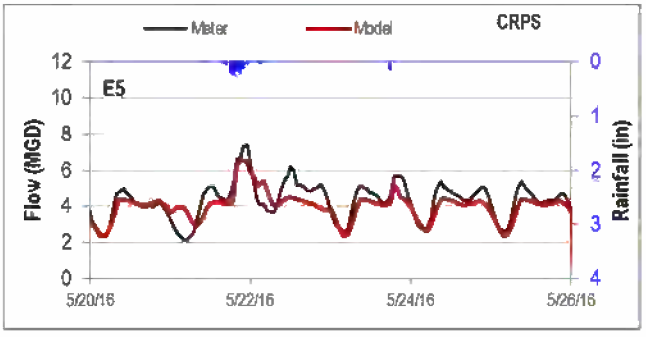


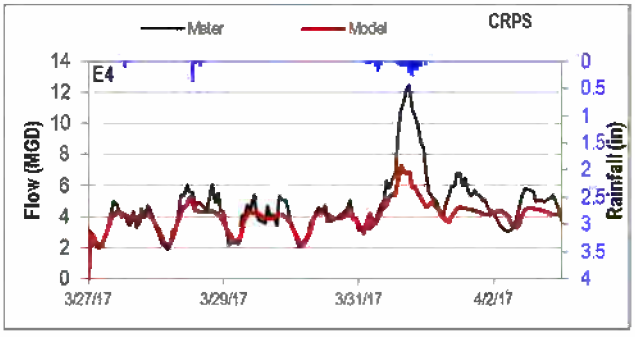




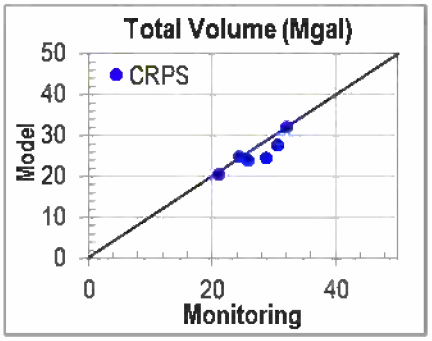


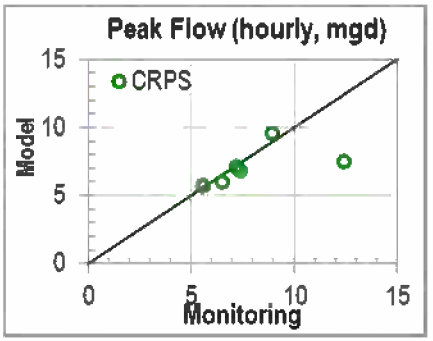
CRPS Model Validation Results (Metered and Modeled Flow)





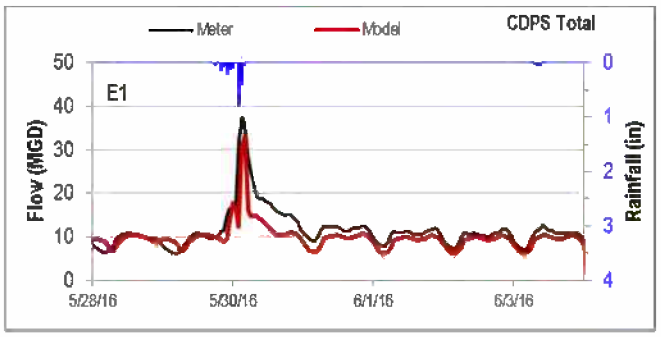
CRPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

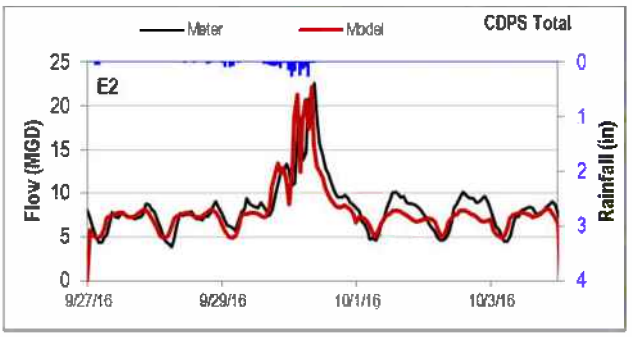


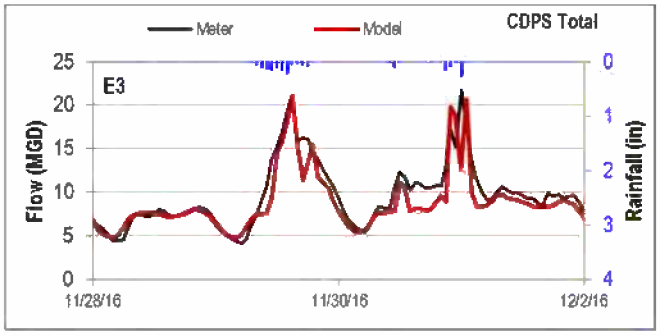


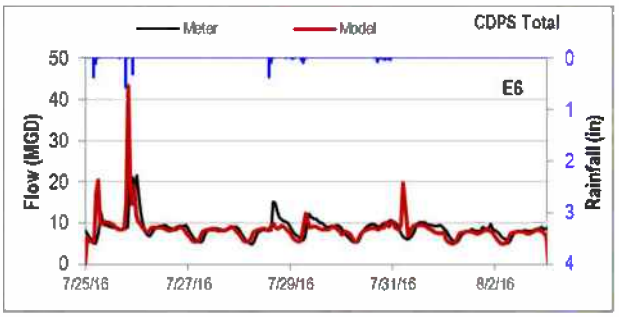
FLOW METER CDPS TOTAL MODEL CALIBRATION AND VALIDATION RESULTS

CDPS Total Model Calibration Results (Metered and Modeled Flow)

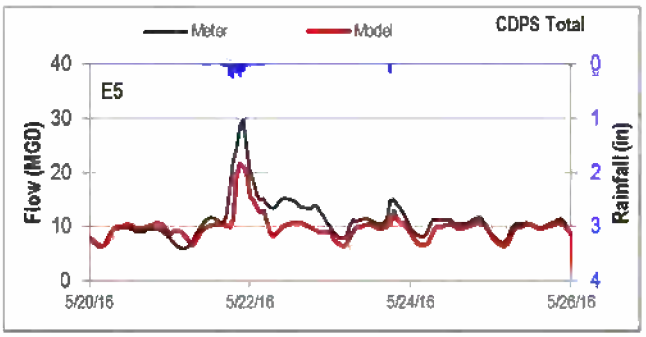


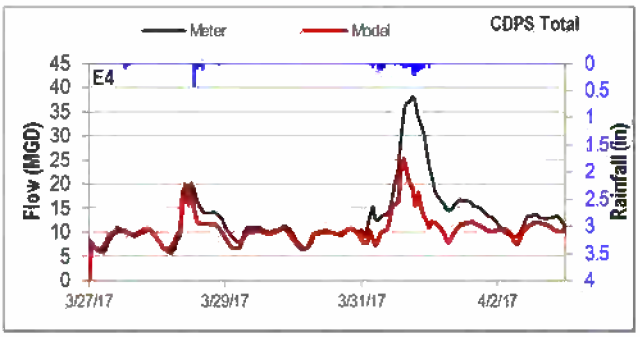




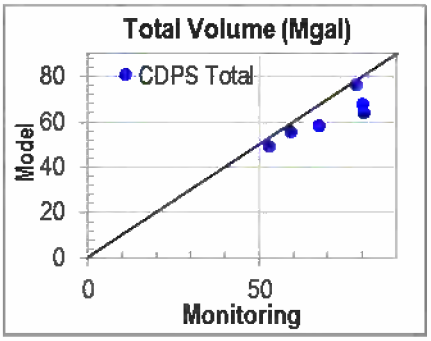


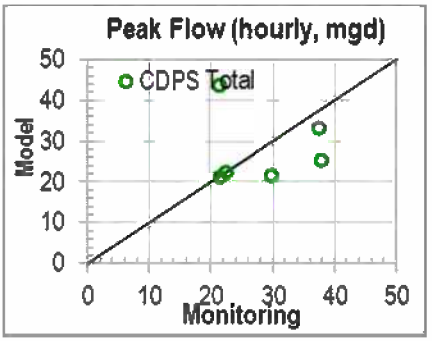
CDPS Total Model Validation Results (Metered and Modeled Flow)





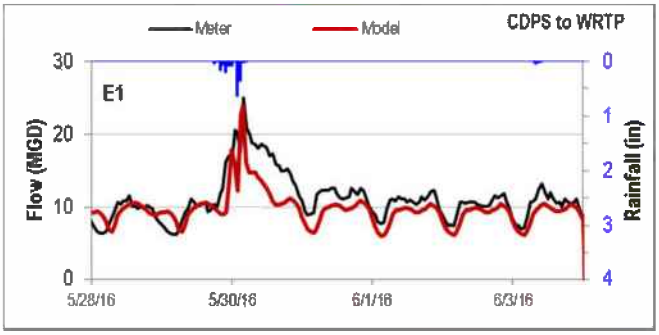
CDPS Total Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

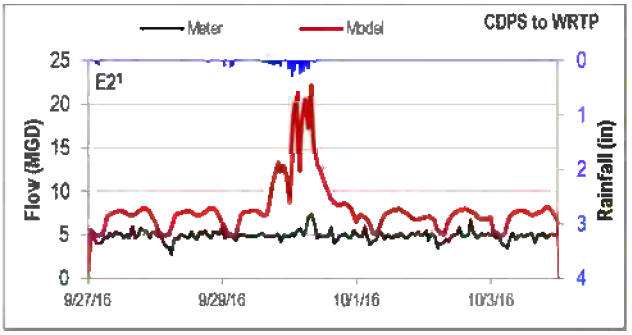


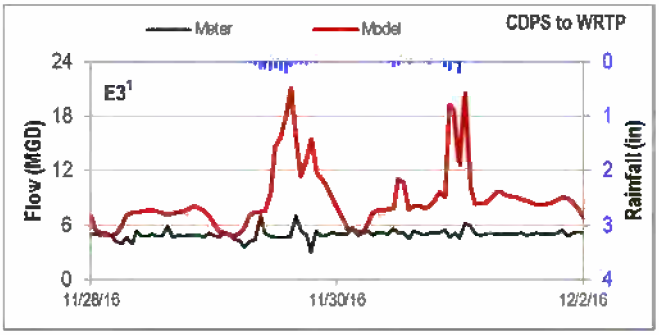


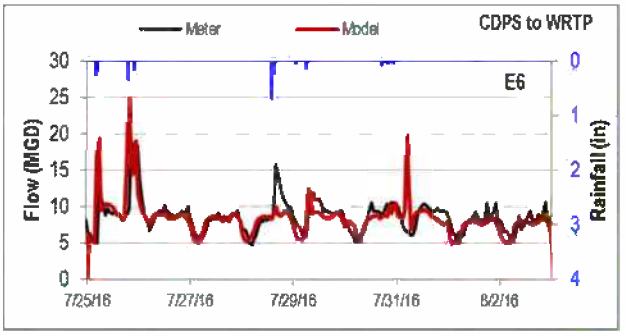
FLOW METER CDPS TO WRTP MODEL CALIBRATION AND VALIDATION RESULTS

CDPS to WRTP Model Calibration Results (Metered and Modeled Flow)

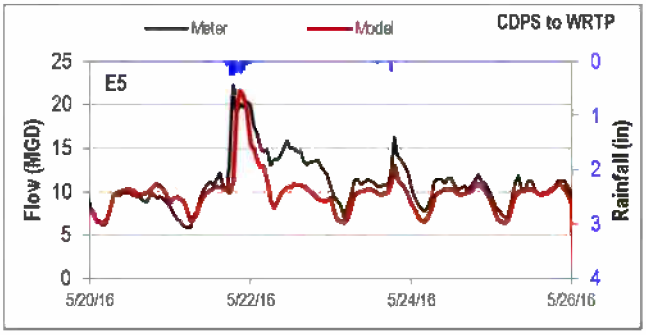


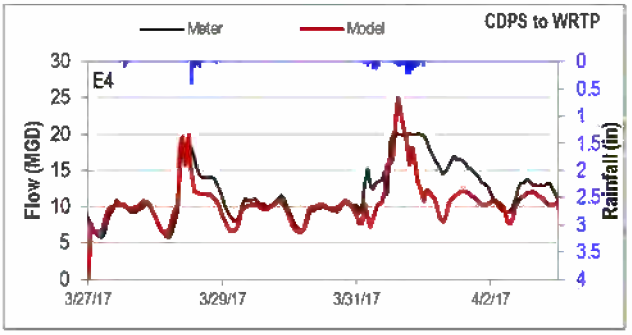






CDPS to WRTP Model Validation Results (Metered and Modeled Flow)

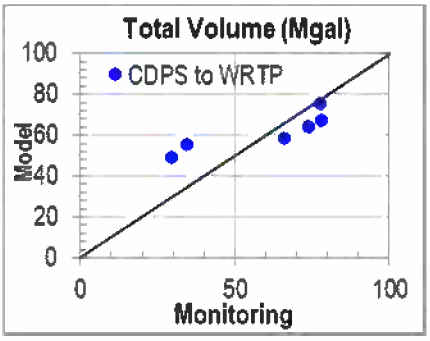


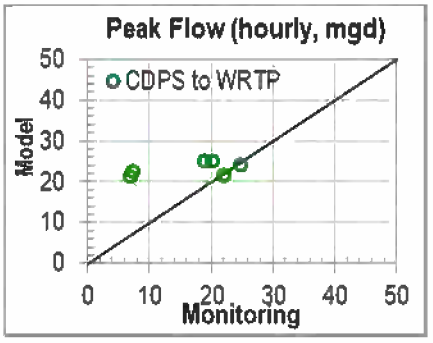


NOTE:

[1] During this storm, CDPS Flow to the plant was capped due to the aeration replacement project.

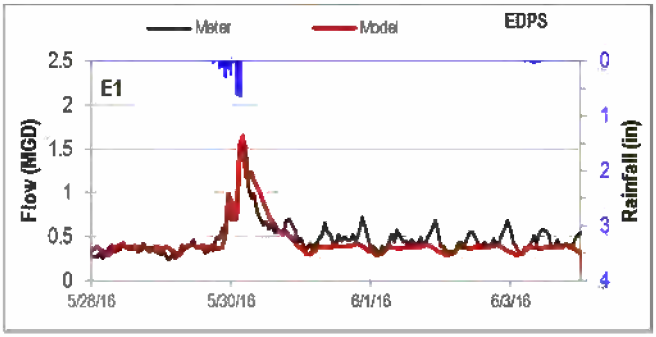
CDPS to WRTP Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

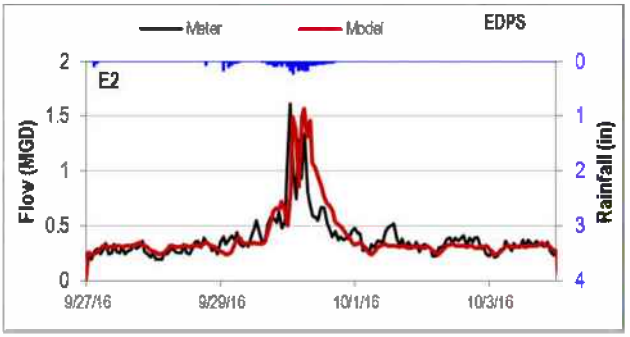


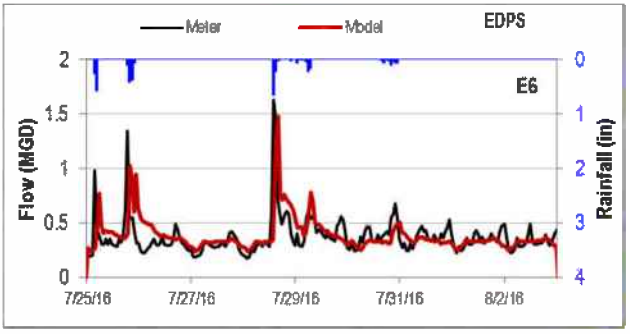


FLOW METER EDPS MODEL CALIBRATION AND VALIDATION RESULTS

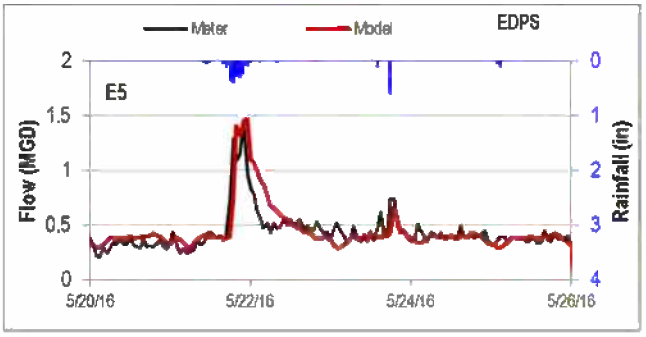
EDPS Model Calibration Results (Metered and Modeled Flow)

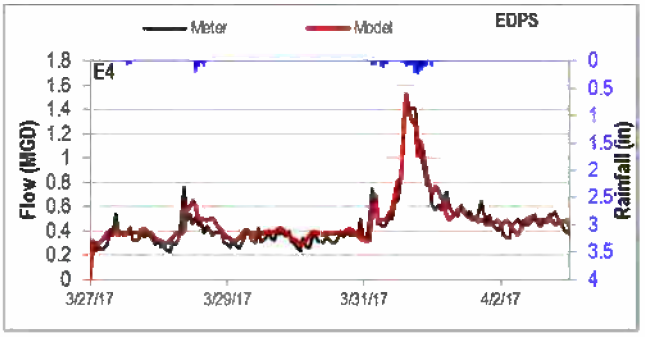




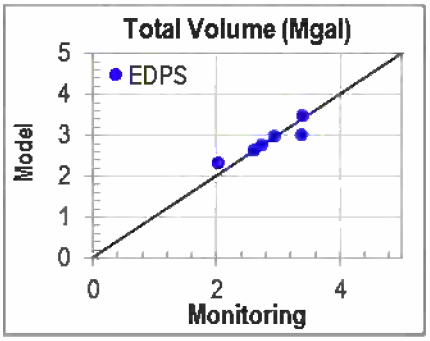


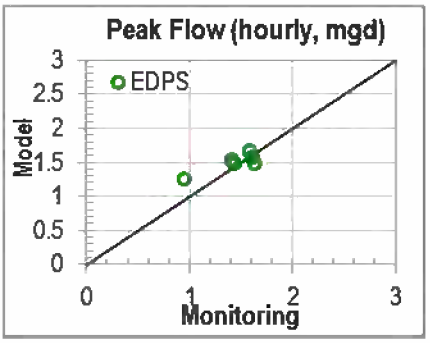
EDPS Model Validation Results (Metered and Modeled Flow)





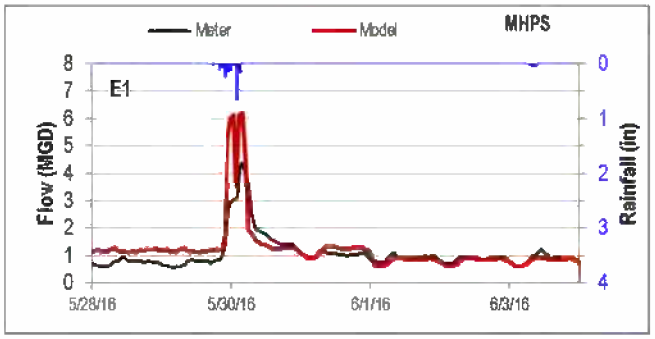
EDPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

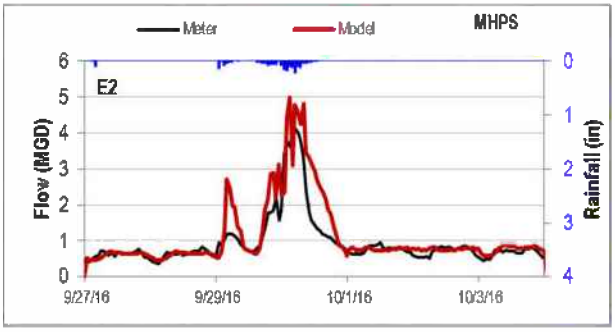


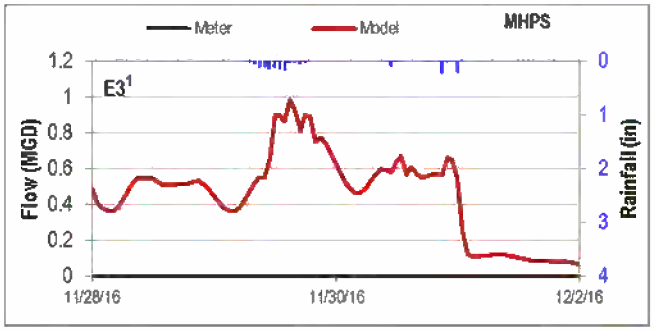


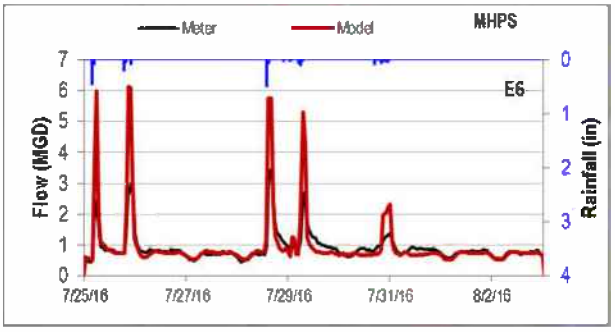
FLOW METER MHPS MODEL CALIBRATION AND VALIDATION RESULTS

MHPS Model Calibration Results (Metered and Modeled Flow)

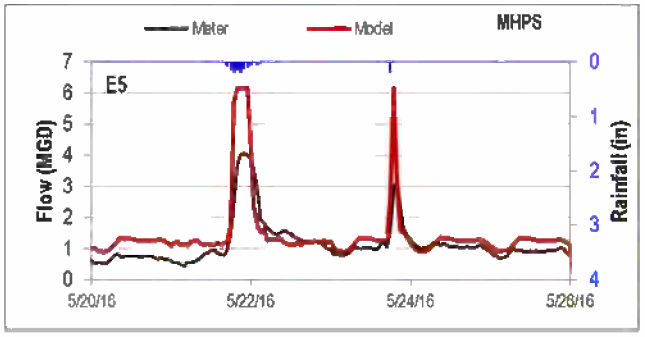


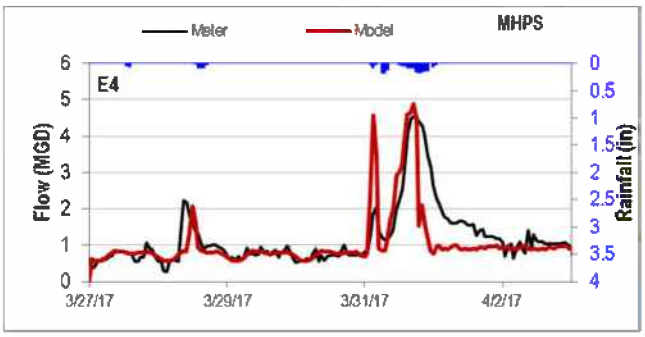






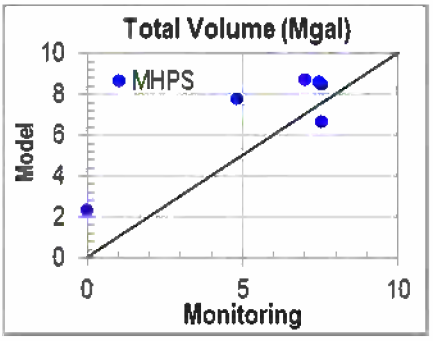
MHPS Model Validation Results (Metered and Modeled Flow)

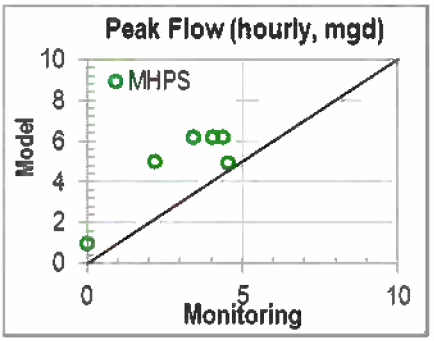




NOTE:
[1] Pump Station Meter data not available from November 22, 2016 to December 22, 2016.

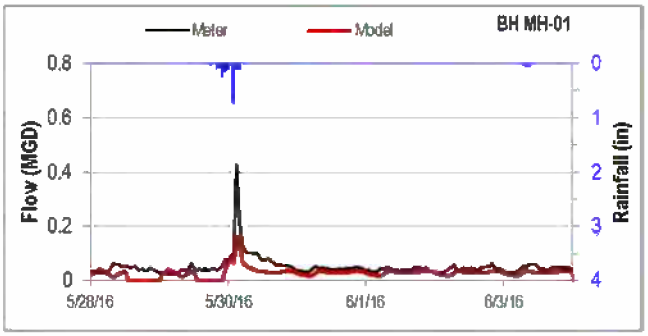
MHPS Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

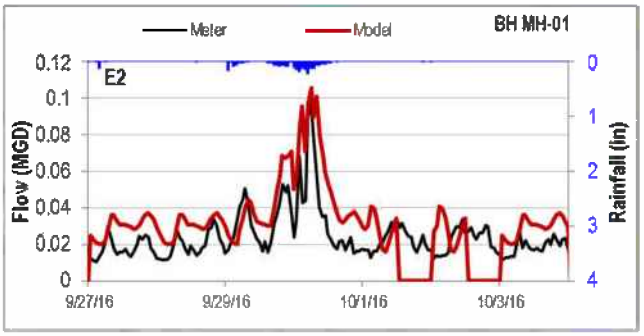


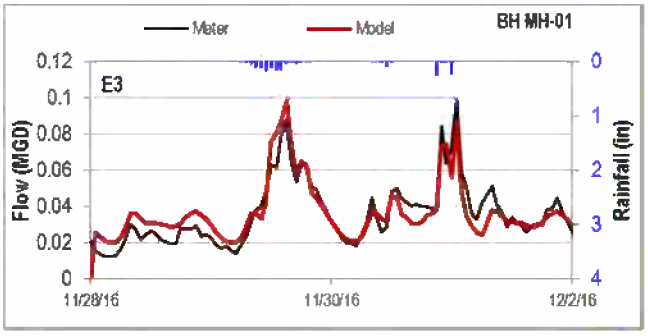


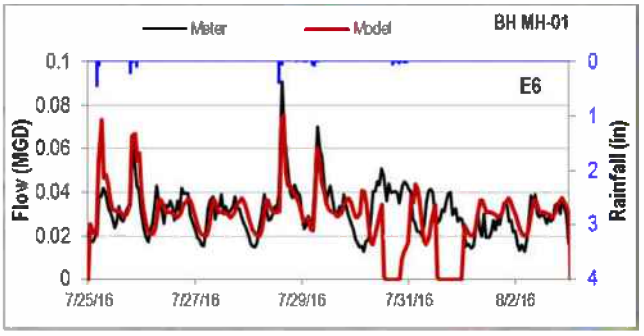
FLOW METER BH MH-01 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-01 Model Calibration Results (Metered and Modeled Flow)

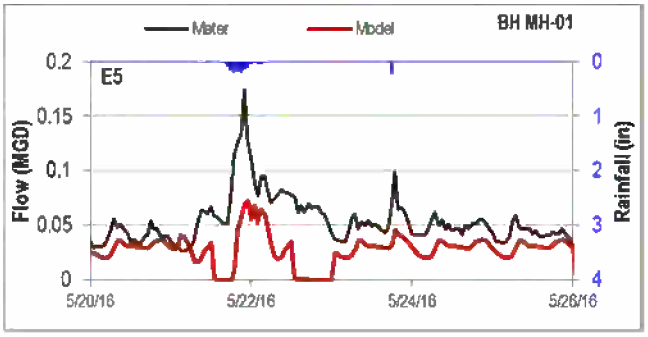


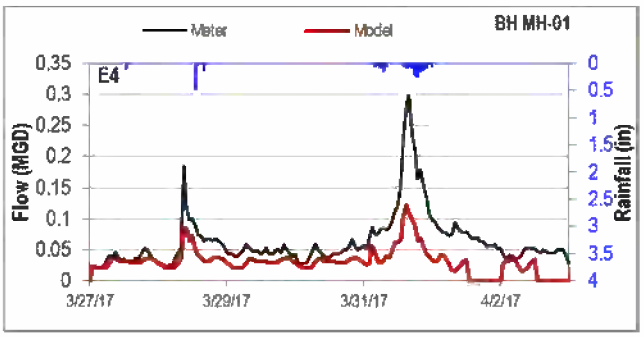




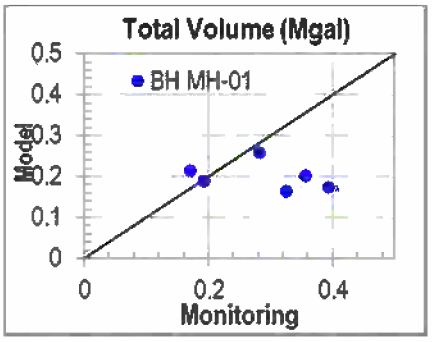


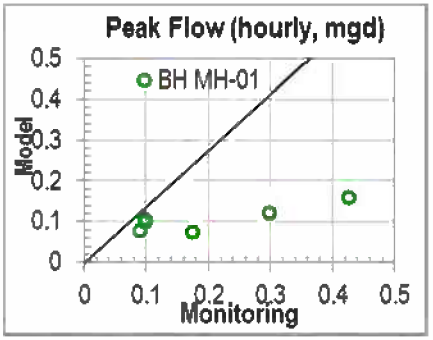
BH MH-01 Model Validation Results (Metered and Modeled Flow)





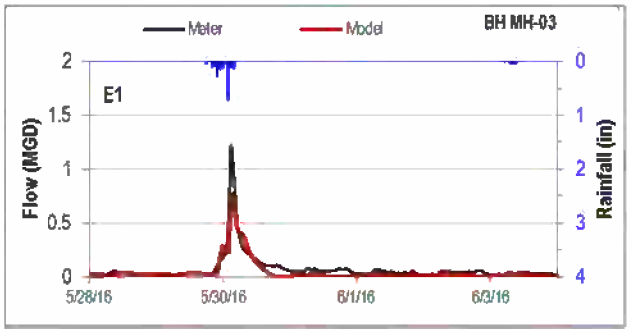
BH MH-01 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

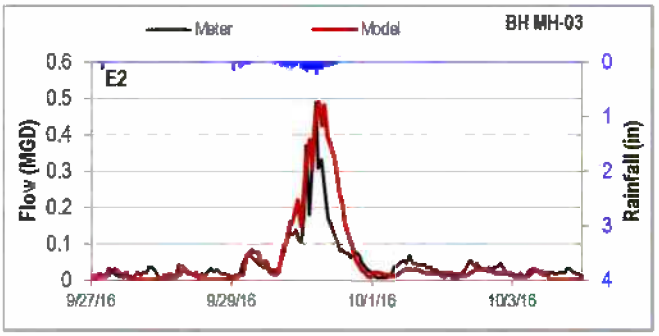


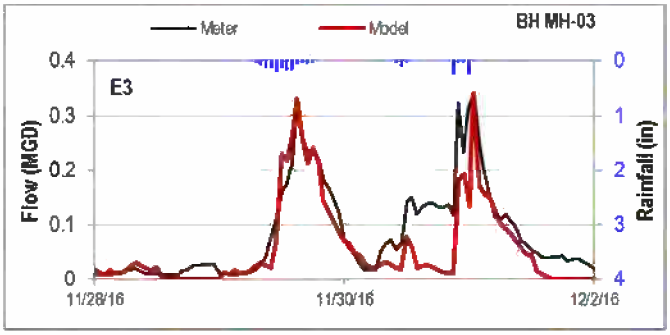


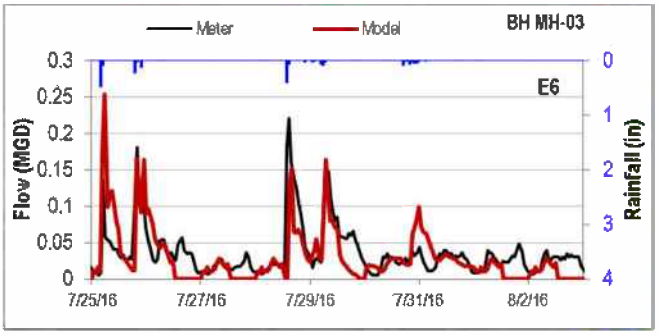
FLOW METER BH MH-03 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-03 Model Calibration Results (Metered and Modeled Flow)

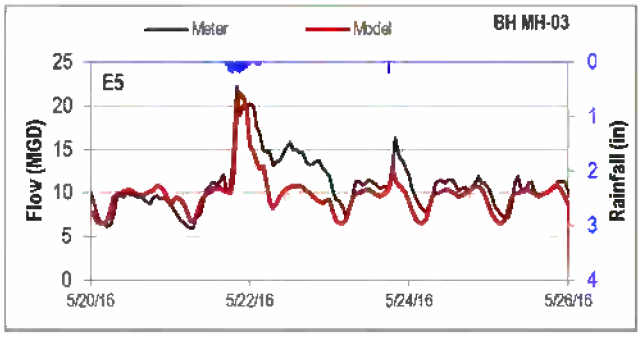


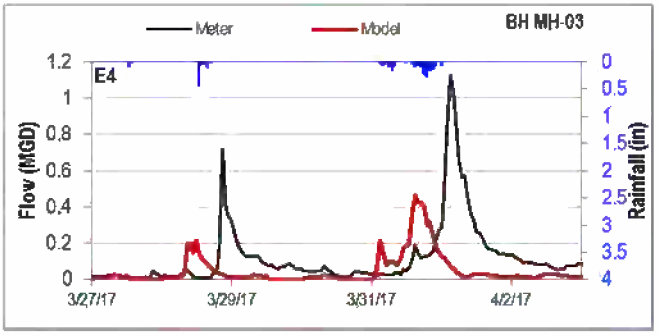




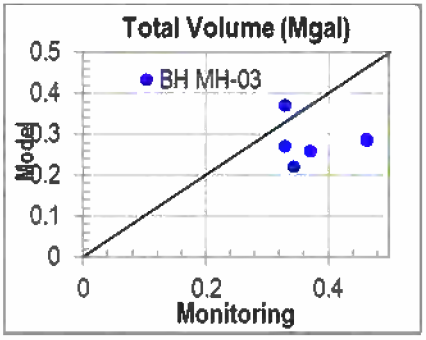


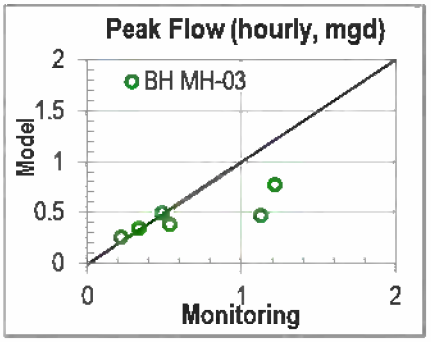
BH MH-03 Model Validation Results (Metered and Modeled Flow)





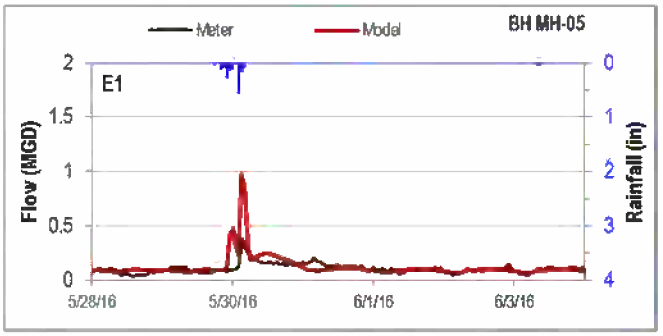
BH MH-03 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

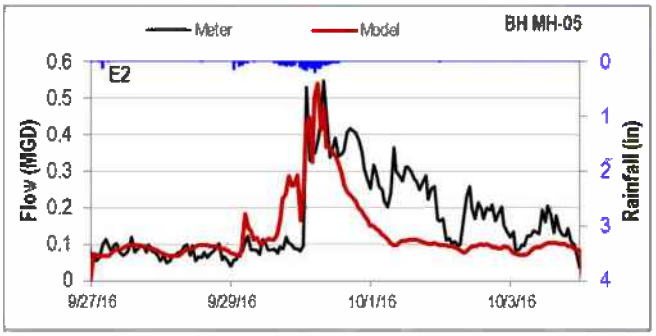


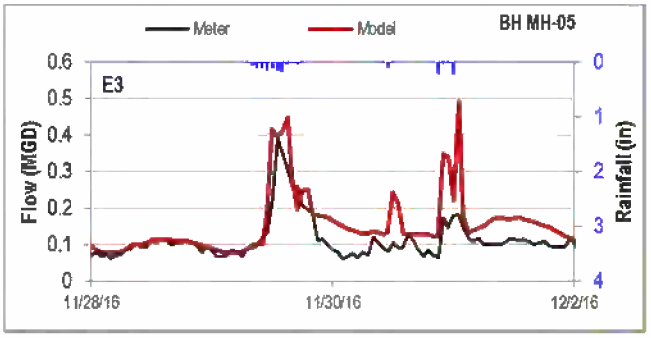


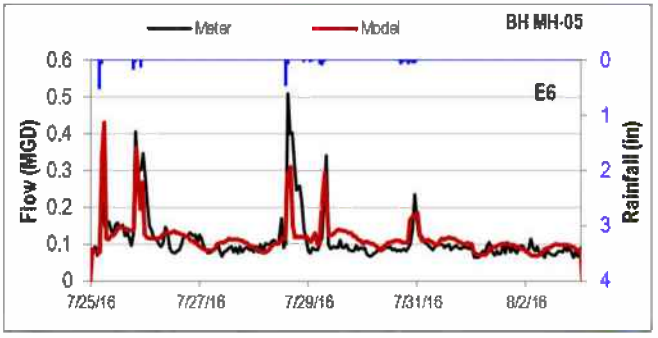
FLOW METER BH MH-05 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-05 Model Calibration Results (Metered and Modeled Flow)

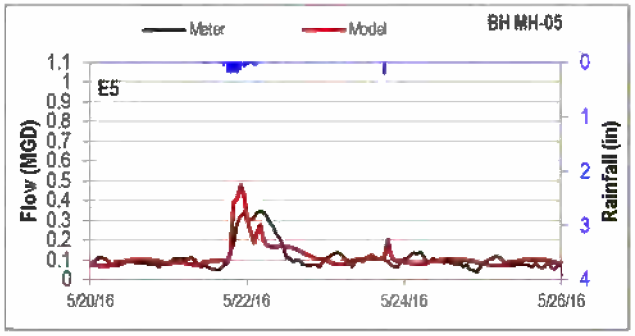


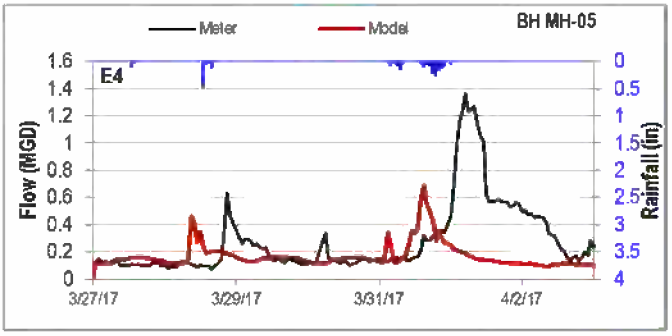




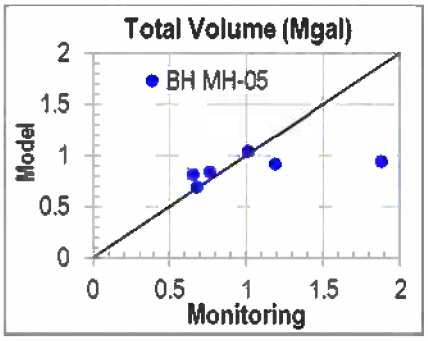


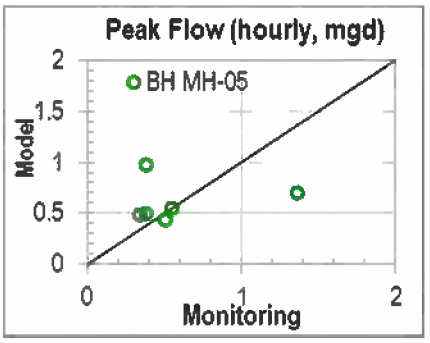
BH MH-05 Model Validation Results (Metered and Modeled Flow)





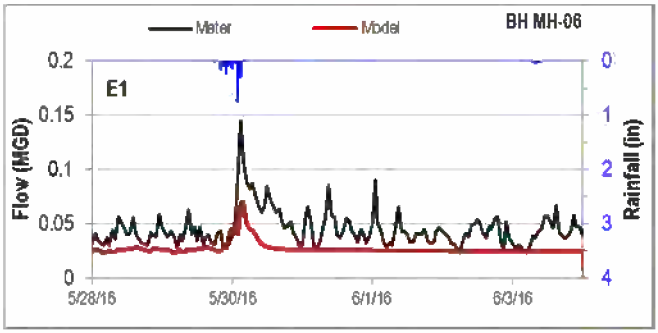
BH MH-05 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

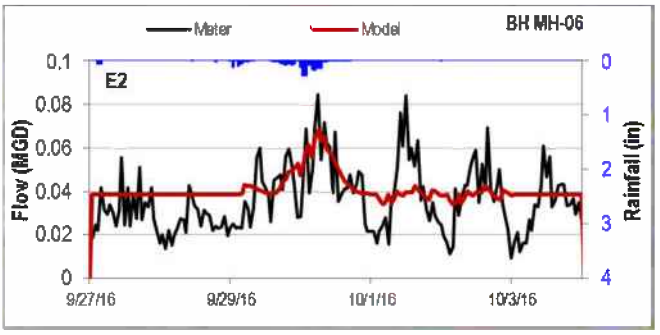


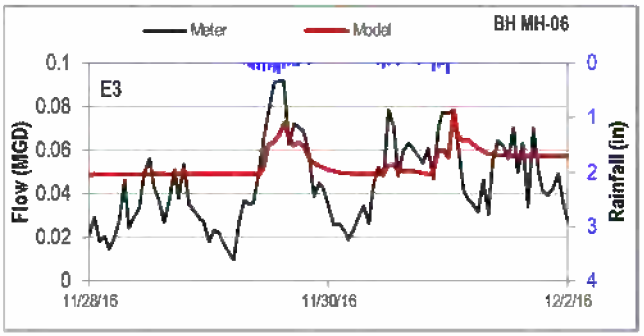


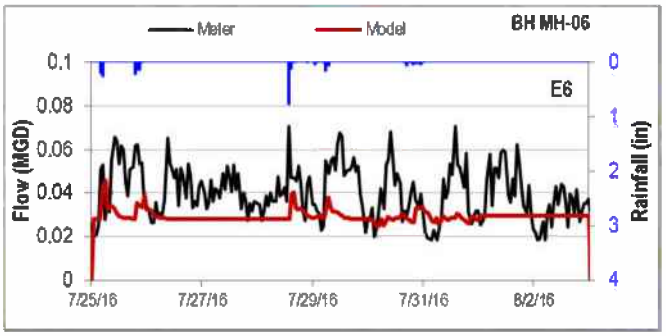
FLOW METER BH MH-06 MODEL CALIBRATION AND VALIDATION RESULTS

BH MH-06 Model Calibration Results (Metered and Modeled Flow)









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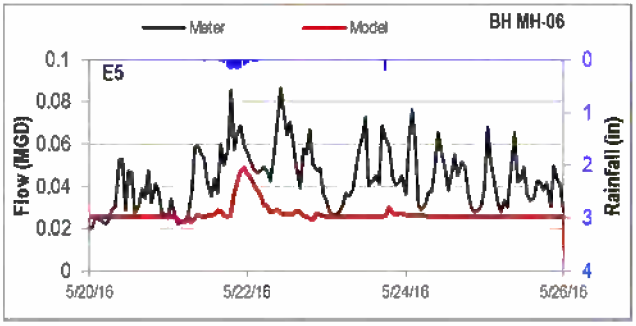
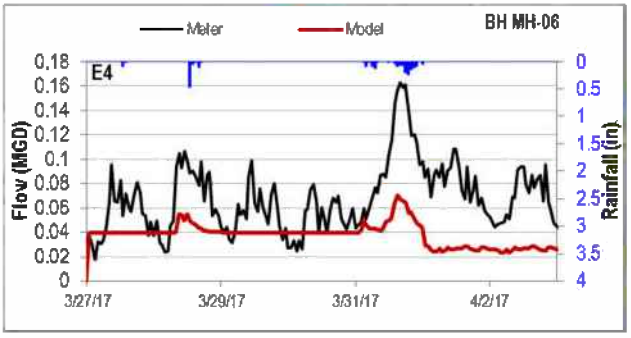
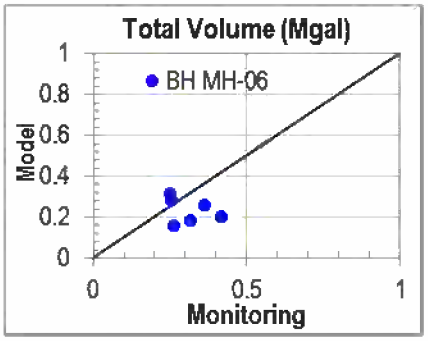
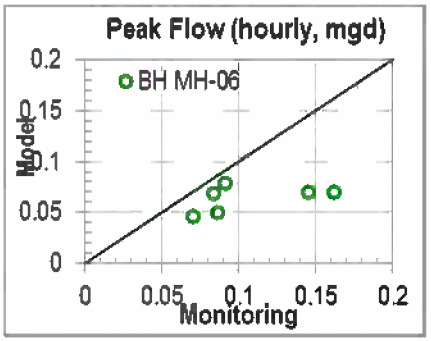




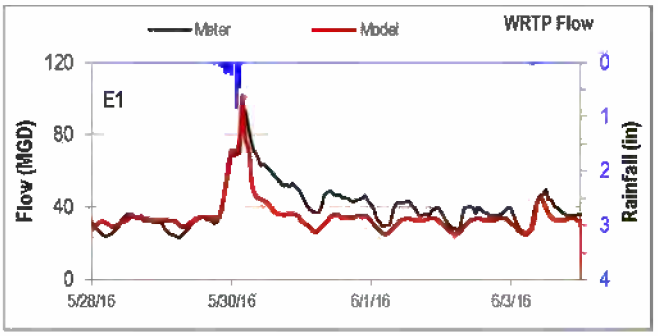
BH MH-06 Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)

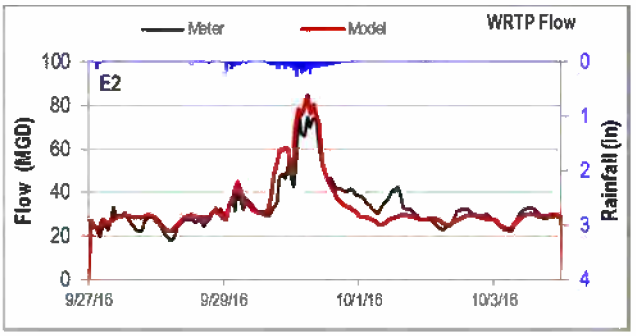


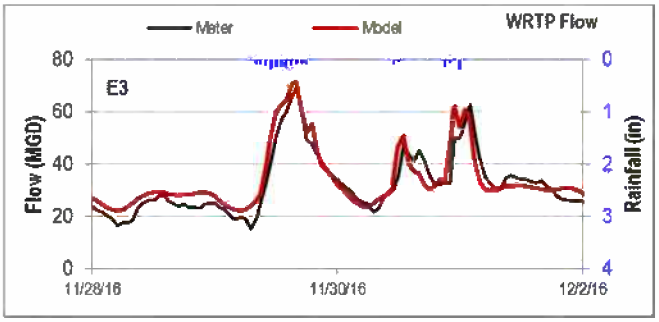


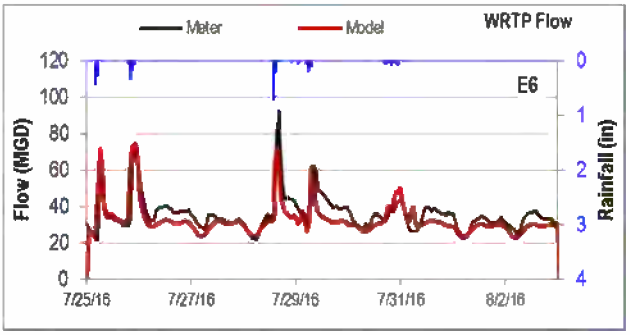
FLOW METER WRTP Flow MODEL CALIBRATION AND VALIDATION RESULTS

WRTP Flow Model Calibration Results (Metered and Modeled Flow)

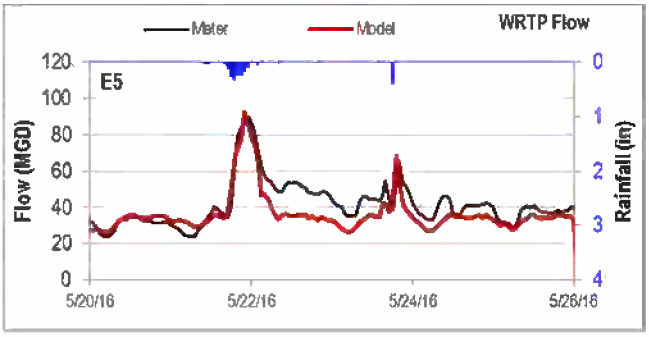


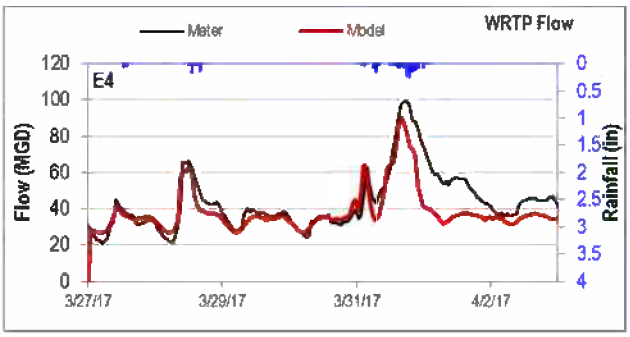




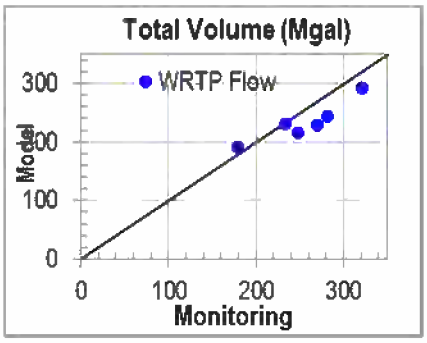


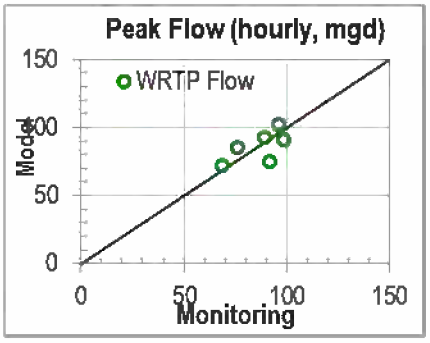
WRTP Flow Model Validation Results (Metered and Modeled Flow)





WRTP Flow Overall Model Calibration and Validation Results (Volume and Flow 1:1 Plots)





Appendix C H&H Model Results for Typical Hydrologic Period

2017 Calibrated and Validated Model Results

Overflow Frequency (occurrence)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32
1994	45.0	53	51	21	73	43	63	41	62	2	53	30	64	27	76	90	42	36	36	53	21	0	55	21	0
1995	31.4	47	43	14	61	35	52	34	54	1	47	24	55	20	69	79	35	28	1	46	14	0	49	13	0
1996	52.1	65	61	28	78	54	70	53	70	1	66	37	72	33	88	103	54	45	1	65	26	0	68	26	0
Average	42.8	55	52	21	71	44	62	43	62	1	55	30	64	27	78	91	44	36	13	55	20	0	57	20	0

Overflow Volume (MG)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32	TOTAL
1994	45.0	13.1	9.8	3.4	42.3	2.2	35.7	8.5	26.7	0.1	24.5	8.2	2.0	10.8	39.6	37.1	37.1	3.7	3.7	5.4	0.7	0.0	9.5	3.3	0.0	327
1995	31.4	8.3	6.1	2.4	29.9	1.3	22.4	4.5	17.8	0.0	16.4	4.0	1.3	4.2	28.3	20.5	20.9	1.7	0.0	3.4	0.2	0.0	6.2	1.1	0.0	201
1996	52.1	15.4	11.5	4.3	53.6	2.5	41.2	8.7	32.0	0.0	30.3	7.4	2.4	7.7	48.5	38.6	44.0	3.4	0.0	6.3	0.4	0.0	11.2	1.8	0.0	371
Average	42.8	12.3	9.2	3.4	41.9	2.0	33.1	7.3	25.5	0.0	23.8	6.5	1.9	7.6	38.8	32.1	34.0	2.9	1.2	5.0	0.4	0.0	9.0	2.0	0.0	300

Overflow Duration (Hour)

	Rainfall	NREG02	NREG03	NREG04	NREG05	NREG07	NREG08	NREG09	NREG11	NREG12	NREG13	NREG14	NREG15	NREG16	NREG17	NREG18	NREG19	NREG20	NREG21	NREG22	NREG23	NREG24	NREG25	NREG26	NREG32
1994	45.0	359	274	99	553	222	606	226	457	7	352	133	398	84	758	1029	251	127	127	294	51	0	352	51	0
1995	31.4	270	204	82	406	169	449	174	339	2	256	92	299	60	559	820	178	103	2	228	36	0	257	35	0
1996	52.1	441	337	161	605	299	699	306	522	2	437	196	470	127	830	1094	329	194	2	358	74	0	422	74	0
Average	42.8	357	272	114	521	230	585	235	439	4	348	140	389	90	716	981	253	141	44	293	54	0	344	53	0

Year	Total WRTP Flow (MG) during wet conditions (precipitation time+6 hr)[1]	Total Overflow (MG)	Total Wet Weather Flow (MG)	Wet Weather Capture
1994	1,293	327	1,620	80%
1995	962	201	1,163	83%
1996	1,531	371	1,902	80%
Average	**1,262**	**300**	**1,562**	**81%**

[1]Volume of combined sewage captured/treated is based on WRTP flow during precipitation events greater than 0.1 inch (including precipitation duration and 6 hours after precipitation)

Appendix D Water Quality Sampling Results

Water Quality Monitoring Program: Overview of Raw Results[1]

Parameter	Event Type	Location	Minimum Value (#/100ml)	Maximum Value (#/100ml)	Average Value (#/100ml)	No. of Samples
E. COLI	DRY	Chester Creek	10	470	130	18
		Delaware River	1	45	17	27
		Ridley Creek	2	1,900	265	16
	WET	Chester Creek	40	22,000	4,937	45
		Delaware River	2	6,900	207	143
		Ridley Creek	56	87,000	5,690	45
		CSO	25,000	1,780,000	254,403	67
		Stormwater	36	156,000	16,248	38
ENTEROCOCCUS	DRY	Chester Creek	8	190	70	18
		Delaware River	1	320	21	22
		Ridley Creek	6	900	167	16
	WET	Chester Creek	40	41,000	9,584	44
		Delaware River	2	40,000	476	141
		Ridley Creek	20	31,000	8,112	45
		CSO	4,800	3,220,000	193,961	67
		Stormwater	1,091	505,000	72,206	38
FECAL COLIFORM	DRY	Chester Creek	4	1,200	361	17
		Delaware River	2	54	27	30
		Ridley Creek	4	3,800	709	18
	WET	Chester Creek	52	44,000	7,134	45
		Delaware River	2	10,000	250	145
		Ridley Creek	44	103,000	7,646	45
		CSO	15,300	1,630,000	165,486	67
		Stormwater	20	1,480,000	54,081	38

Notes:
1. Sampling results currently undergoing QA/QC, summary statistics may change pending QA/QC results.

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Philadelphia, PA 19103
(215) 563-3460
www.greeley-hansen.com

GREELEY AND HANSEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Orig: B. Willert

APR 16 2018

RECEIVED
APR 19 2018
By 2018-0507

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the Delaware County Regional Quality Control Authority (DELCORA) Existing Service Area Characterization Report dated August 15, 2017. EPA accepts and approves the subject report.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: P. Yeany, EPA
M. DeSantis, DELCORA
Tom Magee, PaDEP, SERO
C. Hurst, DELCORA

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Customer Service Hotline: 1-800-438-2474

APPENDIX L

Public Participation Program Plan

- DELCORA Public Participation Plan (Final) dated October 2015 (Updated April 2016)
- USEPA Approval of the Public Participation Plan (PPP) dated April 28, 2016

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

PUBLIC PARTICIPATION PLAN
(Final)

October 2015
(Updated April 2016)

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Public Participation Plan.

DELCORA MANAGEMENT		
Executive Director	Signature	10/19/15 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	10/19/15 Date
(type in other as needed / delete row if unused)	Signature	Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	10/19/15 Date
(type in other as needed / delete row if unused)	Signature	Date
	Signature	Date
	Signature	Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
1	1/26/16	Greeley and Hansen	• Updated Section 2.2. Revised DELCORA's e-mail address and phone number. • Revised Attachment B4 - Website Screenshot.
2	3/30/16	Greeley and Hansen	Updated Public Participation Plan to address USEPA and PaDEP comments received on February 18, 2016. • Revised Executive Summary to address comments • Revised Section 1.3 to address comments • Revised Section 2.3, 2.4 and 2.6 to address comments Revised Section 4.2 to address comments • Revised Attachment B1 – DELCORA Stakeholder's Presentation dated March 15, 2016.

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Attachment B: Public Education Tools and Public Outreach Materials
Attachment B1: DELCORA Stakeholders' Presentation dated August 18, 2015
Attachment B2: Public Education Brochures (7 Brochures)
Attachment B3: Sample Press Release
Attachment B4: DELCORA's CSO LTCPU Website (Sample Screen Shot)
Attachment C: Pennsylvania Sunshine Act
Attachment D: PA Right-to-Know Law Act 3 of 2008

Executive Summary

BACKGROUND

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal authority originally organized under the Pennsylvania Municipal Authorities Act of 1945 (P.L. 382), as amended and supplemented, pursuant to action taken by the Delaware County Council on October 20, 1971. Under County of Delaware Ordinance 2002-1, the term of existence of DELCORA was extended to January 15, 2052.

DELCORA is in the process of developing a Long Term Control Plan (LTCP) for the Combined Sewer System (CSS) as part of a Consent Decree entered with the United States Environmental Protection Agency (USEPA) and the Pennsylvania Department of Environmental Protection (PADEP). As part of this comprehensive effort, a Public Participation Program is being implemented to inform, seek input from, and educate the public (i.e., private citizens, businesses, special interest groups, local government, State government, and the Federal government) in the decision-making process for selecting and developing the appropriate LTCP CSO controls for the CSS.

PURPOSE

The purpose of this report is to document DELCORA's Public Participation Plan (PPP) for the LTCPU. The PPP shall describe how DELCORA will inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies.

The goals of the PPP during the development of the CSO LTCPU include addressing requirements of the United States Environmental Protection Agency (USEPA) Combined Sewer Overflow (CSO) Control Policy (dated April 19, 1994) by *"employing a process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons."* Additionally, in accordance with Section V.A.17 (page 19) of the Consent Decree between the United States of America, the Commonwealth of Pennsylvania, Department of Environmental Protection, and DELCORA, which was lodged on August 17, 2015, the PPP *shall describe in detail how DELCORA will inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The plan shall specifically describe how the LTCP update process will: (i) address the impact of DELCORA's CSOs and LTCP on environmental justice populations, (ii) seek input from communities that may have historically borne a disproportionate share of the negative environmental consequences resulting from DELCORA;s CSOs, and (iii) ensure that the LTCP and selected CSO Control Measures will not impose a disproportionate share of negative*

environmental consequences on such communities in the future. The plan shall also include a schedule for DELCORA's implementation of the plan.

To be consistent with the requirements of the EPA CSO Control Policy and the Consent Decree, this PPP has been prepared to specifically describe how the LTCP update process will:

i. *Address the impact of DELCORA's CSOs and LTCP on environmental justice communities.*

ii. *Seek input from communities that may have historically borne a disproportionate share of the negative environmental consequences resulting from DELCORA's CSOs.*

iii. *Ensure that the LTCP and selected CSO Control Measures will not impose a disproportionate share of negative environmental consequences on such communities in the future.*

iv. *Include a schedule for DELCORA's implementation of the plan.*

PUBLIC AND STAKEHOLDER MEETINGS

The USEPA "Combined Sewer Overflows Guidance for Long-Term Control Plan," dated August 1995, indicates that public participation and Agency interactions should occur at the following steps of the LTCP development process:

1. System Characterization
2. Development and Evaluation of Alternatives for CSO Controls
3. Selection and Implementation of the Long-Term Plan

This PPP has been developed to actively involve the affected public in each of the above steps via Public Participation Meetings and other methods as further described herein. In addition to these minimum requirements, one additional Public Participation Meeting will be considered prior to the required meetings (listed above) to inform the public early in the planning process about the scope and goals of the program. In summary, the Public Participation Meetings to be held will be as follows:

Meeting No. 1: Scope and Purpose of the Study
Meeting No. 2: System Characterization
Meeting No. 3: Development and Evaluation of Alternatives for CSO Controls
Meeting No. 4: Selection and Implementation of the Long-Term Plan

In addition to the above stated Public Participation Meetings, DELCORA will also be holding stakeholder meetings with various agencies, authorities, and special interest groups throughout the course of the LTCP program.

Beyond the above referenced Public Participation Meetings and Stakeholder Meetings, a concerted effort will also be made to make the public aware of the CSO LTCPU development process and to actively involve and educate them about CSO issues and the selection of the CSO control elements through various media, including the following:

1. Update and Educational Material in Sewer Bills
2. CSO Website
3. CSO Newsletters in the form of mail inserts and/or emails
4. Handouts
5. Literature and Documentation will be made available by DELCORA at municipal buildings and public library

Section 1 Introduction

1.1 Background of DELCORA's Facilities

Delaware County Regional Water Quality Control Authority (DELCORA) is responsible for the safe collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA is approximately 82,977 acres, as shown on Figure 1-2, which illustrates that DELCORA serves a significant and widespread portion of Delaware County. The combined sewer area simulated in the original model, also shown in Figure 1-2, is located within the Chester City. It comprises approximately 49% of the Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows.

Historically, DELCORA has characterized its service areas as "Eastern" and "Western." The Western service area discharges to the Western Regional Treatment Plant (WRTP). The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are to be directed to the PWD-SWPCP. As such, dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

Under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection (PADEP), DELCORA is authorized to discharge from the Western Regional Treatment Plant (Outfall 001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow (CSO) outfalls (002-026, 032, 033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek.

There are a total of 26 combined sewer overflow (CSO) outfalls listed with 25 discharge points (Outfalls 009 and 010 both discharge at Outfall 009) in DELCORA's existing NPDES Permit.

1.2 Purpose of Public Participation Plan

The purpose of this Public Participation Plan (PPP) is to present and document DELCORA's Public Participation Program for the LTCPU. The PPP outlines the methods that DELCORA will utilize to actively facilitate public involvement in the decision-making process to develop and select the long term CSO controls.

The goals of the PPP during the development of the CSO LTCPU include addressing requirements of the United States Environmental Protection Agency (USEPA) Combined Sewer Overflow (CSO) Control Policy (dated April 19, 1994) by *"employing a process that actively involves the affected public in the decision-making to select the long-term CSO controls. The affected public includes rate payers, industrial users of the sewer system, persons who reside downstream from the CSOs, persons who use and enjoy these downstream waters, and any other interested persons."* Additionally, in accordance with Section V.A.17 (page 19) of the Consent Decree between the United States of America, the Commonwealth of Pennsylvania, Department of Environmental Protection, and DELCORA, which was lodged on August 17, 2015, the PPP *shall describe in detail how DELCORA will inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The plan shall specifically describe how the LTCP update process will: (i) address the impact of DELCORA's CSOs and LTCP on environmental justice populations, (ii) seek input from communities that may have historically borne a disproportionate share of the negative environmental consequences resulting from DELCORA;s CSOs, and (iii) ensure that the LTCP and selected CSO Control Measures will not impose a disproportionate share of negative environmental consequences on such communities in the future. The plan shall also include a schedule for DELCORA's implementation of the plan.*

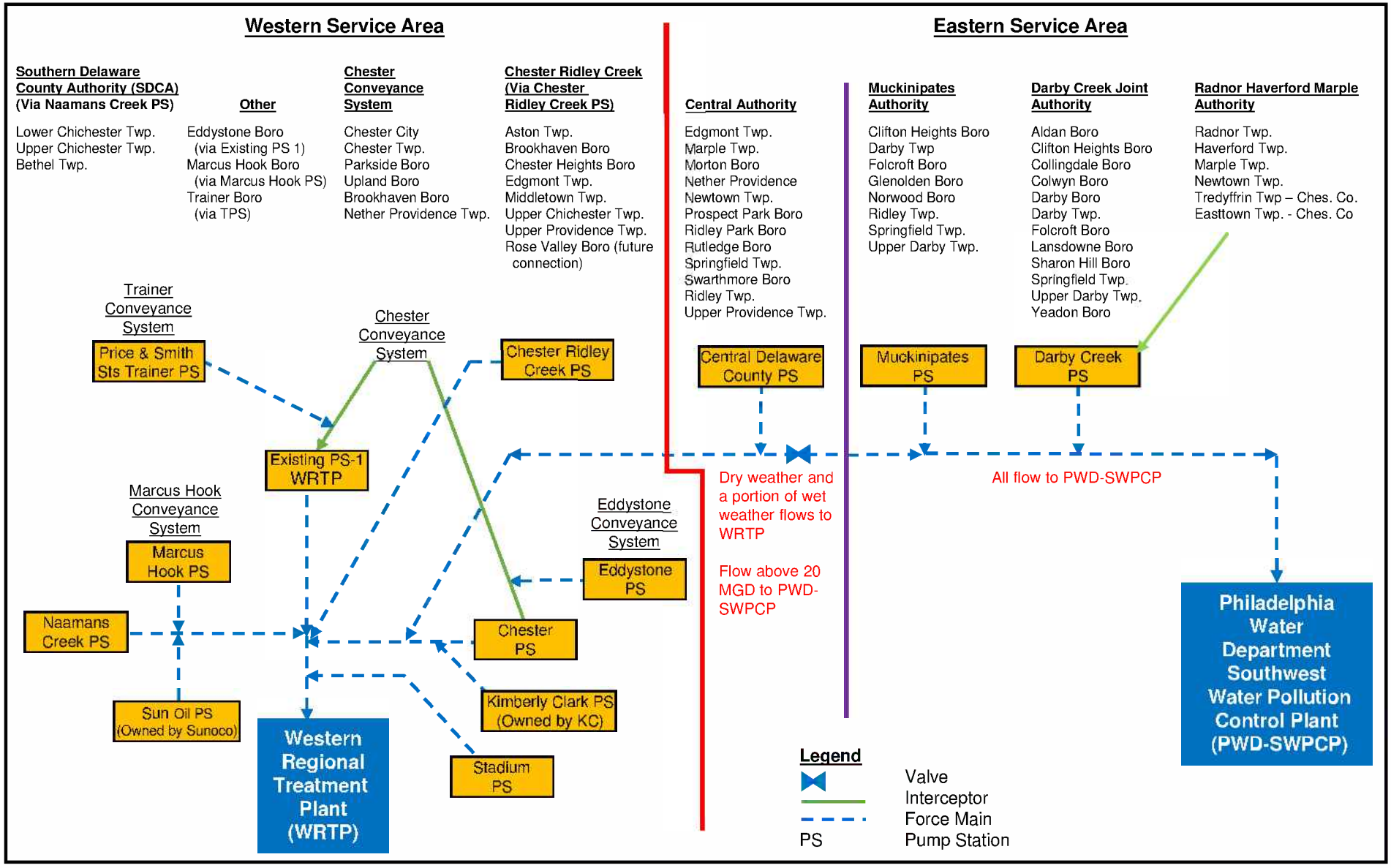
1.3 Public Participation Plan Overview

As part of the Long Term Control Plan Update (LTCPU), this Public Participation Plan (PPP) has been developed to involve key decision makers as described in Section 3.2 for developing and selecting appropriate LTCP objectives for the CSS communities.

To be consistent with the requirements of the EPA CSO Control Policy and the Consent Decree, this PPP has been prepared to specifically describe how the LTCP update process will:

i. *Address the impact of DELCORA's CSOs and LTCP on environmental justice communities.*

ii. *Seek input from communities that may have historically borne a disproportionate share of the negative environmental consequences resulting from DELCORA's CSOs.*



CSO Long-Term Control Plan
Delaware County Regional Water Quality Control Authority

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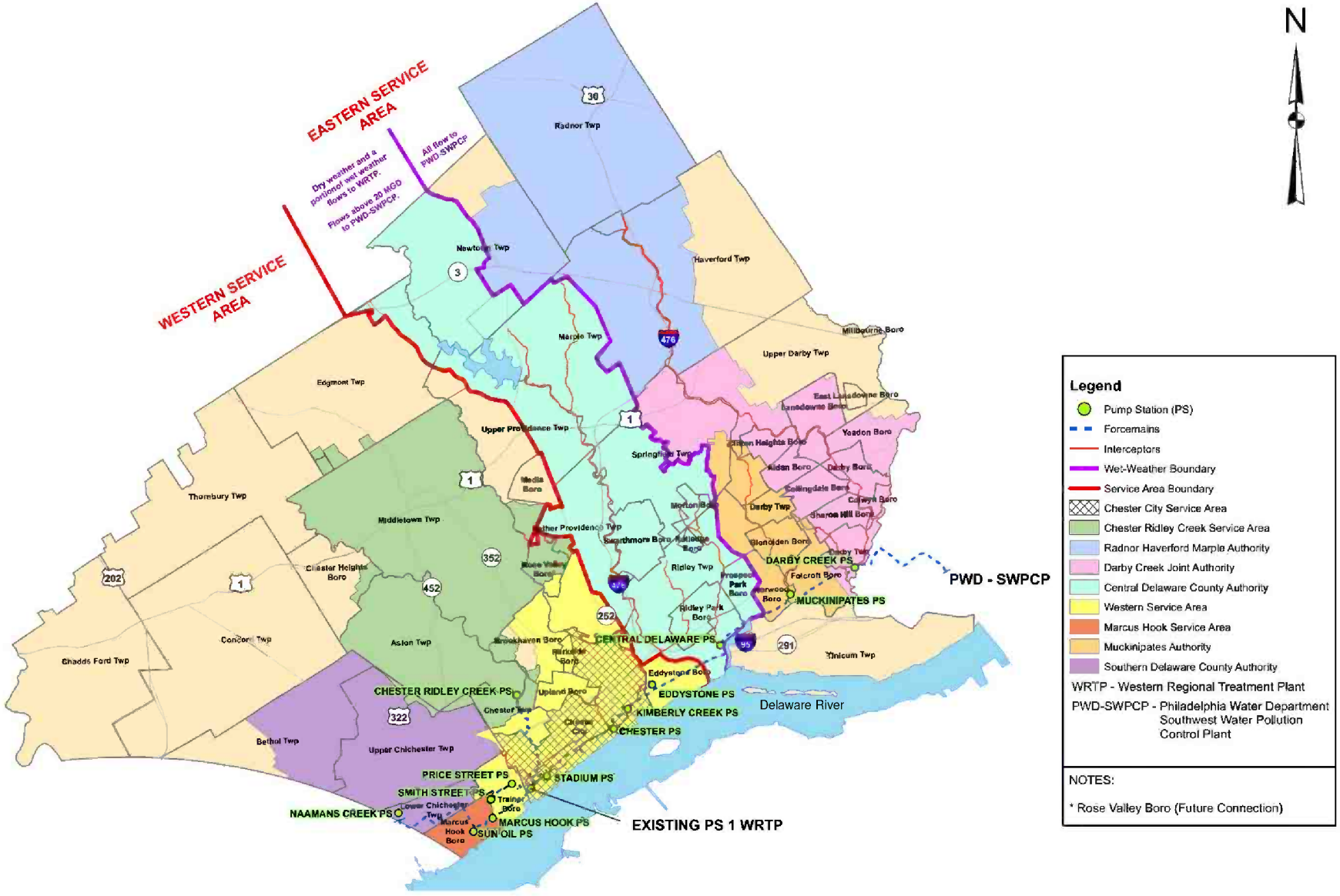
WESTON SOLUTIONS

Figure 1-1
DELCORA'S CONVEYANCE SYSTEM



CSO Long-Term Control Plan

Delaware County Regional Water Quality Control Authority

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Figure 1-2
DELCORA'S SERVICE AREA

iii. *Ensure that the LTCP and selected CSO Control Measures will not impose a disproportionate share of negative environmental consequences on such communities in the future.*

iv. *Include a schedule for DELCORA's implementation of the plan.*

The USEPA "Combined Sewer Overflows Guidance for Long-Term Control Plan," dated August 1995, indicates that public participation and Agency interactions should occur at the following steps of the LTCP development process:

1. System Characterization
2. Development and Evaluation of Alternatives for CSO Controls
3. Selection and Implementation of the Long-Term Plan

This PPP has been developed to actively involve the affected public in each of the above steps via Public Participation Meetings and other methods as further described herein. In addition to these minimum requirements, one additional Public Participation Meeting will be considered prior to the required meetings (listed above) to inform the public early in the planning process about the scope and goals of the program. In summary, the Public Participation Meetings to be held will be as follows:

Meeting No. 1: Scope and Purpose of the Study
Meeting No. 2: System Characterization
Meeting No. 3: Development and Evaluation of Alternatives for CSO Controls
Meeting No. 4: Selection and Implementation of the Long-Term Plan

In addition to the above stated Public Participation Meetings, DELCORA will also be holding stakeholder meetings with various agencies, authorities, and special interest groups throughout the course of the LTCPU program.

Beyond the above referenced Public Participation Meetings and Stakeholder Meetings, a concerted effort will also be made to make the public aware of the CSO LTCPU development process and to actively involve and educate them about CSO issues and the selection of the CSO control elements through various media, include the following:

1. Update and Educational Material in Sewer Bills
2. CSO Website
3. CSO Newsletters
4. Handouts
5. Literature and Documentation

During the course of the LTCPU development and selection process, the public will have the opportunity to be informed, participate in discussions, and provide input through the above meetings.

Section 2 Public Meetings and Engagement Tools

2.1 Objective

The main objective of public meetings and the engagement tools that will be implemented are to foster public awareness and actively facilitate public involvement by taking into consideration public input during the decision making process and selection of the final long term CSO controls.

2.2 Inputs During Public Participation Process

During the public participation process, DELCORA and the Engineering and Program Management Consultant, Greeley and Hansen, will present Public Outreach Material and receive questions and comments.

DELCORA will maintain a website containing information about the Authority and the CSO system. Residents can also report problems or concerns with DELCORA through requests for information. Requests for information will be directed to DELCORA at 610-876-5523 and DELCORA can also be reached by email at ltcpinfo@delcora.org. Comments may also be received through DELCORA's CSO LTCPU website at www.delcora.org.

The comments received will be given consideration during the progress of the program and for the development and selection of the CSO controls.

2.3 Facilities Description and Location

The public meetings will be held at the following four locations. The exact time and location of the meetings will be advertised in advance of the meetings and as described in Section 2.6.

1. **Chester City Hall**
   Address: 1 E. 4th Street Chester, PA 19013

2. **Ridley Township Municipal Building**
   Address: 100 MacDade Boulevard Folsom, PA 19033

3. **Chester City Hall**
   Address: 1 E. 4th Street Chester, PA 19013

4. **Aston Township Administration Building**
   Address: 5021 Pennell Road, Aston, PA 19014

The public meeting locations will be held at different locations in order to maximize the likelihood of attendance for residents and stakeholders. The facilities will have ample meeting space. These locations serve a vital role in Delaware County as the central meeting place and serves as a gathering place for the local community, as well as the hosting of numerous public events, including public information meetings, and are all free to the public.

2.4 Responsiveness Summary

After each public meeting, a Responsiveness Summary will be prepared. Each Responsiveness Summary will include notifications and information that will be made available to the public at the following meeting. This will include a summary of the meeting presentation and attendance; statements, comments, and questions raised by the public, followed by DELCORA's responses.

When preparing the Responsiveness Summary, special attention will be given to address the public statements, comments, and questions, along with DELCORA's responses.

A final copy of the Responsiveness Summary will be provided and reviewed at the subsequent public meeting and a copy will also be placed on DELCORA's CSO LTCPU website. In addition to this the responsiveness summary will also be available at an offline repository location at municipal buildings and/or public library.

2.5 Public Engagement Tools

The public engagement program will be developed in collaboration with DELCORA and the Engineering and Program Management Consultant. This program will include multiple tools nested in primarily the two following strategies:

1. Direct Engagement Strategy

   This strategy will be implemented at the Public Meetings, as well as the Stakeholder Meetings, and will address the complex issues of the LTCP program by providing an opportunity for public participation that is active, interactive, encouraging people to provide ideas and comments and continue to learn about DELCORA's CSO LTCPU program and its objectives. The rationale behind DELCORA's CSO LTCPU will be discussed with the public as part of the engagement program. This strategy will involve stakeholder interactions, use of public meeting talking points, and education based presentations in-line with the requirements of the development process of the LTCP.

2. Digital Engagement Strategy

   This strategy will actively engage the public in providing feedback and comments through the use of digital technology. This will help provide ample information when

people want to know more about the program and its progress. The use of the DELCORA website with a CSO link and notification updates will broaden the range of people that can participate in this program. DELCORA's website will add new content on a regular basis and DELCORA will keep the website updates with the progress milestones of the LTCPU. People will be encouraged to participate by leaving comments or inputs. Informational materials could be posted on the website, as well. This could include advertisements for public meetings, information from communities and other stakeholders, the Responsiveness Summaries from the Public Meetings, project areas and photos, construction notices, as well as key project dates and milestones.

2.6 Public Meeting Descriptions

It is anticipated that there will be four public engagement meetings and each meeting will include elements of the strategies listed above. Meetings will be developed to sync with the needs of the development of the LTCPU. The key points that will be addressed through these public engagement strategies include the following in order to be consistent with the USEPA "Combined Sewer Overflows Guidance for Long-Term Control Plan," dated August 1995:

1. System Characterization
2. Development and Evaluation of Alternatives for CSO Controls
3. Selection and Implementation of the Long-Term Plan

The first public meeting will be used to brief the public on the history, scope and purpose of the study and to obtain their general views on the study. At this meeting a general presentation with information on DELCORA and its CSO LTCPU program will be given to the public. This meeting will provide an effective forum to obtain inputs from interested individuals and organizations. The power point presentation will be provided to the public for review a week in advance of the meeting. The presentation materials will be available for access to the public on DELCORA's CSO LTCPU website under the Combined Sewer System tab.

The second public meeting will focus on updating the public on the scope of activities that make-up system characterization, analysis of existing data and development of the monitoring and modeling programs, identification and status of implementation of the Nine Minimum Controls, and the process for evaluating alternative CSO controls. DELCORA and the Engineering and Program Management Consultant will focus on providing a power-point presentation with hand-outs with the following information to the public as it is developed during this phase, as relevant:

- Scope of monitoring and assessment programs for system characterization
- The watershed approach to CSO control planning
- Identification of watersheds in the CSO area
- Identification and quantification of non-CSO sources
- Existing sewer system conditions and problems (e.g., flooding, basement backups)

- Quantification of CSO flows and loads and impacts of CSOs on receiving waters
- Results of CSS and receiving water monitoring programs
- Development and calibration of the CSS and receiving water models
- Identification and implementation status of the NMC
- Process for evaluating alternatives

DELCORA will interact between various municipal and permitting authorities to reach agreement on the data, information and analysis that is needed to support the development of long-term CSO control plan and review of applicable water quality standards (WQS) as well as implementation procedures. This agreement on the data as well as the power-point presentation will be provided to the public for review a week in advance of the meeting.

The goals of the third public meeting will be to actively involve the public in the development of the alternative solutions that protect the receiving streams, as well as to consider the financial impacts to the community as a whole. During this third Public Meeting, DELCORA and the Engineering and Program Management Consultant will provide a power-point presentation with handouts. The opportunity for citizens to be actively involved in the development of alternatives that provide solutions to protect the local waterways will be provided. Any suggestions, comments and financial impacts to the community will be considered. The following key information will be presented to the public:

- Water quality goals for each receiving water segment
- CSO control goals for each receiving water segment as developed under the presumption and/or demonstration approach options
- Types of control alternatives available to meet CSO control goals
- CSO control alternatives identified to meet the control goals
- Process of evaluating and comparing various alternatives for CSO control

DELCORA will continue to fund and implement the CSO control measures that are currently being implemented under the 1999 LTCP to reduce the frequency, volume, and pollutant load of CSO discharges to local waterways. Additionally, early action CSO control projects will continue to be identified and implemented, where appropriate. Additional CSO control alternatives would be selected based on their water quality impacts, their ease of implementation, and their cost effectiveness. During the Public Participation process, various CSO control measures investigated through engineering analysis will be presented at the third public meeting by the Engineering and Program Management Consultant on behalf of DELCORA. The type and features of the CSO control measures to be considered for each element of the LTCPU would also be based on the nature of the problem, project constraints, and analysis of existing data. Some of the major CSO mitigation measures that would be considered are listed below:

- Capacity Recovery in the existing CSS
- CSO Regulator Improvement Program
- Sewer System Cleaning/Flushing to avoid backups

- Sewer/ CSO Regulator replacement
- Tide Gate Maintenance or replacement
- Reduction of FOG in the sewers
- Outfall Maintenance Program;
- Private Property I/I Elimination
- Outfall Combined Wastewater Diversion and Separation
- Outfall Consolidation, Relocation, or Elimination
- Additional Conveyance Systems
- Inlet Replacement Program
- Downspout Disconnect Program

Presentations will be provided to the public and other listed stakeholders (as discussed in Section 3) on the various advantages and disadvantages of these control measures for further inputs and comments.

The fourth public meeting will discuss and present progress on the development and selection of the alternatives for implementation of the Long-Term Plan. Once the alternatives have been evaluated in detail, but prior to selection of specific CSO controls, the public will be informed of each alternative and ranked based on preference in a draft report. The results of the evaluation will be summarized in an executive summary. The extent of implementation of each alternative evaluated will be based on public input. The schedule and financing method will also be described in the report prior to selection.

During the CSO control measures evaluation stage, alternative measures that can reduce the impact of CSO discharges will typically fall into one of the following four categories:

1. Source Control Technologies/Alternatives - eliminating or preventing pollution before it is created.

2. Collection System Control Reducing Technologies/Alternatives – reducing the discharge volume, concentration, or frequency.

3. Storage Technologies/Alternatives - capturing all or some of the discharge and then releasing for treatment.

4. Treatment Technologies/Alternatives - treating as much as possible.

After assembling a list of possible control alternatives, the necessary preliminary screening will be conducted in order to better evaluate which control alternatives have the highest potential to protect receiving water quality. The selected alternatives will be screened against evaluation

criteria that were selected based upon characteristics of CSO discharges that are measurable and can impact the receiving water. The preliminary screening criteria are as follows:

- Flow reduction
- BOD reduction
- DO improvement
- Settleable solids removal
- Bacteria reduction
- Floatables reduction
- Toxic materials reduction
- Implementation and operation factors

The final CSO control alternatives will be prioritized based on their potential to reduce the CSO discharge frequency and pollutant load to each water body, their cost effectiveness, and on the financial capability. The following impact points will be considered while implementing the final CSO control alternatives:

- CSO Impacts - Sensitive Areas
- CSO Impacts - Water Quality Objectives
- CSO Impacts - Pollutant Load by Water Body
- CSO Control Technology - Pollutant Load Reduction by Water Body
- CSO Control Technology - Cost Effectiveness

During this meeting, the alternative rankings will be presented and discussed thoroughly. The technical solutions will be presented in a simple format with information covering background of project, description of facility, level of control needed, any impacts, and mitigation measures to be taken, as well as the cost. Graphs will be used to present each alternative along with benefits, resource requirements and cost.

DELCORA will continue to interact with municipal and permitting authorities even in this phase with sharing of technical information. CSO control measure performance will be discussed with regulatory authorities to reach agreement. DELCORA will consult with permitting authorities to ensure consistency with the CSO Control Policy provisions regarding CSOs occurring in sensitive areas and show that all reasonable options in developing a list of final alternatives for evaluation have been studied while incorporating all identified concerns.

During all meetings, an agenda will be developed, distributed to the public and followed during the presentations. One person will be designated to take meeting notes and collect public comment sheets so all views are recorded. In addition, written comments from the public will be accepted until one month after the date of the public meetings described above. As previously discussed, after each public meeting, a Responsiveness Summary will be prepared. Each Responsiveness Summary will include notifications and information that will be made available to the public at the following meeting, as well as on DELCORA's CSO LTCPU website.

DELCORA will submit to the regulatory authorities any technical memorandums, interim reports, meeting minutes, and the Responsiveness Summary for comments. Once comments are received, DELCORA will respond to each agency.

Information will be presented to the public in the most understandable manner and in a format that is most appropriate for the public. Any technical information or complex charts will be avoided. Additionally a review of the responsiveness summary from the prior meetings will occur at the second, third and fourth public meetings.

The presentation materials will be available for access to the public at offline repositories as stated in the Executive Summary and DELCORA's CSO LTCPU website under Combined Sewer System tab at least a week in advance of all scheduled meetings. Public will be notified for these materials through the public notice for the meetings.

The public's input will be actively solicited by receiving questions and comments as it relates to the presentation. Public will be advised that there will be an opportunity to raise questions, provide comments and give ideas at the meeting as well. Public will be informed that they have 30 days to submit questions and comments. Last slide of every presentation will have contact information to submit questions and comments. A copy of each presentation will be provided as handout to the participants. At each public meeting public can submit comments and ideas will be solicited.

Public will be informed through a notice in the form of an advertisement prior to the scheduled meetings to raise comments and questions. The public will be encouraged to ask questions as the presentation proceeds and will be asked to provide any comments in writing, as well. Comments arising from all public meeting presentations can be submitted by one of the following methods within 30 days after the scheduled meeting:

- By Mail:
  DELCORA
  P.O. Box 999
  Chester, PA 19016-0999
- By Phone: 610-876-5523
- By Email: ltcpinfo@delcora.org.
- By Website: www.delcora.org.

2.7 Meeting Schedule

Public meetings will be held over the course of the LTCPU development effort to describe how DELCORA will inform and actively solicit input to its updated LTCPU from stakeholders, including the public, customer communities, and the regulatory agencies. Public meetings will be held as described in Section 2.6. The proposed schedule for these meetings is as follows (subject to coordination with USEPA):

Table 2-1: Public Meeting Schedule

Meetings	Description	Scheduled
Meeting No. 1	Scope and Purpose of the Study	1st Quarter of 2016
Meeting No. 2	System Characterization	3rd Quarter of 2017
Meeting No. 3	Development and Evaluation of Alternatives for CSO Controls	4th Quarter of 2017
Meeting No. 4	Selection and Implementation of the Long-Term Plan	3rd Quarter of 2018

The detailed meeting schedule for the implementation of the PPP has been attached herein as Attachment A.

2.8 Meeting Advertisement

The public will be invited through advertisements on DELCORA's CSO LTCPU website in advance.

The public meeting notice will also be advertised in the following local newspapers or circulations:

1. Chester Spirit
2. Delaware County Daily Times
3. Philadelphia Inquirer
4. Press Newspaper

Per the requirements of Pennsylvania's Sunshine Act (provided herein as Attachment C), DELCORA will give public notice of its meetings not less than three (3) days in advance of the meeting and shall give public notice of its remaining meetings. DELCORA shall also give public notice of any special meeting or rescheduled meeting at least 24 hours in advance of the time of the convening of the meeting specified in the notice.

The definition of the "Public Notice" per Pennsylvania's Sunshine Act is as follows:

"(1) For a meeting:

(i) Publication of notice of the place, date and time of a meeting in a newspaper of general circulation, as defined by 45 Pa.C.S. Â§ 101 (relating to definitions), which is published and circulated in the political subdivision where the meeting will be held, or in a newspaper of general circulation

which has a bona fide paid circulation in the political subdivision equal to or greater than any newspaper published in the political subdivision.

(ii) Posting a notice of the place, date and time of a meeting prominently at the principal office of the agency holding the meeting or at the public building in which the meeting is to be held.

(iii) Giving notice to parties under section 709(c) (relating to public notice).

(2) For a recessed or reconvened meeting:

(i) Posting a notice of the place, date and time of the meeting prominently at the principal office of the agency holding the meeting or at the public building in which the meeting is to be held.

(ii) Giving notice to parties under section 709(c).”

Section 3 Stakeholder Members

3.1 Purpose

In addition to the Public Meetings and Engagement Tools as described in Section 2, a group comprising of stakeholder members will be formed for this PPP. The stakeholder meetings will be held on an as-needed basis throughout the course of the LTCP program. These meetings will provide an opportunity for active input and consultation on the LTCP development process. These meetings will also provide an effective forum for an in-depth exchange of information, ideas, and results as the LTCP process moving forward.

3.2 Selection of Members

To reflect a balance of perspectives, stakeholder members may consist of representatives from the public, customer communities, regulatory agencies, and special interest groups. The list of stakeholders considered by DELCORA is provided below. These members will provide inputs through stakeholder meetings. DELCORA will be scheduling independent meetings with each of these stakeholders. These meetings will be beyond the public meetings that are described in Section 2 of this PPP. Presentations will be made to these stakeholders throughout the CSO LTCPU program. A sample copy of this presentation has been provided herein as Attachment B1.

1. Darby Creek Joint Authority
2. Central Delaware County Authority
3. Muckinipates Authority
4. Delaware River Basin Commission
5. Radnor, Haverford, Marple Authority
6. Southern Delaware County Authority
7. Southwest Delaware County Municipal Authority
8. Middletown Township Sewer Authority
9. Chester Environmental Partnership
10. Department of Environmental Protection - Southeast Regional Office
11. Delaware County Planning Department
12. State Elected Officials
13. Local Municipal Officials
14. National Association for the Advancement of Colored People (NAACP)
15. Chester City Council
16. Pennsylvania Resource Council
17. Chester, Ridley & Crum Creek Watershed Association
18. Chester Water Authority (CWA)
19. Delaware County Public Relations Department

20. Delaware Riverkeeper
21. PA Sea Grant
22. Delaware County Council
23. Delaware County Chamber of Commerce
24. Industrial Contributors
25. Chester Business Association

The contact information for the stakeholders will be maintained accurately in a database throughout the project. The potential stakeholders will be identified by DELCORA and the Engineering and Program Management Consultant.

3.3 Meeting Site, Format and Time

Meetings will convene in a meeting room at a predetermined and mutually agreed upon location. The location of the meeting will be coordinated with the Stakeholder member(s). Some of these meetings will also be held at DELCORA's Western Regional Treatment Plant (WRTP). DELCORA will chair each meeting and provide an update on the progress and status of current issues. The following public participation team members from DELCORA may be present at the meetings:

1. Bob Willert – Executive Director
   a. Email: willertr@delcora.org
   b. Contact Number: 610-876-5523 ext. 110

2. Ed Bothwell – Director of Engineering
   a. Email: bothwelle@delcora.org
   b. Contact Number: 610-876-5523 ext. 216

3. Michael DiSantis – Director of Operations & Maintenance
   a. Email: disantism@delcora.org
   b. Contact Number: 610-876-5523 ext. 264

4. Robert Powell – Business Development & Strategic Planning Manager
   a. Email: powellr@delcora.org
   b. Contact Number: 610-876-5523 ext. 127

5. John Pileggi – Controller
   a. Email: pileggij@delcora.org
   b. Contact Number: 610-876-5523 ext. 118

The meeting will then be opened for discussion, questions, and comments. DELCORA will provide the stakeholder an opportunity to sign-up to receive updates on the project and information covering items like agenda and educational materials.

Following each meeting, a brief summary of the meeting will be prepared and distributed to all participants.

Section 4 Public Information Plan

4.1 Notices and Advertisements

To encourage public awareness of, and involvement in, the public meetings, notifications and background information will be made available to the public at least three (3) days prior to each meeting as required by Pennsylvania's Sunshine Act (provided herein as Attachment C). Access to public information will be provided as required by the Pennsylvania Right-to-Know Law Act 3 of 2008 (provided herein as Attachment D).

Sample copies of Public Education and Outreach Materials have been provided under Attachments B1, B2, B3 and B4. These material samples include Stakeholders' powerpoint presentation, public education brochures, newspaper press release and a sample screen shot of what the DELCORA's CSO LTCPU website may look like.

Announcements will be communicated to the public through the following media devices:

- Local Newspapers: Advance notices of public meetings will be published in at least four local newspapers in accordance with Pennsylvania's Sunshine Act (see Section 2.8).

- Internet Websites: Notices of the public meetings will also be placed on DELCORA's website with a CSO LTCPU Link (www.delcora.org).

- Notice by Mail: A list of citizens and representatives of businesses, interest groups, federal government, local government, regulatory agencies, neighboring jurisdictions, and inter-jurisdictional agencies will be developed and accumulated as the study progresses. Any person or group who provided a name and address will be added to the list. Persons on the mailing list will be sent special notices of upcoming public meetings, as well as the responsiveness summaries for each meeting.

4.2 Public Education and Involvement

A concerted effort will be made to make the public aware of the CSO LTCPU development process and to actively involve and educate them about CSO issues through the following media:

1. Updates and Educational Material in Sewer Bills – A public meeting notice will be prepared and this mailing insert will be included in sewer bills mailed out to DELCORA customers.

The topics discussed in the mailing insert will be as follows:

- Definition of combined sewers and how they function
- Explanation of the LTCPU development effort
- Invitation for the public to become involved and provide input
- Illustration of how a combined sewer system functions
- Reporting of any dry weather overflows
- The role of littering in causing dry weather overflows
- Illustrations of how a CSO regulator structure functions during dry and wet weather

2. CSO Website – DELCORA will create a special section of its Internet website devoted exclusively to CSO issues. This section of the website will be called "Combined Sewer System". The website will include information on the nature of CSOs, maps showing the location of outfalls, descriptions of the LTCPU development process, CSO monitoring results, information on pollution prevention, ways in which the public can get involved, previous meeting responsiveness summaries, and an option to post comments or questions on the program. Notices for public meetings will also be posted on the website. The website will provide a means to sign up to receive any newsletters. A downloadable copy of the newsletter will be uploaded to the CSO website as well.

3. CSO Newsletters – Project updates will be sent out to the mailing list created through the first public meeting, as well as subsequent requests from the public and interested stakeholders. The mailing lists will be developed using the sign-in sheets and also all the billed customers. The sign-in sheet will include a means to opt for a preferred method for receiving or not newsletters. The preferred options would be a digital copy by email or a hardcopy by mail. The topics discussed in these newsletters will include the following:

   - Explanation of combined sewers, CSO's, and the LTCPU process
   - Schedule for public meetings
   - Netting system demonstration project
   - Monitoring program update and illustration

4. Handouts - For each public meeting and stakeholder meeting, handouts will be prepared regarding information presented. These handouts will be made available to everyone who attends. These handouts will be designed for the general audience and serve to provide an overview of the LTCP update. These documents will provide information on the history, background, and approach taken by DELCORA to control CSOs, and will include information on how members of the public and interested

stakeholders can actively provide input and/or comments. These documents will be uploaded to the CSO LTCPU section of the DELCORA website, as well.

5. Literature and Documentation – Responsiveness summaries for the public meetings will be prepared for each public meeting. These summaries will also include responses to any comments received from previous meetings. These documents will be made available at the next meeting and uploaded to the CSO LTCPU section of the DELCORA website. Literature and Documentation will also be made available by DELCORA at the following municipal building and public library locations:

   DELCORA Administration Building
   100 East Fifth Street
   Chester, PA 19013

   J. Lewis Crozer Library
   620 Engle Street
   Chester, PA 19013

   Marcus Hook Municipal Building
   1015 Green Street
   Marcus Hook, PA 19061

   Ridley Township Building
   100 MacDade Blvd.
   Folsom, PA 19033

   Upland Borough Office
   224 Castle Avenue
   Brookhaven, PA 19015

   Chester Township
   1150 Engle Street
   Chester, PA 19013

6. Presentations to Stakeholder Members – Presentations will be made to other selected DELCORA stakeholder members as listed below. A sample copy of this presentation has been provided herein as Attachment B1.

   - Darby Creek Joint Authority
   - Central Delaware County Authority
   - Muckinipates Authority
   - Delaware River Basin Commission

- Radnor, Haverford, Marple Authority
- Southern Delaware County Authority
- Southwest Delaware County Municipal Authority
- Middletown Township Sewer Authority
- Chester Environmental Partnership
- Department of Environmental Protection - Southeast Regional Office
- Delaware County Planning Department
- State Elected Officials
- Local Municipal Officials
- National Association for the Advancement of Colored People (NAACP)
- Chester City Council
- Pennsylvania Resource Council
- Chester, Ridley & Crum Creek Watershed Authority
- Chester Water Authority (CWA)
- Delaware County Public Relations Department
- Delaware Riverkeeper
- PA Sea Grant
- Delaware County Council
- Delaware County Chamber of Commerce
- Industrial Contributors
- Chester Business Association

Presentation materials will cover introduction and progress on the LTCPU program. The purpose of these meetings are to actively solicit input from the stakeholder members at each phase of the program and present progress in the scheduled meetings.

ATTACHMENT A

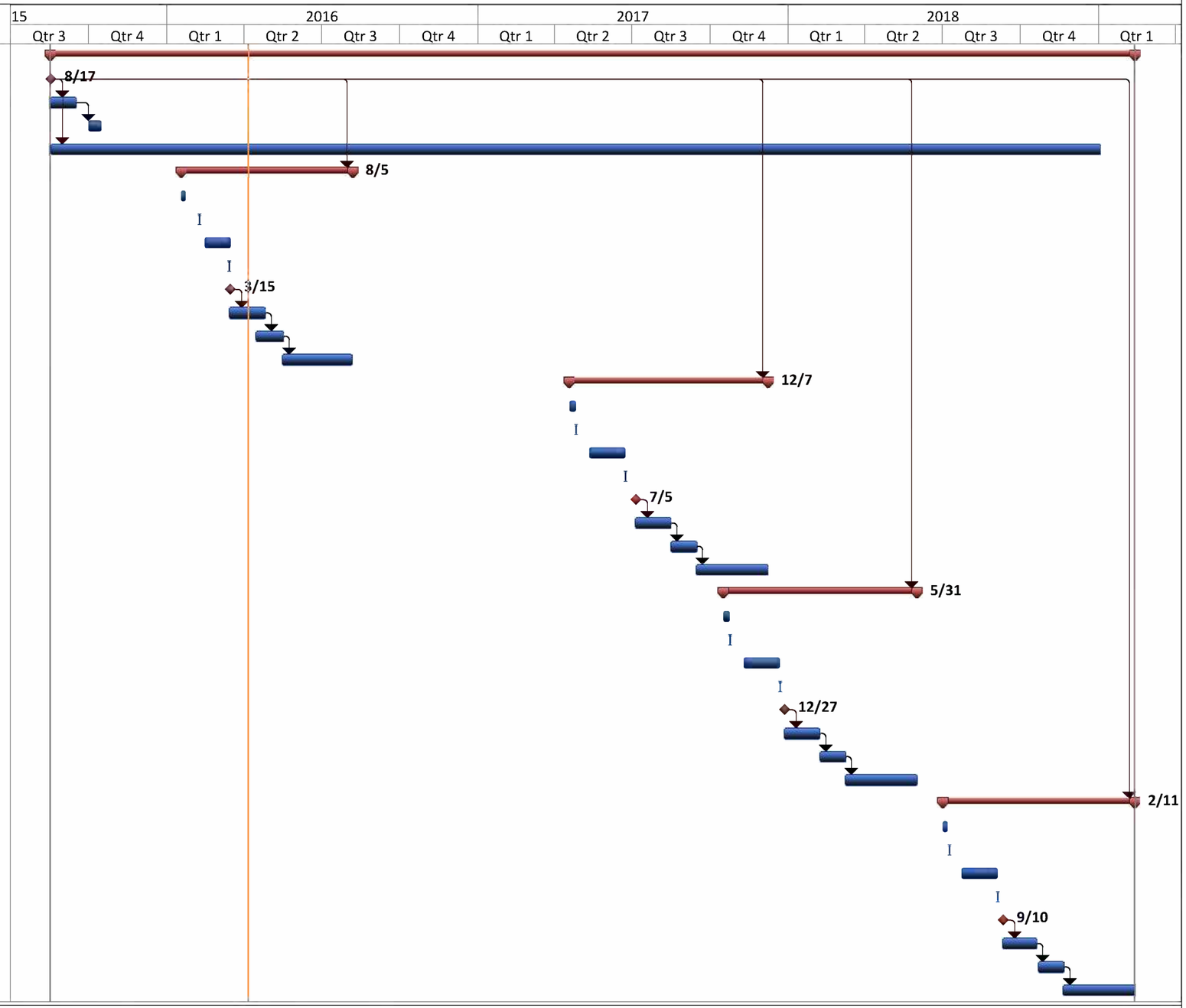
IMPLEMENTATION SCHEDULE

DELCORA

PUBLIC PARTICIPATION IMPLEMENTATION SCHEDULE

Greeley and Hansen LLC

ID	Task Name	Duration
1	**Public Participation Plan during the course of CSO LTCP**	**911 days**
2	**Consent Decree Lodging Date**	**1 day**
3	Draft Plan Development	22 days
4	Final Plan Development	11 days
5	**Stakeholder Meetings (As Required)**	882 days
6	**Public Meeting 1: Discuss Scope and Purpose of the Study**	**145 days**
7	Draft Public Notice	5 days
8	Send Notice to Paper	1 day
9	Advertise Meeting (per Pennsylvania Sunshine Act)	22 days
10	Review Documentation with DELCORA	1 day
11	**Public Meeting 1: Scope and Purpose of the Study**	**1 day**
12	Receive Public comments on website	30 days
13	Regulatory Agency Coordination and Review meeting with DELCORA	22 days
14	Address Public comments on website	60 days
15	**Public Meeting 2: System Characterization**	**167 days**
16	Draft Public Notice	5 days
17	Send Notice to Paper	1 day
18	Advertise Meeting (per Pennsylvania Sunshine Act)	30 days
19	Review Documentation with DELCORA	1 day
20	**Public Meeting 2: System characterization**	**1 day**
21	Receive Public comments on website	30 days
22	Regulatory Agency Coordination and Review meeting with DELCORA	22 days
23	Address Public comments on website	60 days
24	**Public Meeting 3: Development and Evaluation of Alternatives for CSO Controls**	**163 days**
25	Draft Public Notice	5 days
26	Send Notice to Paper	1 day
27	Advertise Meeting (per Pennsylvania Sunshine Act)	30 days
28	Review Documentation with DELCORA	1 day
29	**Public Meeting 3: Development and Evaluation of Alternatives for CSO Controls**	**1 day**
30	Receive Public comments on website	30 days
31	Regulatory Agency Coordination and Review meeting with DELCORA	22 days
32	Address Public comments on website	60 days
33	**Public Meeting 4: Selection and Implementation of the Long-Term Plan**	**161 days**
34	Draft Public Notice	5 days
35	Send Notice to Paper	1 day
36	Advertise Meeting (per Pennsylvania Sunshine Act)	30 days
37	Review Documentation with DELCORA	1 day
38	**Public Meeting 4: Selection and Implementation of the Long-Term Plan**	**1 day**
39	Receive Public comments on website	30 days
40	Regulatory Agency Coordination and Review meeting with DELCORA	22 days
41	Address Public comments on website	60 days



GREELEY AND HANSEN | Task | Milestone | Summary | Subask | Deadline | Progress

ATTACHMENT B

PUBLIC EDUCATION TOOLS AND PUBLIC OUTREACH MATERIALS

ATTACHMENT B1

DELCORA STAKEHOLDERS' PRESENTATION DATED March 15, 2016

Delaware County Regional Water Quality Control Authority

DELCORA

Delaware County, PA

Combined Sewer Overflow - Long Term Control Plan Update

DELCORA

Public Participation Meeting No. 1

LTCPU Scope and Purpose

March 15, 2016

Chester City Hall Community Room

1 E. 4th Street, Chester, PA

Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

Public Participation Plan Goals

- DELCORA's goals and objectives for the Public Participation Program are to :
  - Inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies
  - Educate the public
  - Address public concerns

Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

General Information

- DELCORA is the Delaware County Regional Water Quality Authority, established in 1971, responsible for collecting, conveying and treating wastewater in the greater Philadelphia Area including 42 Municipalities in Delaware and Chester County.

DELCORA Mission

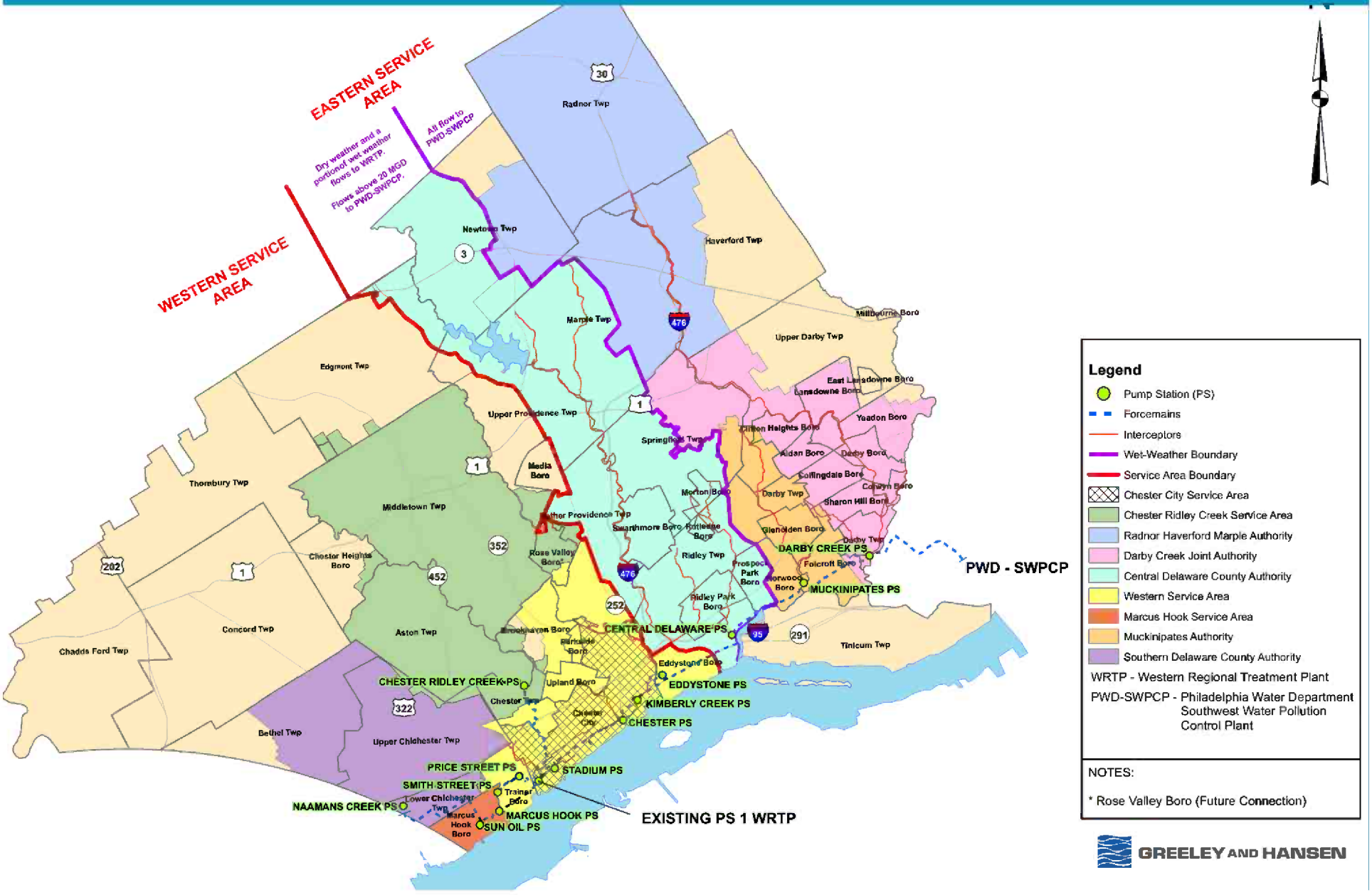
"Provide environmentally responsible and cost effective wastewater management services to the citizens, businesses, and industries of Southeastern Pennsylvania"

Delaware County Regional Water Quality Control Authority

DELCORA

Delaware County, PA

DELCORA Service Area



Legend

- Pump Station (PS)
- Forcemains
- Interceptors
- Wet-Weather Boundary
- Service Area Boundary
- Chester City Service Area
- Chester Ridley Creek Service Area
- Radnor Haverford Marple Authority
- Darby Creek Joint Authority
- Central Delaware County Authority
- Western Service Area
- Marcus Hook Service Area
- Muckinipates Authority
- Southern Delaware County Authority

WRTP - Western Regional Treatment Plant

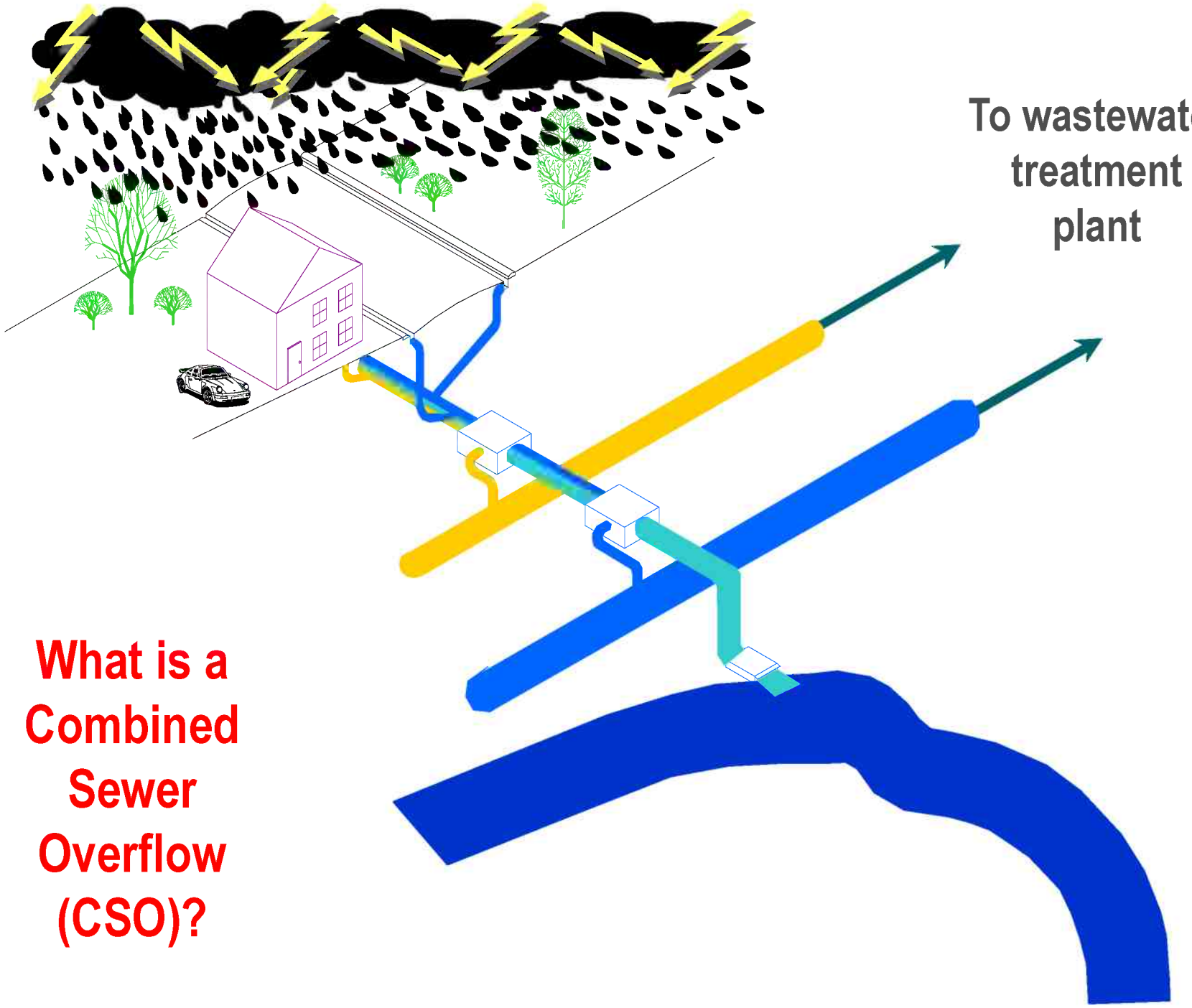
PWD-SWPCP - Philadelphia Water Department Southwest Water Pollution Control Plant

NOTES:

* Rose Valley Boro (Future Connection)

GREELEY AND HANSEN

What is a Combined Sewer Overflow (CSO)?



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Definitions

- **LTCP:** The Long Term Control Plan is the document that lays out how DELCORA will maintain the outfalls and reduce the flow and/or treat the discharge from the outfalls to the water ways to meet the requirements of the Clean Water Act.
- **Sanitary Sewer:** The system that contains only waste from bathrooms, sinks, washers etc.
- **Storm Sewer:** Run off from streets.
- **Combined Sewer System:** Pipe that has both sanitary sewage and storm water in it.
- **Combined Sewer Overflow:** An overflow is the relief point in the combined sewer system that allows the extra flow when it rains to be discharged directly to streams and rivers.
- EPA: United States Environmental Protection Agency
- DEP: Pennsylvania Department of Environmental Protection

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History of Combined Sewer System

- In the early 1900's the City of Chester's Combined Sewer System was constructed.
  - This was, at the time, a typical engineering practice in Urban areas.
- In 1971 DELCORA became the owner of the existing Sanitary and Combined Sewer System in the City of Chester.
- Discharges from CSOs are authorized through the National Pollutants Discharge Elimination System (NPDES) permit during Wet Weather Flow.

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DELCORA Combined Sewer Area

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History of EPA LTCPs

- LTCP Consent Decrees/Order for various wastewater systems not only throughout Pennsylvania, but the entire country.
  - Washington DC, New York City, Richmond,
- Current Pennsylvania communities already impacted by LTCP Consent Decree Costs & Fines:
  - Williamsport
  - Scranton
  - Harrisburg
  - Pittsburgh

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Philadelphia LTCP

- DELCORA is currently contributing to the Philadelphia LTCP.
  - Philadelphia's LTCP has an overall price tag of over $2 Billion over 25 years.
  - DELCORA's proportionate share of the Philadelphia LTCP is $178 million over 15 years due to the term of our contract with Philadelphia.

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DELCORA LTCP Background

- In 1999 in response to increased environmental regulations, DELCORA implemented an LTCP for the DELCORA Combined Sewer System in the City of Chester.
- The LTCP identified capital improvements and operation and maintenance practices to reduce overflows.
- From 1999-2009 DELCORA spent in excess of $5 million on improvements and contributions to the City of Chester that resulted in decreased volume of overflows, reduced debris in overflows, provided remote monitoring of the system, and improved routine maintenance.
- In 2009, the DEP and EPA determined that DELCORA's LTCP was no longer in compliance with increased regulations of the Clean Water Act. In response, DELCORA began working with DEP and EPA to update the LTCP.

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LTCP Background (Continued)

- In 2012, DELCORA submitted a revised LTCP to DEP and EPA.
- A key element in DELCORA's revised plan position was that the CSOs are only found in the City of Chester and the financial burden on the City of Chester residents must be considered.
- In 2014, DEP and EPA determined that DELCORA's revised LTCP required further evaluation and development so the Department of Justice was assigned to pursue a Consent Decree.

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DELCORA Consent Decree

- The Consent Decree was agreed to by DELCORA on July 1, 2015 and signed into effect by the Dept. of Justice (DOJ) in November 2015. The Consent Decree is a legally binding agreement between DELCORA, EPA , and DEP in which DELCORA agrees to update the current LTCP.
- Generally, the Consent Decree consists of:
  - Compliance Measures
  - Milestones for plan update and implementation
  - Civil penalty
  - Stipulated penalties for non-compliance
- DELCORA has been given 42 months (3½ years) to develop a plan and 20 total years to implement the plan. When projects are complete and on-line, sewer fee charges will include costs for the updated LTCP.

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LTCPU Summary – Where We Are

- Hired expert consultants with a good track record as well as experience specifically related to the LTCP.
  - Greeley & Hansen: Engineering Consultant for the LTCP
  - Municipal & Financial Services Group: Rate Model Consultant
  - Blank Rome: Law Firm
- 100% compliance to date with Consent Decree
  - Submitted to date :
    - Public Participation Plan
    - Hydrologic and Hydraulic Model Update and Calibration Plan
    - Typical Hydrologic Period Plan
    - Semi-Annual Report
    - Sensitive Areas and Pollutants of Concern Report
  - To be Submitted by May 17, 2016
    - Draft FCA and Alternative Evaluation Report

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Financial Capability Assessment (FCA)

- The Consent Decree requires DELCORA to submit a DRAFT FCA by May 17, 2016 and FINAL FCA at the end of the project.
- Financial Capability Assessment's (FCA's) purpose is to determine the affordability of the LTCP.
- Develop fair, equitable, and legal cost share for conveyance, storage, and treatment of wet weather flows

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Financial Capability Assessment (FCA)

Financial Capability Matrix

Permittee Financial Capability Indicators Score (Socioeconomic, Debt & Financial Indicators)	Residential Indicator (Cost Per Household as a % of MHI)		
	Low (1.0% and Below)	Mid-Range (Between 1.0% and 2.0%)	High (2.0% and Above)
Weak (1.5 and Below)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (2.5 and Above)	Low Burden	Low Burden	Medium Burden

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LTCPU Summary – Next Phase

- Sampling
- Flow Monitoring and Precipitation Monitoring Installation
- Data Analysis
- Model Development
- System Characterization
- Development and Evaluation of Alternatives for CSO Controls
- Selection and Implementation of the Long-Term Plan
- Continued Public and Stakeholder Involvement

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Future Public Meetings

- **2nd Meeting**

  Topic: System Characterization
  When: 3rd Quarter 2017
  Where: Ridley Township Municipal Building
  100 MacDade Boulevard; Folsom, PA 19033

- **3rd Meeting**

  Topic: Development and Evaluation of Alternatives for CSO Controls
  When: 4th Quarter 2017
  Where: Chester City Hall
  1 E. 4th Street; Chester, PA 19103

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Public Meetings (Continued)

- **4th Meeting**

  Topic: Selection and Implementation of the Long-Term Plan
  When: 3rd Quarter 2018
  Where: Aston Township Administration Building
  5021 Pennell Road; Aston, PA 19014

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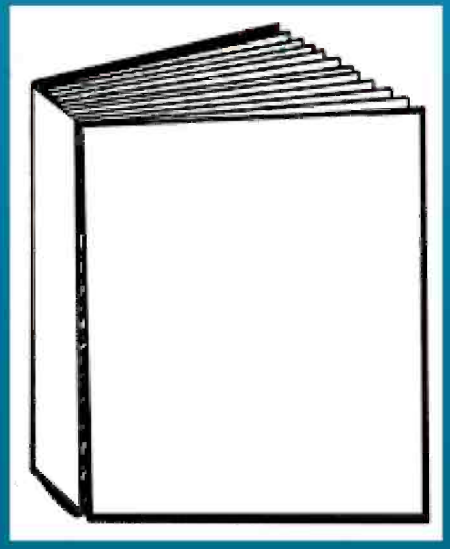
Literature and Documentation

- Literature and documentation will be made available by DELCORA at the following public locations and on the DELCORA website:
  - **DELCORA Administration Building**
    100 East Fifth Street; Chester, PA 19013
  - **Lewis Crozer Library**
    620 Engle Street; Chester, PA 19013
  - **Marcus Hook Municipal Building**
    1015 Green Street; Marcus Hook, PA 19061
  - **Ridley Township Building**
    100 MacDade Blvd.; Folsom, PA 19033
  - **Upland Borough Office**
    224 Castle Avenue; Brookhaven, PA 19015
  - **Chester Township**
    1150 Engle Street; Chester, PA 19013



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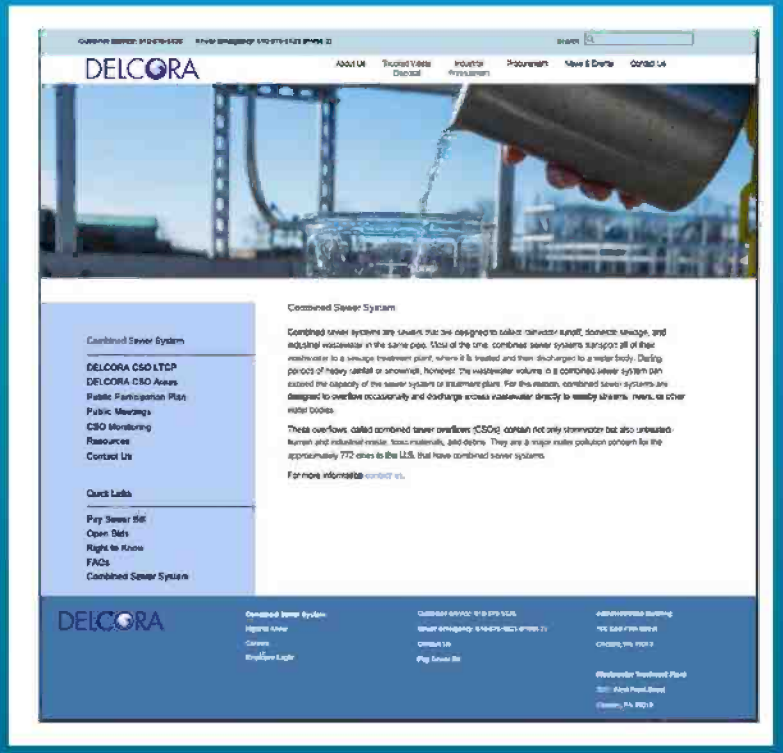
DELCORA WEBSITE



www.delcora.org

Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

CONTACT DELCORA

- Mail Address:
  - DELCORA
    P.O. Box 999
    Chester, PA 19016-0999
- Email: ltcpinfo@delcora.org
- On the WEB: www.delcora.org
- General Phone Number: 610-876-5523
- Newsletter
- Sign-Up Sheet

-Thank You-

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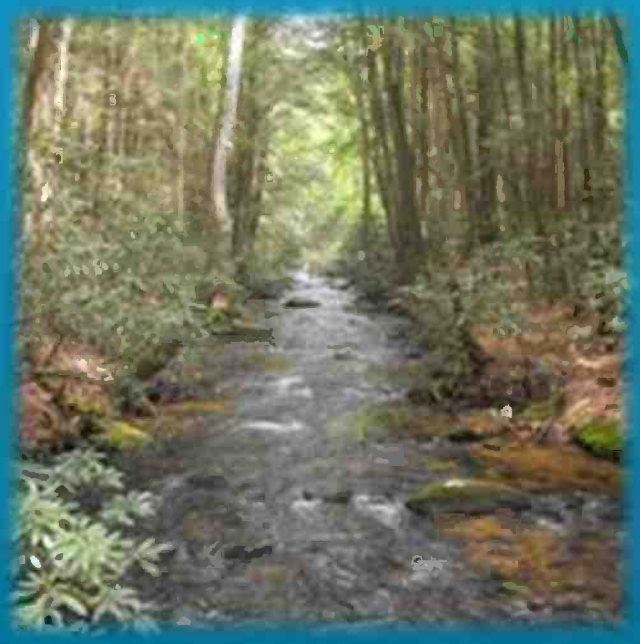
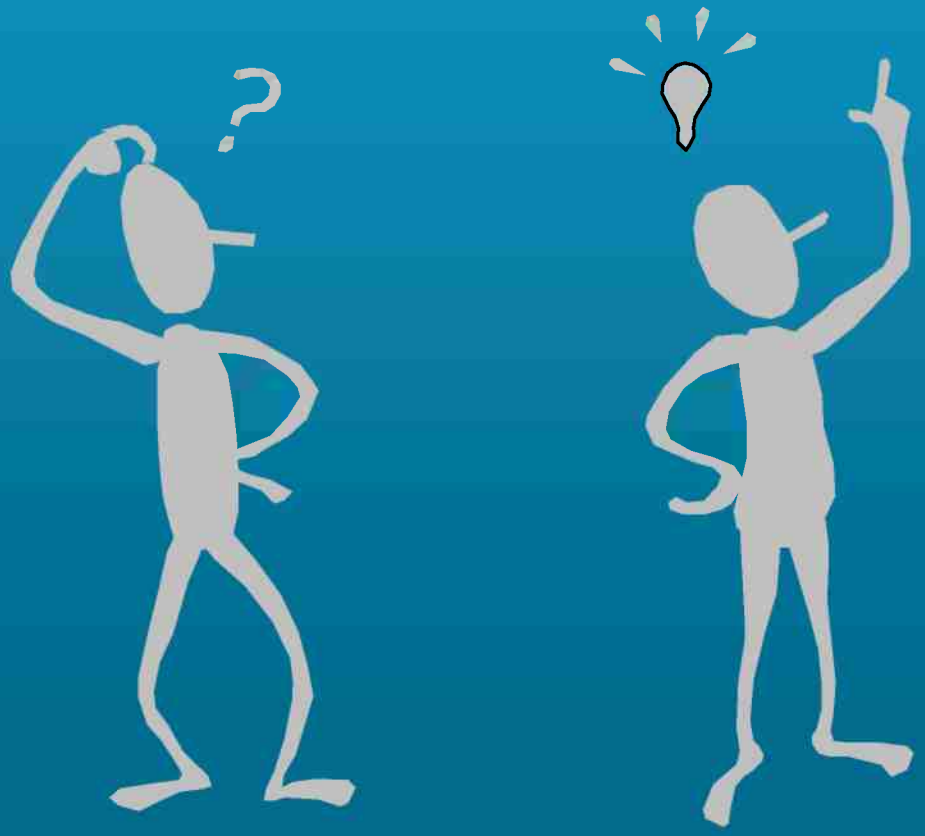
Discussion - Q&A





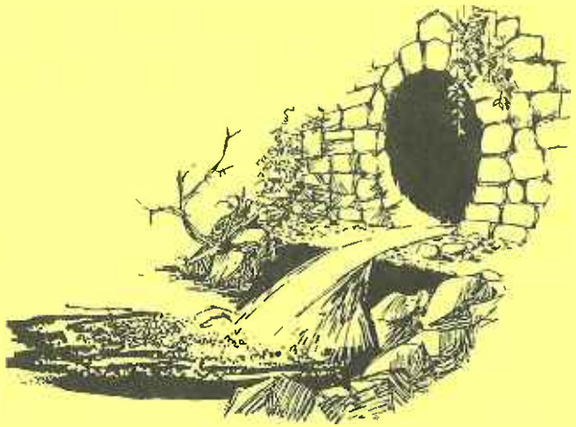
ATTACHMENT B2

PUBLIC EDUCATION BROCHURES (7 Brochures)

2011

DELCORA CSO LONG TERM CONTROL PLAN 2011

PLAN UPDATE



Community Education Series

100 East Fifth Street
P.O. Box 999
Chester, PA 19016-0999

What is a Combined Sewer Overflow (CSO)?

Some communities collect both rainwater runoff and sanitary wastewater in the same sewer. These are called "Combined Sewers". Sometimes when it rains, sewers do not have enough capacity to carry all the rainwater and wastewater and the treatment plant is not large enough to treat the total combined flow. In these situations, the combined wastewater overflows untreated into the nearest body of water, streams or rivers, creating a combined sewer overflow.

In the case of storm water from the street, whatever litter, also known as floatables, that is in the street washes into the CSO and either to the treatment plant or directly into our community's streams, rivers, and water bodies. Inlets help to keep trash and other floatables out of the sewer system.

PROGRAM ACTIVITIES

Under the current CSO Long Term Control Plant (LTCP), DELCORA provides $75,000.00 per year to the City of Chester to replace storm-water inlets. The DELCORA program will act in concert with the City's efforts to replace the inlets with a PennDOT approved type M inlet. Inlets are the openings adjacent to the roadway curb that direct stormwater runoff to the sewer system. The type M inlet is installed in the roadway. It has steel grates that prevent trash from entering the sewer.

Inlets are replaced to reduce the amount of litter and other floatables that enter the sewer system. These pollutants clog the system, causing sewer backups, and increase treatment costs by adding non-biodegradable material to the waste stream. Replacement helps keep our streams and waterways cleaner.

DELCORA also replaces the regulators in the sewer system to maximize flow to the treatment plant. Regulators direct the wastewater to the treatment plants. To date DELCORA has replaced 15 of 25 regulators.

The US. Environmental Protection Agency (EPA) ordered DELCORA to update its LTCP. The new plan was submitted February 1, 2011. EPA Approval is pending. New technologies were investigated and cost estimates were prepared. It is likely that sewer rates will increase as a result.

DELCORA'S LONG TERM CONTROL PLAN

- Identifies all Combined Sewer Overflow (CSO) Locations
- Prohibits all dry weather discharges
- Requires proper operation and maintenance of all CSO flow control regulators
- Requires an Inlet Replacement Program
- Maximizes flow treated at the Plant
- Schedules replacement of all CSO regulators over a 20 year period
- Outlines a detailed monitoring and upkeep schedule of all CSO regulators
- Develops implementation for a sewer cleaning program targeting segments with the greatest CSO impact
- Requires a Public Education program. A meeting was held November 17, 2011.

What are the benefits of the CSO Long Term Control Plan?

- A cleaner & healthier environment to live and work in.
- A planned program of level expenditures, helping to keep sewer rates stable. However, the USEPA's required update of the Plan may require more upgrades of the sewer system. It is likely that rates will increase.
- Citizen response, participation and input.
- A better citizen understanding of why the program is needed.
- Regular, monitored cleaning and repair of our sewer system.
- Improved stewardship of our water resources.

LEARN TO IDENTIFY CSO OUTFALLS

There are 28 CSO outfalls in the Chester area; thirteen drain to the Delaware River, ten to the Chester Creek and five to the Ridley Creek.

All outfalls are marked by a sign.

How you can help.

- Disconnect your downspouts from your sewer lateral.
- Don't litter! Keep trash out of sewer inlets.
- Keep grease, fats, and oils out of your drains.
- Use environment friendly cleaning agents and cleansers.
- Properly dispose of hazardous wastes.
- Dispose of prescription drugs and personal care products properly.
- Conserve your water usage.
- Learn more about CSO's.
- Remember—Clean water is everybody's business.

Want to learn more?

DELCORA welcomes and encourages your input. Additionally, tours of the treatment plant can be arranged for civic, school or church groups.

If you would like to review a complete copy of the 2011 proposed DELCORA CSO Long Term Control Plan 2011, please call or fill out the form below and mail to "Administration/CSO Information". We will gladly schedule a time during daily business hours when you can visit our Administrative offices and review the plan.

NAME_____

ADDRESS_____

_____

TELEPHONE_____

◊ I'D LIKE TO READ THE DELCORA CSO LONG TERM CONTROL PLAN.

MAIL TO:
DELCORA
ADMINISTRATION/CSO INFO.
100 EAST FIFTH STREET
PO BOX 999
CHESTER, PA 19016-0999

Phone: 610-876-5523
Fax: 610-876-2728
Email: CSOinfo@delcora.org
www.delcora.org

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Special thanks to the City of Lynchburg, Virginia, and Blair Communications for help with this brochure.

This brochure was prepared under Cooperative Agreement Assistance #CX824505 between the Water Environment Federation (WEF) and the U.S. Environmental Protection Agency. For more information about sewer backups, overflows, and downspout disconnection, contact your local sewer system authority, or

Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
Phone: 703/684-2400
Fax: 703/684-2492
Web site: http://www.wef.org

For additional copies of this brochure, contact WEF at 1-800-666-0206 or http://www.wef.org.

Delaware County Regional Water Quality Control Authority
100 East Fifth Street
Chester, PA 19013
610-876-5523
www.delcora.org

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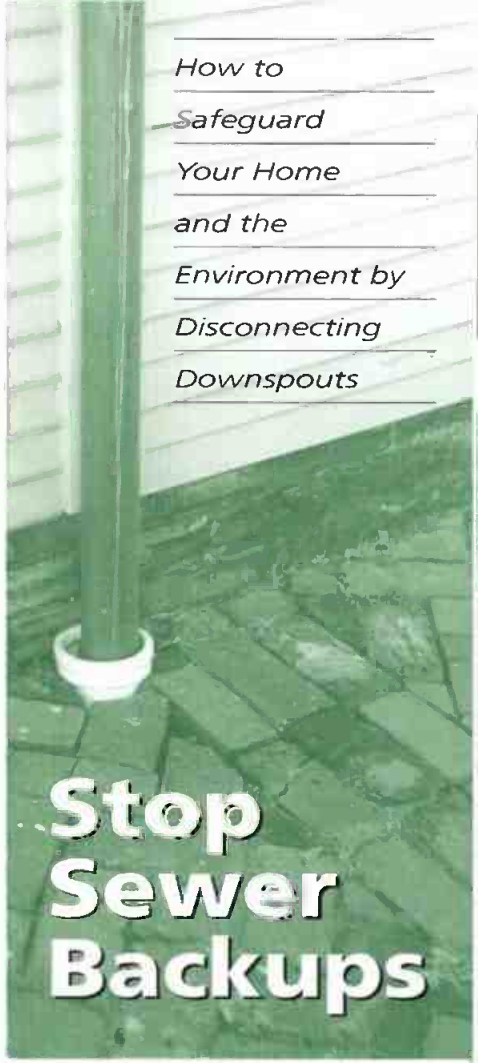

How to Safeguard Your Home and the Environment by Disconnecting Downspouts

Stop Sewer Backups

Connected downspouts — what are they?

Many older homes, especially in cities, have gutters connected directly to the sanitary sewer. This means that rain from the roof runs directly into the sewer. Not all downspouts that look like this picture are connected to the sanitary sewer; some may empty into a storm drain. Call your local sewer system authority or public works department to find out if your connected downspout empties into the sanitary sewer.

Why is this a problem?

The problem is too much water. Sanitary sewer systems can only handle a certain amount of water. During a rainstorm, water gets into the sewer from connected downspouts and other sources. When there is too much water for the system, the excess has to go somewhere, and that somewhere is often somebody's basement, a manhole, or a nearby creek or river. Municipalities have a legal requirement to stop water from overflowing out of sewers. Even if the water does not overflow, it's still a problem, because the wastewater treatment plant has to treat the extra water.

Why should you care?

Sewage backups and overflows are messy, costly, and a threat to health and the environment.

Cleaning house. When there is a sewer backup into a house, the homeowner may have to pay the cost to clean up, repair damage, and replace ruined carpets and furniture. Basic homeowner's insurance often does not cover this damage (unless the policy has an added clause or "rider").

Health. Raw sewage contains microorganisms that can cause diseases such as hepatitis, giardiasis, and gastroenteritis.

Long term environmental damage. Raw sewage in streams and lakes can cause illnesses in fish, kill aquatic life, and make the water unusable for swimming, fishing, and as a drinking water source.

Higher costs mean higher utility rates. The utility ends up treating the extra water, and may even have to increase the size of the treatment plant. The utility may also have to pay fines when raw sewage is released to the environment. Increased utility costs are passed along to consumers as rate increases.

What can you do?

You should check to see whether disconnecting your home's downspouts can help solve the problem. Disconnection is usually a simple, relatively inexpensive process. The steps are shown on the inside of this brochure. Your local sewer system authority or public works department should be able to tell whether your downspouts are connected to the sanitary sewer and, if so, whether disconnection makes sense.

You can also let other people know why downspouts need to be disconnected and how sewer overflows cost the entire community.

How to Disconnect Your Downspout

Check Before You Start

The steps outlined below are general guidelines for disconnecting downspouts and do not apply in all situations. Contact your local sewer system authority or public works department to see what specific guidance is available and to obtain information on local conditions, materials, and regulations. You may want, or be required, to hire a professional contractor or plumber to do the work. In some areas, an inspection of the disconnection is also required. Be aware, too, that some municipalities discourage or prohibit downspout disconnection due to local zoning or concerns about runoff.

Use of the information provided in this brochure is voluntary. The organizations that prepared this brochure assume no responsibility for consequences arising from its use and specifically disclaim all liability for damages of any kind arising out of or resulting from the use of the information in this brochure.

1. Tools and materials you are likely to need:

- safety glasses
- work gloves
- hammer
- chisel
- hacksaw
- measuring tape
- screw driver
- trowel or other digging tools
- bucket (for concrete)
- spare gutter pipe
- splash block
- gutter "elbows" or other discharge devices
- flexible/corrugated pipe
- concrete mix (or other permanent, weatherproof sealant)
- plastic boot cap

2. Safety

Make sure that you have the safety equipment that you need, including work gloves and safety glasses. Many disconnections involve hammering and sawing which can be hazardous to your eyes. Aluminum gutters can be extremely sharp after being cut, so protect your hands with work gloves.

3. Call before digging

If you bury part of your discharge pipe, remember that even digging a shallow trench can sever a utility line. To be safe, call your local utilities (most jurisdictions have a "call before you dig" hot line) to make sure you avoid digging near service lines.

Disconnection Steps

STEP 1 — Remove downspout from boot

Unless your gutter downspout can be easily lifted out of the boot, you'll need to cut it just a few inches above the boot—making sure that you've left enough room for the downspout "elbow" or other end-of-pipe device.

© Blair Communications

© Blair Communications

STEP 2 — Remove the boot (Optional)

You can leave the boot in place, or remove the boot for a more finished look. To remove the boot, cut it with a hacksaw, or hammer and chisel. Be sure to wear safety glasses, and remove sharp edges that remain on the pipe after cutting.

STEP 3 — Seal the boot

The boot must be permanently sealed to keep water from entering the sewer line. There are different ways to seal the pipe so before proceeding, check to find out what approach is recommended for your area. Some jurisdictions suggest the following method:

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The pipe can be sealed with concrete or other material that makes a permanent, weatherproof seal. Before starting, check the pipe to make sure that you will not block any other junction (such as your washing machine draining into the same pipe). Then push balled-up newspaper tightly three or four inches down into the boot. Make sure that the fit is snug, otherwise the concrete could actually block the sewer. Carefully pour the concrete or other material that gives a permanent weatherproof seal into the pipe, and smooth the top surface.

Other areas do not recommend using newspaper and suggest the use of friction or sewer plugs, which are often available from licensed contractors.

STEP 4 — Redirect rainwater with end-of-pipe device(s)

The last step is to redirect the rainwater away from the house. The exact approach depends on individual conditions. It is important that the rainwater discharges a safe distance from your foundation (three or four feet is usually enough), that the runoff is not a nuisance to your neighbors, or causes other problems, like discharging across a sidewalk so that ice forms in the winter.

© Blair Communications

Sometimes all that is needed is an "elbow" pipe to the bottom of the gutter downspout and a plastic or concrete splashblock. Other situations (such as sloping ground) may require a different solution. There are a number of devices available designed to channel the rainwater away from your home (ask a hardware store to recommend the best one for your needs).

Check with your local sewer system authority or public works department for other redirection options in your area.

Disconnection is usually a simple, relatively inexpensive process.

Special Situations

Steep Slopes

If the gutter is next to a steep slope, be careful that the discharge from the new downspout will not wash away soil on the hillside. There are two ways to avoid this: attach a pipe long enough to drain the rainwater to a safe area, or install an attachment that controls how fast water comes out of the gutter. Always make sure that you are not draining water onto a neighbor's property and that runoff from your downspouts does not cause erosion or flooding of your neighbor's yard. Do not discharge stormwater too close to your property line.

© Blair Communications

© Blair Communications

Extended Boot

Some older homes have boots that extend several feet above the ground. You can leave the boot in place and permanently seal the top of the pipe (step 3) or you can remove the tall boot. If you remove the boot, you will usually need to install a new section of gutter pipe and then an end-of-pipe device (step 4).

Inadequate Drainage

Some gutters may be located on very flat ground with no place for the water to drain. One solution is to pipe the water safely away from the house with a pipe attached to the downspout's "elbow." Another option is to use a device that will disperse the water enough so that it doesn't form a puddle. Make sure that it is draining away from your foundation.

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- ✓ **Look for and check your** *sewer cleanout.* The cleanout usually is a small pipe, about 4 inches in diameter, outside your house or business that is used to access the service lateral for cleaning the sewer line. You can find it near the house, where the service lateral comes out, and/or near the street, where the service lateral connects to the main sewer line. Make sure the cap to the cleanout pipe is on and has not been damaged by a lawn mower or something else. Replace missing caps; otherwise, rain can get into the sewer line, causing it to overflow.

- ✓ **Avoid pouring grease down your sink.** When the grease cools in the sewer line, it can form clogs and blockages, which then can cause the sewer to overflow or back up into buildings. The grease also can contribute to restricted flow in your home plumbing and service laterals, resulting in costly repairs.

- ✓ **Avoid planting trees and shrubs above or near the service lateral** that runs from your building to the street. Roots can enter and clog sewers, causing them to back up and overflow.

- ✓ **Learn about your local sewer system.** Contact your local sewer authority or department of public works. and ask them to describe how the system works. Ask for the general location of the main sewer lines and treatment plant(s) and what type of monitoring is being conducted to detect SSOs.

- ✓ **Support local programs that aim to improve the way your sanitary sewer system is maintained and operated.** Proper operation and maintenance of the sanitary sewer system are key to preventing the damage caused by SSOs and prolong the life of the sewer system, saving taxpayer dollars.

This brochure is provided by Citizens Environmental Research Institute and funded by the U.S. Environmental Protection Agency, Cooperative Agreement Assistance I.D. No. CX824853-01. For more information about SSO's contact:

Citizens Environmental Research Institute
225 Main Street, Suite 2
Farmingdale, NY 11735
Web site: http://www.ceriworld.org
516-390-7150 Fax: 610-516-390-7160

DELCORA
100 East Fifth Street, P.O. Box 999
Chester, PA 19016-5523
Web site: http://www.DELCORA.org
610-876-5523 Fax: 610-876-2728

DELCORA

TOP SEVEN TERMS FOR BETTER UNDERSTANDING SSOs:

1. INFILTRATION. The water entering a sanitary sewer system through pipe joints, line breaks or cracks.

2. INFLOW. Rainwater from roofs, pavements, yards, manholes, and manhole covers that flows directly into a sanitary sewer.

3. SERVICE LATERAL. The sewer pipe that connects a house or other building to the main sewer line in the street.

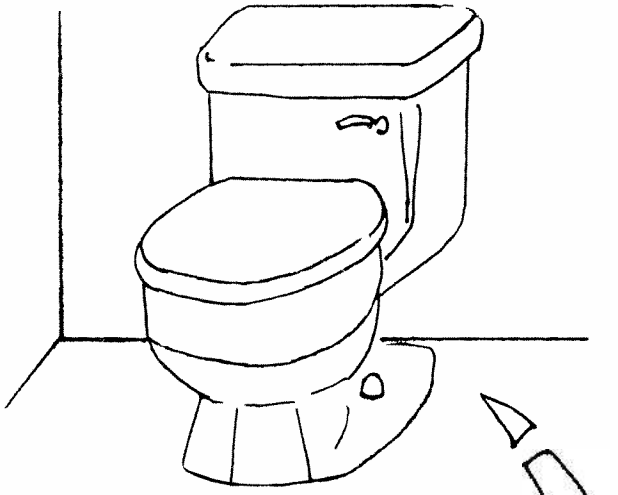
4. SEWER CLEANOUT. A small pipe with a cap, located near the place in a house or other building where the service lateral enters. The cleanout is used to free blockages that may form in the service lateral.

5. PATHOGENS. Organisms in raw sewage that cause diseases, including cholera, dysentery, hepatitis, and gastroenteritis.

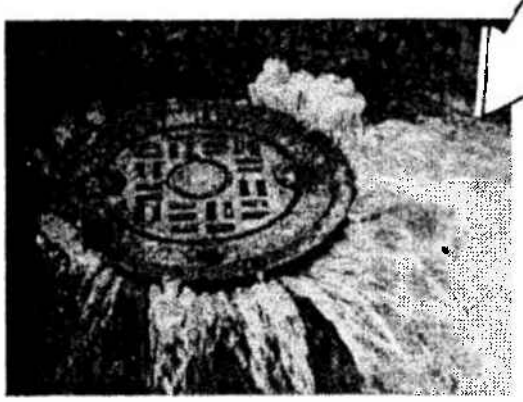
6. MANHOLE & MANHOLE COVER. A structure, usually found in a street, parking area, or sidewalk, that is used to provide access to the main underground sewer lines.

7. COLLECTION SYSTEM. The series of progressively larger pipes through which sewage is carried from homes and businesses to a treatment plant. The collection system includes service laterals and the main sewer lines.

SANITARY SEWER OVERFLOWS



What are they?
Why are they a problem?
What can we do about them?



A Citizens Guide

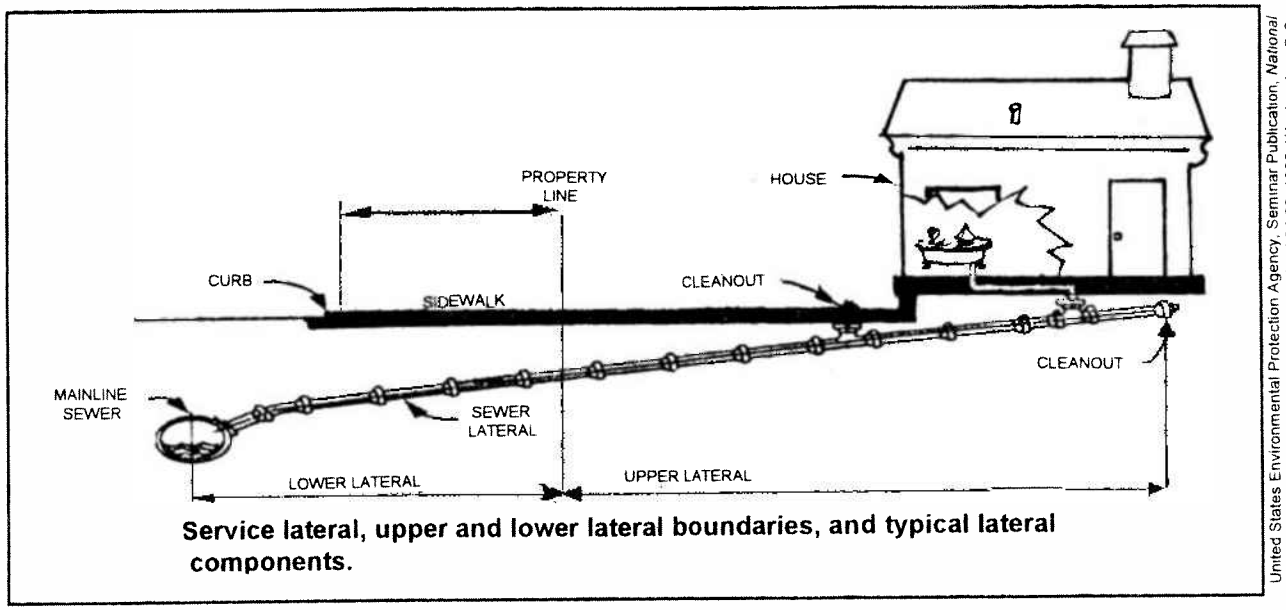
What is a Separate Sanitary Sewer and what is its purpose?

A *Separate Sanitary Sewer* collects and carries household and industrial sewage from individual buildings such as homes and commercial businesses through a series of progressively larger sewer pipes called the *collection system*. A *separate* sanitary sewer system is different from a *combined* system, which carries sewage and storm water runoff together. Separate sanitary sewer systems are not designed to carry rain water.

The primary purpose of a separate sanitary sewer is to protect public health and the environment. Raw sewage contains disease-causing organisms, which can make people sick if they become directly exposed. Raw sewage also can contain toxic chemicals and offensive odors. The sanitary sewer system carries the raw sewage away from homes and businesses to a treatment plant, where most of the harmful organisms are destroyed, odors are controlled, and the level of toxic chemicals is reduced.

Why are Sanitary Sewer Overflows a public health, environmental and economic problem?

Sanitary Sewer Overflows (SSOs) occur when raw or partially diluted sewage is discharged from a sewer collection system before it reaches the sewage treatment plant. SSOs threaten public health because they can cause people to be directly exposed to disease-causing germs called *pathogens*, such as *E. coli* and *Cryptosporidium*, which are present in sewage. SSOs also can have negative impacts on the natural environment, causing poor water quality in lakes, rivers and streams, and polluting groundwater, which may be used for drinking water purposes. SSOs can cause economic damage as well, hurting water-dependent businesses, such as commercial fishing and tourism. SSOs that result in basement flooding not only are unhealthy, but also are extremely unpleasant and costly to clean up. Where these chronically occur, property values may be reduced.



Service lateral, upper and lower lateral boundaries, and typical lateral components.

United States Environmental Protection Agency, Seminar Publication, *National Conference on Sanitary Sewer Overflows* April 24-26, 1995, Washington D C

How might you be contributing to the problem of SSOs?

Many property owners are not aware that the maintenance of the sewer line connection between a home or a business (i.e. "upper lateral" in figure) and the main sewer line in the street usually is their responsibility. When poorly constructed or improperly maintained, these connections, called *service laterals,* frequently cause raw sewage to back up in basements.

The connection of roof-gutter downspouts or sump-pump drains directly to the service lateral adds excess water to the main sewer lines, and can contribute to raw sewage being discharged into the streets (**SSO**) and other public areas. Homes and small businesses, such as restaurants, can contribute to SSOs by disposing grease into the sewer line. When grease cools, it can form blockages, which then cause the sewer to overflow.

What should you do when you identify an SSO?

Make sure that people are kept away from the area of the overflow, typically a *manhole* cover. This is especially important for children and pets who may play near the overflow area (e.g. street, public park, or local stream). Report the sewer overflow immediately to the local health department, the sewer operator, and the state environmental agency. Precautions then can be taken by them to reduce the risk of public exposure to raw sewage by monitoring the impact of the overflow and ensuring proper cleanup.

What can you do to prevent and reduce SSOs?

You can prevent and reduce SSOs if you:

- ✓ **Make sure the basement sump pump does not connect to your sewage drain pipes or to a sink or floor drain in your basement.** Such connections are illegal. The water from these pumps can overload the sewer, causing it to overflow raw sewage into a stream, the street, or someone else's basement.

- ✓ **Inspect the gutters** on your house or business to see if the downspout connects to a sewer line. Such connections are illegal in many communities. **If the gutters are connected to the sewer line, have them disconnected—the runoff water from the roof can contribute to an SSO.**

2008

What Restaurant and Building Owners Need to Know About Grease Traps or Interceptors

Restaurants, large buildings, such as apartment complexes; and other commercial establishments may have grease traps or interceptors that keep grease out of the sewer system. For a grease trap or interceptor to work correctly, it must be properly

1. **Designed (sized and manufactured to handle the amount that is expected),**
2. **Installed (level, vented, etc.), and**
3. **Maintained (cleaned and serviced on a frequent basis).**

Solids should never be put into grease traps or interceptors. Routine, often daily, maintenance of grease traps and interceptors is needed to ensure that they properly reduce or prevent blockages.

Be cautious of chemicals and additives (including soaps and detergents) that claim to dissolve grease. Some of these additives simply pass grease down pipes where it can clog the sewer lines in another area.

This brochure was prepared under Cooperative Agreement Assistance #CX824505-01-0 between the Water Environment Federation (WEF) and the U.S. Environmental Protection Agency. For more information, contact your local sewer system authority or the

Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1004
Phone: 703/684-2400
Fax: 703/684-2492
Web site: http://www.wef.org

For additional copies of this brochure, contact WEF at 1-800-666-0206, 1-703-684-2452 or http://www.wef.org

Water Environment Federation®

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Fat-Free Sewers

How to Prevent Fats, Oils, and Greases from Damaging Your Home and the Environment

Fats, Oils, and Greases aren't just bad for your arteries and your waistline; they're bad for sewers, too.

Sewer overflows and backups can cause health hazards, damage home interiors, and threaten the environment. An increasingly common cause of overflows is sewer pipes blocked by grease. Grease gets into the sewer from household drains as well as from poorly maintained grease traps in restaurants and other businesses.

Where does the grease come from?

Most of us know grease as the byproduct of cooking. Grease is found in such things as:

- Meat fats
- Lard
- Cooking oil
- Shortening
- Butter and margarine
- Food scraps
- Baking goods
- Sauces
- Dairy products

Too often, grease is washed into the plumbing system, usually through the kitchen sink. Grease sticks to the insides of sewer pipes (both on your property and in the streets). Over time, the grease can build up and block the entire pipe.

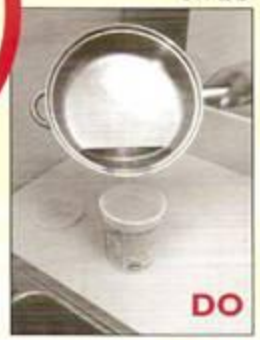
Home garbage disposals do not keep grease out of the plumbing system. These units only shred solid material into smaller pieces and do not prevent grease from going down the drain.

Commercial additives, including detergents, that claim to dissolve grease may pass grease down the line and cause problems in other areas.

© James L. Graham, Jr., P.E.

The results can be:

- Raw sewage overflowing in your home or your neighbor's home;
- An expensive and unpleasant cleanup that often must be paid for by **you, the homeowner;**
- Raw sewage overflowing into parks, yards, and streets;
- Potential contact with disease-causing organisms; and
- An increase in operation and maintenance costs for local sewer departments, which causes higher sewer bills for customers.



© NYCDEP

What we can do to help

The easiest way to solve the grease problem and help prevent overflows of raw sewage is to keep this material out of the sewer system in the first place.

There are several ways to do this.

1) Never pour grease down sink drains or into toilets.
2) Scrape grease and food scraps from trays, plates, pots, pans, utensils, and grills and cooking surfaces into a can or the trash for disposal (or recycling where available).
3) Do not put grease down garbage disposals. Put baskets/strainers in sink drains to catch food scraps and other solids, and empty the drain baskets/strainers into the trash for disposal.
4) Speak with your friends and neighbors about the problem of grease in the sewer system and how to keep it out. Call your local sewer system authority if you have any questions.

2009

Water Environment Federation®
Preserving & Enhancing the Global Water Environment

601 Wythe Street
Alexandria, Virginia
22314-1994 USA
Tel. 1-800-666-0206
Fax. 1-703-684-2492
www.wef.org

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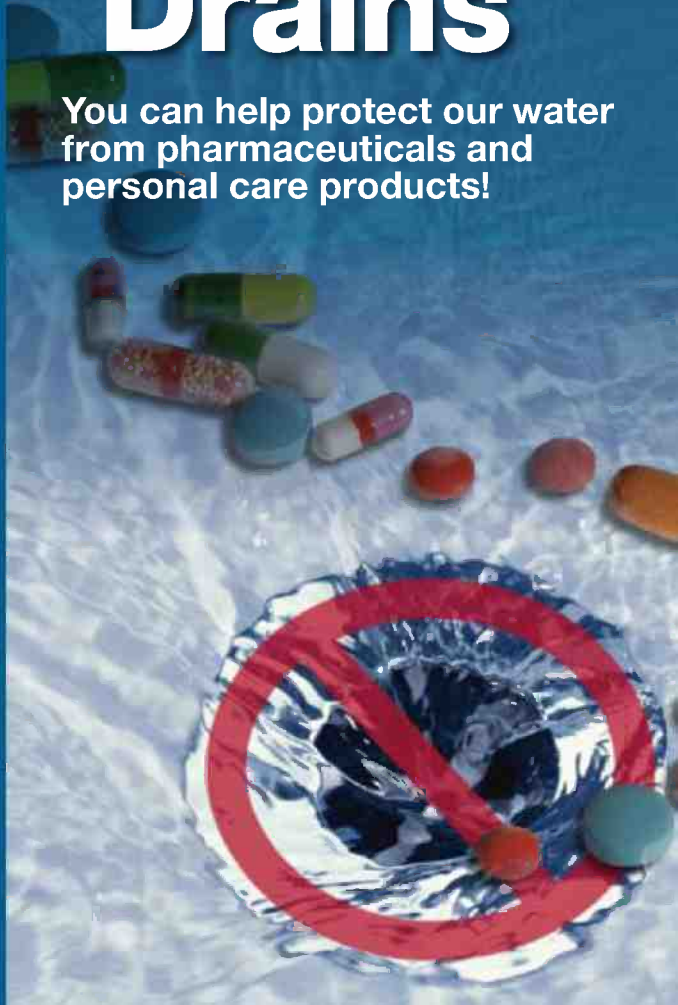
HS1802 6/2008

Drug-Free Drains

You can help protect our water from pharmaceuticals and personal care products!



You can help

protect our water from pharmaceuticals and personal care products!

Every day the average adult uses nine personal care products that contain 126 unique compounds that could end up in our water. In addition to traces of products like shampoo, toothpaste, sunscreen, and cosmetics, minute amounts of prescription and over-the-counter drugs also make their way into water. They should be limited or prevented from entering our environment.

Due to our increased use of these products and greater analytical sensitivity, very tiny amounts of compounds and drugs can be detected in conventional treatment plant outflow and end up in creeks, streams, and rivers. While there is no evidence these traces pose a risk to human health, scientists can sometimes find interference with aquatic organisms, and studies continue. Meanwhile, it's prudent to control what we put into water, and everyone's help is important.

In addition to following product recommendations for use and disposal and decreasing use when possible, you can help keep water clean by simply not flushing unused medication down the toilet! Controlling what goes down the drain is the easiest and most effective way to protect the environment, and you can start today!

Help keep our drains drug-free!

For more information on how to dispose of household products, please visit:

http://www.wef.org/AboutWater/ForThePublic/FactSheets/FactSheetDocuments/HouseholdWaste.htm

Visit the White House Office of National Drug Control Policy consumer guidance for the Proper Disposal of Prescription Drugs at

http://www.whitehousedrugpolicy.gov/drugfact/factsht/proper_disposal.html

Every year Delaware County residents pay millions of dollars to treat rainwater in the sanitary sewer systems!

That's tens of thousands of dollars wasted each week and it's paid for through your sewer fees!

Your sewer lateral is the pipe from your house to the sewer main in your street. You own the sewer lateral under your yard.

Leaky sewer laterals, connected downspouts, and sump pumps allow rainwater to enter the sanitary sewer system.

Once that rainwater mixes with the sewage, it must be treated at the sewage treatment plant.

You are responsible for properly maintaining your sewer lateral to stop rainwater from entering the sanitary sewer system.

A well-maintained lateral protects public health and the environment and can help you save money.

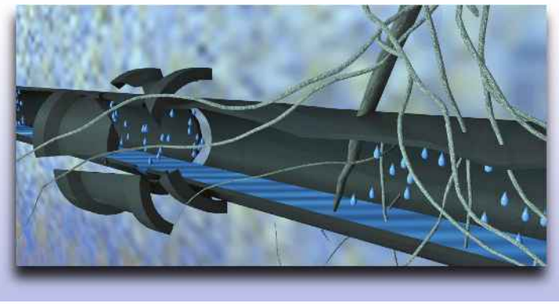
Sewer laterals need to be inspected periodically. If you have not inspected, repaired, or replaced your lateral, it could be failing.

Failing laterals have old-age cracks, loose pipe joints, and tree roots, which let rainwater into the sewer system.

Rainwater also enters the lateral through connected downspouts, basement sump pumps, foundation drains, and driveway drains.

When rainwater is allowed into your lateral, the sewer mains can overload, leading to a backup of raw sewage in basements.

Sewage is foul smelling, very difficult to clean up, and it can make your family very sick. It is a nightmare if sewage backs up into a house, damaging furniture, children's toys, irreplaceable family photos, or an entertainment/recreational area.



DELCORA
100 East Fifth Street
P.O. Box 999
Chester, PA 19016-0999

Stop Throwing Money down the Drain!

How to Safeguard your Home, Community, and Environment

SEWAGE TREATMENT PLANTS ARE DESIGNED TO TREAT THE WASTEWATER FROM THE HOMES, BUSINESSES, AND INDUSTRIES IN YOUR COMMUNITY. BUT WHEN CONNECTED DOWNSPOUTS, SUMP PUMPS, AND LEAKY LATERALS LET RAINWATER INTO THE SYSTEM, THE EXTRA WATER CAN OVERLOAD THE SEWAGE TREATMENT FACILITY.

If extra water overwhelms the treatment facility, raw sewage may overflow manholes into the streets.

Raw sewage may even be discharged from the treatment facility directly into streams and rivers in your community.

Raw sewage in public areas can make people very sick! And raw sewage in creeks and streams is an environmental disaster!

A QUALIFIED PLUMBER CAN FIND PROBLEMS IN YOUR SEWER LATERAL AND HELP FIND ANY IMPROPER CONNECTIONS USING ONE OF THE FOLLOWING TECHNIQUES:

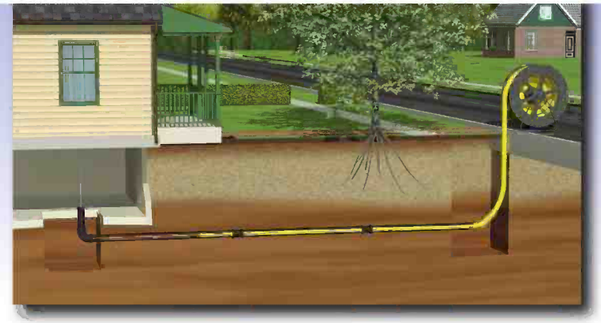
- **Visual inspection** - A special camera is pushed through your lateral. The plumber can view the lateral's interior on a video screen and see any problems.

- **Dye testing** - A non-toxic dye is dripped into locations around your house, including downspouts and the soil above the lateral. Dye appearing in nearby manholes indicates problems.

- **Smoke testing** - A special, non-toxic smoke is pumped from the sewer main into your lateral and monitored to see where the smoke appears. Smoke escaping from the pipe up through the ground indicates a break in the pipe. Smoke escaping from the downspout indicates an improper connection.

IF A DOWNSPOUT OR SUMP PUMP IS CONNECTED TO YOUR LATERAL, YOU MUST HAVE IT DISCONNECTED.

IF YOUR LATERAL HAS CRACKS, LOOSE PIPE JOINTS, OR TREE ROOTS, YOU MUST HAVE IT REPAIRED OR REPLACED.



YOU CAN HAVE YOUR LATERAL REPAIRED IN SEVERAL WAYS:

- **Open cut excavation** is the traditional method of digging out your lateral for removal and replacement.

- **Slip lining** (pictured left) does not require extensive excavation. A winch pulls a flexible, liner pipe into place inside your existing pipe.

- **Pipe bursting** is like slip lining except a small, metal ram is pulled through your existing pipe. The ram breaks the pipe and pushes the pieces into the soil, pulling a new pipe into place behind it.

- **CIPP (cured-in-place pipe)** involves a felt tube, saturated with glue, being inflated inside your existing damaged pipe. Once the glue has set, the felt tube liner is left in place and the repair is complete.

AS LATERALS AGE WITHOUT BEING INSPECTED OR REPAIRED, THE COST GOES UP TO TREAT RAINWATER AND THE CHANCE INCREASES FOR A SEWAGE BACKUP IN YOUR BASEMENT.

Everyone knows how important it is to maintain your property and home. It is just as important to maintain your sewer lateral even though you cannot see it.

You must inspect your sewer lateral to ensure that you are not contributing to the problem.

The Delaware County Regional Water Quality Control Authority (DELCORA) exists to protect and improve the quality of life of our communities.

For more information, contact:

DELCORA
100 East Fifth Street
P.O. Box 999
Chester, PA 19016-0999

Or
Your Local Sewer Agency
You may find the address on your sewer bill or in the phonebook

OR WATCH A FREE VIDEO ON THE INTERNET: WWW.DELCORA.ORG

Function of Sump Pumps & Downspouts

Rainwater can enter the basement through many sources. The job of a sump pump is to divert the water from inside your basement to a location outside of the house. A sump pump is usually installed in a sump pit which stores the water. When this water reaches a certain level, it triggers the sump pump which pumps the water back outside, away from the house. A downspout's purpose is to direct water from the roof gutters away from the house.

The Problem of Inflow

Inflow is caused by improperly connected foundation (footing) drains, sump pumps, and downspouts. Instead of directing the clear rain water outside and away from the house, it directs the water into the sanitary sewer system. Inflow is a problem because it creates an extra water burden for the sanitary sewer system, and when this system is overloaded, sewage can back up into our streets, buildings, and your home. It also means that our utility bills are higher because we are collectively paying for the unnecessary treatment of clean water!

Rules and Regulations

Inflow is a problem for all of Delaware County's communities and sanitary sewer systems. All municipalities have adopted ordinances which make it illegal to have improper connections to the sanitary sewer. Fees and other enforcement measures can be used to achieve compliance. To avoid fines make sure your sump pumps and downspouts discharge properly.

Homeowners have an impact on preventing or causing the problem of inflow. Your community and neighbors are relying on you to take responsibility for making sure that your connections are not contributing to the problem.

For more information regarding what is being done about inflow in your community, contact your local municipality or sewer author-

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
100 EAST FIFTH STREET
CHESTER, PA 19013
WWW.DELCORA.ORG
610-876-5523

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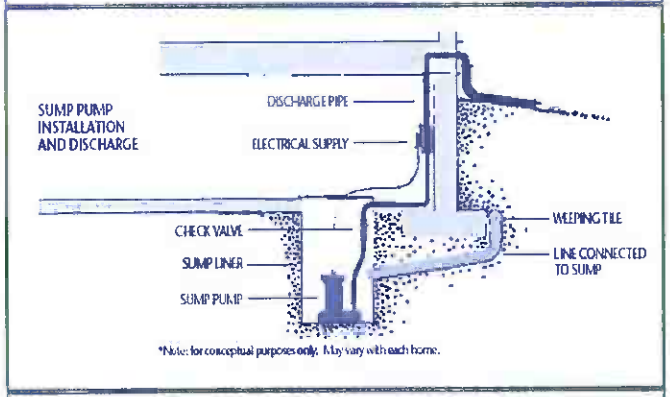
FARIBAULT COUNTY
SOIL AND WATER CONSERVATION DISTRICT
BLUE EARTH, MN 56013
www.faribaultcountyswcd.com

Disconnecting & Redirecting Your Sump Pump & Downspouts

In wet weather it only takes a few improperly connected sump pumps to cause a sanitary sewer backup into basements, streets and waterways.

How Do I Know If My Sump Pump Is Improperly Connected?

Your sump pump is improperly connected to the sanitary sewer if it is connected to the drain or sink in your basement. Unless you are sure your basement drain is not connected to the sanitary sewer, your sump pump is probably improperly connected.



Proper sump pump discharge connections are to the outside of the house only!

How Do I Know If My Downspout Is Improperly Connected?

If your downspouts disappear into the ground rather than discharging into your yard, they may be connected to the sanitary sewer. While connections to the *storm* sewer are permitted, connections to the *sanitary* sewer must be disconnected and redirected.

Downspouts that look like this could be connected to the sanitary sewer.

Disconnecting Your Sump Pump

If your sump pump discharges to the sanitary system in any way, the discharge must be re-directed out of the sanitary sewer system. The change could be as simple as directing the discharge outside the house through a hose. If you aren't familiar with the work, contact a plumbing professional, your local municipality, or your sewer authority for more information.

Each household or business that redirects their stormwater out of the sanitary sewer helps solve the problem of sewage backing up into basements, streets, and waterways.

Disconnecting Your Downspout

Disconnecting your downspout from the sanitary sewer is easy to do yourself.

1. Cut the downspout, leaving enough space to insert the elbow.

2. Tightly cap the end of the pipe sticking out of the ground that leads to the sanitary sewer.

3. Attach an elbow to the end of the downspout and use an appropriate extension to direct the water away from your home.

Where Should I Direct the Flow of My Disconnected Sump Pump and Downspout?

Water should be discharged away from your house or it may seep back into your basement. It should flow to an area where it can seep into the ground or be stored for later use. Direct flow to:

Raingarden

Lawn

Trees

Rain Barrel

Never direct stormwater into a sanitary sewer or onto a neighboring property!

ATTACHMENT B3

SAMPLE PRESS RELEASE

August 18, 2015

DELCORA Enters Agreement with EPA to Invest in Major Infrastructure Improvements in City of Chester

Authority will seek to reduce overflows from City's combined wastewater system

Chester, PA - The Delaware County Regional Water Quality Control Authority (DELCORA) announced today that is has entered into a settlement agreement with the Environmental Protection Agency (EPA) to make improvements to the combined sewer and stormwater drainage system in the City of Chester to address issues related to the overflow of the system during high rain events.

Under the consent decree, negotiated in good faith by and between DELCORA and the EPA, DELCORA has 42 months to develop a long-term plan to control and reduce overflows from the City of Chester's combined sewer and stormwater system and 20 years to implement the plan. Contrary to public reports stating the project could cost up to $200 million, DELCORA said it has not determined the cost of the long-term control plan and would be unable to do so for up to another three years when development of the plan is completed.

DELCORA inherited Chester's antiquated system in 1971 when it took over the operations of wastewater treatment from the City. The system was constructed in the early 1900s and the combined sewer system – which includes one pipe that combines both sewer and stormwater runoff – was a typical engineering practice at the time in urban areas.

When DELCORA assumed control of the system in the 1970s, discharges from the system were in compliance with the agency's permits, but as new technologies have developed in recent years, the EPA has become more stringent in its interpretation of the Clean Water Act as it relates to combined sewer systems. Over the past several years, the EPA has entered into consent decrees and issued civil penalties for wastewater systems in many urban communities in Pennsylvania and across the country, including Philadelphia, Williamsport, Scranton, Harrisburg, and Pittsburgh.

Currently, the City of Philadelphia is in the process of implementing a $2 billion long-term control plan following its consent decree with the EPA. DELCORA is funding $178 million over 15 years for the improvements because part of its wastewater system flows into the City's system.

"We take our commitment to the environment and our customers very seriously," said Robert Willert, Executive Director of DELCORA. "During a 10-year period, from 1999 to 2009 DELCORA developed a long-term control plan and invested $5 million in infrastructure improvements to address the issues of overflows during rain events that impacted the combined wastewater system in Chester."

Willert said that the $5 million infrastructure investment included upgrades to regulators, which control the flow and discharge of wastewater during rain events. DELCORA also paid the City of Chester $750,000 to put in place new storm water inlets on city streets that help stop trash and debris from flowing into the combined system, which could lead to backups and the unnecessary discharge of wastewater from the system.

Willert noted that industrial wastewater is kept separate from the combined system and that DELCORA has worked to mitigate the problem by requiring that new projects – such as PPL Park and the reconstruction of Route 291 – divert water to a separate stormwater system that is distinct from the combined system that exists throughout most of Chester.

DELCORA has brought on a team of experts to help develop the long-term control plan, including an engineering firm that specializes in the issue of combined wastewater systems and a municipal and financial service firm to help develop a rate model for customers to fund the needed improvements. Under the consent decree with the EPA, DELCORA will also pay a $1.375 million penalty to the state and federal government.

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal authority that owns, operates, and maintains wastewater facilities that serve approximately 500,000 people in the greater Philadelphia area, including 42 municipalities in Delaware and Chester Counties.

ATTACHMENT B4

DELCORA'S CSO LTCPU WEBSITE
(Sample Screen Shot)

DELCORA

Providing environmentally responsible and cost-effective wastewater management services to the citizens, businesses, and industries of Southeastern PA.

Pay Sewer Bill | Open Bids | Right to Know | FAQs | Combined Sewer System

About DELCORA

Delaware County residents and businesses generate over 100 million gallons of wastewater every day. This wastewater must be collected, conveyed, and treated in a safe, effective way to prevent the contamination of our community's streams, rivers, and general water supply. DELCORA has been providing this vital function to our communities for over three decades. As a result, the citizens of our region enjoy clean, healthy water.

News & Events

DELCORA Enters Agreement with EPA

August 18, 2015 Chester, PA – The Delaware County Regional Water Quality Control Authority (DELCORA) announced today that it has entered into a settlement agreement with the Environmental Protection Agency (EPA) to make improvements to the combined sewer and stormwater drainage system in the City of Chester to address issues related to the overflow of the system during […]

Read More

Edgmont's public sewer system to be finished in fall

By Susan L. Serbin, Times Correspondent The public sewer system along the West Chester Pike and Providence Road corridors is in the final stages of construction, with activities continuing through the summer months and into the early fall. After years on a wish list, supervisors put into action a comprehensive plan for a build out […]

Read More

Administration Building
100 East Fifth Street
Chester, PA 19013

Wastewater Treatment Plant
3201 West Front Street
Chester, PA 19013

Combined Sewer System

DELCORA CSO LTCP
DELCORA CSO Areas
Public Participation Plan
Public Meetings
CSO Monitoring
Resources
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Right to Know
FAQs
Combined Sewer System

Combined Sewer System

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies.

These overflows, called combined sewer overflows (CSOs), contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris. They are a major water pollution concern for the approximately 772 cities in the U.S. that have combined sewer systems.

For more information contact us.

Administration Building
100 East Fifth Street
Chester, PA 19013

Wastewater Treatment Plant
3201 West Front Street
Chester, PA 19013

ATTACHMENT C

PENNSYLVANIA SUNSHINE ACT

As amended September 5, 2011

Pennsylvania's Sunshine Act

Act of October 15, 1998, P.L. 729, No. 93
as amended by Act of July 15, 2004, P.L. 743, No. 88
As amended by Act of June 30, 2011, No. 56

65 Pa.C.S.A. § 701 et seq.

An act requiring public agencies to hold certain meetings and hearings open to the public; and providing penalties.

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The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

Section 701. Short title of chapter

This chapter shall be known and may be cited as the Sunshine Act.

Section 702. Legislative findings and declaration

(a) **Findings.** The General Assembly finds that the right of the public to be present at all meetings of agencies and to witness the deliberation, policy formulation and decisionmaking of agencies is vital to the enhancement and proper functioning of the democratic process and that secrecy in public affairs undermines the faith of the public in government and the public's effectiveness in fulfilling its role in a democratic society.

(b) **Declarations.** The General Assembly hereby declares it to be the public policy of this Commonwealth to insure the right of its citizens to have notice of and the right to attend all meetings of agencies at which any agency business is discussed or acted upon as provided in this chapter.

Section 703. Definitions

The following words and phrases when used in this chapter shall have the meanings given to them in this section unless the context clearly indicates otherwise:

"Administrative action." The execution of policies relating to persons or things as previously authorized or required by official action of the agency adopted at an open meeting of the agency. The term does not, however, include the deliberation of agency business.

"Agency." The body, and all committees thereof authorized by the body to take official action or render advice on matters of agency business, of all the following: the General Assembly, the executive branch of the government of this Commonwealth, including the Governor's Cabinet when meeting on official policymaking business, any board, council, authority or commission of the Commonwealth or of any political subdivision of the Commonwealth or any State, municipal, township or school authority, school board, school governing body, commission, the boards of trustees of all State-aided colleges and universities, the councils of trustees of all State-owned colleges and universities, the boards of trustees of all State-related universities and all community colleges or similar organizations created by or pursuant to a statute which declares in substance that the organization performs or has for its purpose the performance of an essential governmental function and through the joint action of its members exercises

governmental authority and takes official action. The term shall include the governing board of any nonprofit corporation which by a mutually binding legal written agreement with a community college, or State-aided, State-owned or State-related institution of higher education is granted legally enforceable supervisory and advisory powers regarding the degree programs of the institution of higher education. The term does not include a caucus or a meeting of an ethics committee created under rules of the Senate or House of Representatives.

"Agency business." The framing, preparation, making or enactment of laws, policy or regulations, the creation of liability by contract or otherwise or the adjudication of rights, duties and responsibilities, but not including administrative action.

"Caucus." A gathering of members of a political party or coalition which is held for purposes of planning political strategy and holding discussions designed to prepare the members for taking official action in the General Assembly.

"Conference." Any training program or seminar, or any session arranged by State or Federal agencies for local agencies, organized and conducted for the sole purpose of providing information to agency members on matters directly related to their official responsibilities.

"Deliberation." The discussion of agency business held for the purpose of making a decision.

"Emergency meeting." A meeting called for the purpose of dealing with a real or potential emergency involving a clear and present danger to life or property.

"Executive session." A meeting from which the public is excluded, although the agency may admit those persons necessary to carry out the purpose of the meeting.

"Litigation." Any pending, proposed or current action or matter subject to appeal before a court of law or administrative adjudicative body, the decision of which may be appealed to a court of law.

"Meeting." Any prearranged gathering of an agency which is attended or participated in by a quorum of the members of an agency held for the purpose of deliberating agency business or taking official action.

"Official action."

(1) Recommendations made by an agency pursuant to statute, ordinance or executive order.

(2) The establishment of policy by an agency.

(3) The decisions on agency business made by an agency.

(4) The vote taken by any agency on any motion, proposal, resolution, rule, regulation, ordinance, report or order.

"Political subdivision." Any county, city, borough, incorporated town, township, school district, intermediate unit, vocational school district or county institution district.

"Public notice."

(1) For a meeting:

(i) Publication of notice of the place, date and time of a meeting in a newspaper of general circulation, as defined by 45 Pa.C.S. Â§ 101 (relating to definitions), which is published and circulated in the political subdivision where the meeting will be held, or in a newspaper of general circulation which has a bona fide paid circulation in the political subdivision equal to or greater than any newspaper published in the political subdivision.

(ii) Posting a notice of the place, date and time of a meeting prominently at the principal office of the agency holding the meeting or at the public building in which the meeting is to be held.

(iii) Giving notice to parties under section 709(c) (relating to public notice).

(2) For a recessed or reconvened meeting:

(i) Posting a notice of the place, date and time of the meeting prominently at the principal office of the agency holding the meeting or at the public building in which the meeting is to be held.

(ii) Giving notice to parties under section 709(c).

"Special meeting." A meeting scheduled by an agency after the agency's regular schedule of meetings has been established.

Section 704. Open meetings

Official action and deliberations by a quorum of the members of an agency shall take place at a meeting open to the public unless closed under section 707 (relating to exceptions to open meetings), 708 (relating to executive sessions) or 712 (relating to General Assembly meetings covered).

Section 705. Recording of votes

In all meetings of agencies, the vote of each member who actually votes on any resolution, rule, order, regulation, ordinance or the setting of official policy must be publicly cast and, in the case of roll call votes, recorded.

Section 706. Minutes of meetings, public records and recording of meetings

Written minutes shall be kept of all open meetings of agencies. The minutes shall include:

(1) The date, time and place of the meeting.

(2) The names of members present.

(3) The substance of all official actions and a record by individual member of the roll call votes taken.

(4) The names of all citizens who appeared officially and the subject of their testimony.

Section 707. Exceptions to open meetings

(a) **Executive session**. An agency may hold an executive session under section 708 (relating to executive sessions).

(b) **Conference**. An agency is authorized to participate in a conference which need not be open to the public. Deliberation of agency business may not occur at a conference.

(c) **Certain working sessions**. Boards of auditors may conduct working sessions not open to the public for the purpose of examining, analyzing, discussing and deliberating the various accounts and records with respect to which such boards are responsible, so long as official action of a board with respect to such records and accounts is taken at a meeting open to the public and subject to the provisions of this chapter.

Section 708. Executive sessions

(a) **Purpose**. An agency may hold an executive session for one or more of the following reasons:

(1) To discuss any matter involving the employment, appointment, termination of employment, terms and conditions of employment, evaluation of performance, promotion or disciplining of any specific prospective public officer or employee or current public officer or employee employed or appointed by the agency, or former public officer or employee, provided, however, that the individual employees or appointees whose rights could be adversely affected may request, in writing, that the matter or matters be discussed at an open meeting. The agency's decision to discuss such matters in executive session shall not serve to adversely affect the due process rights granted by law, including those granted by Title 2 (relating to administrative law and procedure). The provisions of this paragraph shall not apply to any meeting involving the appointment or selection of any person to fill a vacancy in any elected office.

(2) To hold information, strategy and negotiation sessions related to the negotiation or arbitration of a collective bargaining agreement or, in the absence of a collective bargaining unit, related to labor relations and arbitration.

(3) To consider the purchase or lease of real property up to the time an option to purchase or lease the real property is obtained or up to the time an agreement to purchase or lease such property is obtained if the agreement is obtained directly without an option.

(4) To consult with its attorney or other professional advisor regarding information or strategy in connection with litigation or with issues on which identifiable complaints are expected to be filed.

(5) To review and discuss agency business which, if conducted in public, would violate a lawful privilege or lead to the disclosure of information or confidentiality protected by law, including matters related to the initiation and conduct of investigations of possible or certain violations of the law and quasi-judicial deliberations.

(6) For duly constituted committees of a board or council of trustees of a State-owned, State-aided or State-related college or university or community college or of the Board of Governors of the State System of Higher Education to discuss matters of academic admission or standings.

(b) **Procedure.** The executive session may be held during an open meeting, at the conclusion of an open meeting, or may be announced for a future time. The reason for holding the executive session must be announced at the open meeting occurring immediately prior or subsequent to the executive session. If the executive session is not announced for a future specific time, members of the agency shall be notified 24 hours in advance of the time of the convening of the meeting specifying the date, time, location and purpose of the executive session.

(c) **Limitation.** Official action on discussions held pursuant to subsection (a) shall be taken at an open meeting. Nothing in this section or section 707 (relating to exceptions to open meetings) shall be construed to require that any meeting be closed to the public, nor shall any executive session be used as a subterfuge to defeat the purposes of section 704 (relating to open meetings).

Section 709. Public notice

(a) **Meetings.** An agency shall give public notice of its first regular meeting of each calendar or fiscal year not less than three days in advance of the meeting and shall give public notice of the schedule of its remaining regular meetings. An agency shall give public notice of each special meeting or each rescheduled regular or special meeting at least 24 hours in advance of the time of the convening of the meeting specified in the notice. Public notice is not required in the case of an emergency meeting or a conference. Professional licensing boards within the Bureau of Professional and Occupational Affairs of the Department of State of the Commonwealth shall include in the public notice each matter involving a proposal to revoke, suspend or restrict a license.

(b) **Notice**. With respect to any provision of this chapter that requires public notice to be given by a certain date, the agency, to satisfy its legal obligation, must give notice in time to allow it to be published or circulated within the political subdivision where the principal office of the agency is located or the meeting will occur before the date of the specified meeting.

(c) **Copies**. In addition to the public notice required by this section, the agency holding a meeting shall supply, upon request, copies of the public notice thereof to any newspaper of general circulation in the political subdivision in which the meeting will be held, to any radio or television station which regularly broadcasts into the political subdivision and to any interested parties if the newspaper, station or party provides the agency with a stamped, self-addressed envelope prior to the meeting.

(d) **Meeting of the General Assembly in Capitol Complex**. Notwithstanding any provision of this section to the contrary, in case of sessions of the General Assembly, all meetings of legislative committees held within the Capitol Complex where bills are considered, including conference committees, all legislative hearings held within the Capitol Complex where testimony is taken and all meetings of legislative commissions held within the Capitol Complex, the requirement for public notice thereof shall be complied with if, not later than the preceding day:

(1) The supervisor of the newsroom of the State Capitol Building in Harrisburg is supplied for distribution to the members of the Pennsylvania Legislative Correspondents Association with a minimum of 30 copies of the notice of the date, time and place of each session, meeting or hearing.

(2) There is posting of the copy of the notice at public places within the Main Capitol Building designated by the Secretary of the Senate and the Chief Clerk of the House of Representatives.

(e) **Announcement**. Notwithstanding any provision of this chapter to the contrary, committees may be called into session in accordance with the provisions of the Rules of the Senate or the House of Representatives and an announcement by the presiding officer of the Senate or the House of Representatives. The announcement shall be made in open session of the Senate or the House of Representatives.

Section 710. Rules and regulations for conduct of meetings

Nothing in this chapter shall prohibit the agency from adopting by official action the rules and regulations necessary for the conduct of its meetings and the maintenance of order. The rules and regulations shall not be made to violate the intent of this chapter.

Section 710.1 Public participation

(a) **General rule**. Except as provided in subsection (d), the board or council of a political subdivision, or of an authority created by a political subdivision shall provide a reasonable opportunity at each advertised regular meeting and advertised special meeting for residents of the political subdivision or of the authority created by a political subdivision or for taxpayers of the political subdivision or of the authority created by a political subdivision or for both, to comment on matters of concern, official action or deliberation which are or may be before the board or council prior to taking official action. The board or council has the option to accept all public comment at the beginning of the meeting. If the board or council determines that there is not sufficient time at a meeting for residents of the political subdivision or of the authority created by a political

subdivision or for taxpayers of the political subdivision or of the authority created by the political subdivision or for both to comment, the board or council may defer the comment period to the next regular meeting or to a special meeting occurring in advance of the next regular meeting.

(b) **Limitation on judicial relief**. If a board or council of a political subdivision or an authority created by a political subdivision has complied with the provisions of subsection (a), the judicial relief under section 713 (relating to business transacted at unauthorized meeting void) shall not be available on a specific action solely on the basis of lack of comment on that action.

(c) **Objection**. Any person has the right to raise an objection at any time to a perceived violation of this chapter at any meeting of a board or council of a political subdivision or an authority created by a political subdivision.

(d) **Exception**. The board or council of a political subdivision or of an authority created by a political subdivision which had, before Jan. 1, 1993, established a practice or policy of holding special meetings solely for the purpose of public comment in advance of advertised regular meetings shall be exempt from the provisions of subsection (a).

Section 711. Use of equipment during meetings

(a) **Recording devices**. Except as provided in subsection (b), a person attending a meeting of an agency shall have the right to use recording devices to record all the proceedings. Nothing in this section shall prohibit the agency from adopting and enforcing reasonable rules for their use under section 710 (relating to rules and regulations for conduct of meetings).

(b) **Rules of the Senate and House of Representatives.** The Senate and House of Representatives may adopt rules governing the recording or broadcast of their sessions and meetings and hearings of committees.

Section 712. General Assembly meetings covered

Notwithstanding any other provision, for the purpose of this chapter, meetings of the General Assembly which are covered are as follows: all meetings of committees where bills are considered, all hearings where testimony is taken and all sessions of the Senate and the House of Representatives. Not included in the intent of this chapter are caucuses or meetings of any ethics committee created pursuant to the Rules of the Senate or the House of Representatives.

Section 713. Business transacted at unauthorized meeting void

A legal challenge under this chapter shall be filed within 30 days from the date of a meeting which is open, or within 30 days from the discovery of any action that occurred at a meeting which was not open at which this chapter was violated, provided that, in the case of a meeting which was not open, no legal challenge may be commenced more than one year from the date of said meeting. The court may enjoin any challenged action until a judicial determination of the legality of the meeting at which the action was adopted is reached. Should the court determine that the meeting did not meet the requirements of this chapter, it may in its discretion find that any or all official action taken at the meeting shall be invalid. Should the court determine that the meeting met the requirements of this chapter, all official action taken at the meeting shall be fully effective.

Section 714. Penalty

(a) **Fines and costs.** Any member of any agency who participates in a meeting with the intent and purpose by that member of violating this chapter commits a summary offense and shall, upon conviction, be sentenced to pay:

(1) For a first offense, the costs of prosecution plus a fine of at least $100 and, in the discretion of the sentencing authority, of not more than $1,000.

(2) For a second or subsequent offense, the costs of prosecution plus a fine of at least $500 and, in the discretion of the sentencing authority, of not more than $2,000.

(b) **Payment.** An agency shall not make a payment on behalf of or reimburse a member of an agency for a fine or cost resulting from the member's violation of this section.

Section 714.1. Attorney fees

If the court determines that an agency willfully or with wanton disregard violated a provision of this chapter, in whole or in part, the court shall award the prevailing party reasonable attorney fees and costs of litigation or an appropriate portion of the fees and costs. If the court finds that the legal challenge was of a frivolous nature or was brought with no substantial justification, the court shall award the prevailing party reasonable attorney fees and costs of litigation or an appropriate portion of the fees and costs.

Section 715. Jurisdiction and venue of judicial proceedings

The Commonwealth Court shall have original jurisdiction of actions involving State agencies and the courts of common pleas shall have original jurisdiction of actions involving other agencies to render declaratory judgements or to enforce this chapter by injunction or other remedy deemed appropriate by the court. The action may be brought by any person where the agency whose act is complained of is located or where the act complained of occurred.

Section 716. Confidentiality

All acts and parts of acts are repealed insofar as they are inconsistent with this chapter, excepting those statutes which specifically provide for the confidentiality of information. Those deliberations or official actions which, if conducted in public, would violate a lawful privilege or lead to the disclosure of information or confidentiality protected by law, including matter related to the investigation of possible or certain violations of the law and quasi-judicial deliberations, shall not fall within the scope of this chapter.

ATTACHMENT D

PA RIGHT-TO-KNOW LAW ACT 3 OF 2008

Pennsylvania's New Right to Know Law

Act 3 of 2008, as signed by Gov. Edward G. Rendell on February 14, 2008
Effective January 1, 2009

AN ACT

Providing for access to public information, for a designated open-records officer in each Commonwealth agency, local agency, judicial agency and legislative agency, for procedure, for appeal of agency determination, for judicial review and for the Office of Open Records; imposing penalties; providing for reporting by State-related institutions; requiring the posting of certain State contract information on the Internet; and making related repeals.

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The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

CHAPTER 1. PRELIMINARY PROVISIONS

Section 101. Short title.

This act shall be known and may be cited as the Right-to-Know Law.

Section 102. Definitions.

The following words and phrases when used in this act shall have the meanings given to them in this section unless the context clearly indicates otherwise:

"Administrative proceeding." A proceeding by an agency the outcome of which is required to be based on a record or documentation prescribed by law or in which a statute or regulation is particularized in application to individuals. The term includes an appeal.

"Agency." A Commonwealth agency, a local agency, a judicial agency or a legislative agency.

"Aggregated data." A tabulation of data which relate to broad classes, groups or categories so that it is not possible to distinguish the properties of individuals within those classes, groups or categories.

"Appeals officer." As follows:

(1) For a Commonwealth agency or a local agency, the appeals officer designated under section 503(a).

(2) For a judicial agency, the individual designated under section 503(b).

(3) For a legislative agency, the individual designated under section 503(c).

(4) For the Attorney General, State Treasurer, Auditor General and local agencies in possession of criminal investigative records, the individual designated under section 503(d).

"Commonwealth agency." Any of the following:

(1) Any office, department, authority, board, multistate agency or commission of the executive branch; an independent agency; and a State-affiliated entity. The term includes:

(i) The Governor's Office.

(ii) The Office of Attorney General, the Department of the Auditor General and the Treasury Department.

(iii) An organization established by the Constitution of Pennsylvania, a statute or an executive order which performs or is intended to perform an essential governmental function.

(2) The term does not include a judicial or legislative agency.

"Confidential proprietary information." Commercial or financial information received by an agency:

(1) which is privileged or confidential; and

(2) the disclosure of which would cause substantial harm to the competitive position of the person that submitted the information.

"Financial record." Any of the following:

(1) Any account, voucher or contract dealing with:

(i) the receipt or disbursement of funds by an agency; or

(ii) an agency's acquisition, use or disposal of services, supplies, materials, equipment or property.

(2) The salary or other payments or expenses paid to an officer or employee of an agency, including the name and title of the officer or employee.

(3) A financial audit report. The term does not include work papers underlying an audit.

"Homeland security." Governmental actions designed to prevent, detect, respond to and recover from acts of terrorism, major disasters and other emergencies, whether natural or manmade. The term includes activities relating to the following:

(1) emergency preparedness and response, including preparedness and response activities by volunteer medical, police, emergency management, hazardous materials and fire personnel;

(2) intelligence activities;

(3) critical infrastructure protection;

(4) border security;

(5) ground, aviation and maritime transportation security;

(6) biodefense;

(7) detection of nuclear and radiological materials; and (8) research on next-generation securities technologies.

"Independent agency." Any board, commission or other agency or officer of the Commonwealth, that is not subject to the policy supervision and control of the Governor. The term does not include a legislative or judicial agency.

"Judicial agency." A court of the Commonwealth or any other entity or office of the unified judicial system.

"Legislative agency." Any of the following:

(1) The Senate.

(2) The House of Representatives.

(3) The Capitol Preservation Committee.

(4) The Center for Rural Pennsylvania.

(5) The Joint Legislative Air and Water Pollution Control and Conservation Committee.

(6) The Joint State Government Commission.

(7) The Legislative Budget and Finance Committee.

(8) The Legislative Data Processing Committee.

(9) The Independent Regulatory Review Commission.

(10) The Legislative Reference Bureau.

(11) The Local Government Commission.

(12) The Pennsylvania Commission on Sentencing.

(13) The Legislative Reapportionment Commission.

(14) The Legislative Office of Research Liaison.

(15) The Legislative Audit Advisory Commission.

"Legislative record." Any of the following relating to a legislative agency or a standing committee, subcommittee or conference committee of a legislative agency:

(1) A financial record.

(2) A bill or resolution that has been introduced and amendments offered thereto in committee or in legislative session, including resolutions to adopt or amend the rules of a chamber.

(3) Fiscal notes.

(4) A cosponsorship memorandum.

(5) The journal of a chamber.

(6) The minutes of, record of attendance of members at a public hearing or a public committee meeting and all recorded votes taken in a public committee meeting.

(7) The transcript of a public hearing when available.

(8) Executive nomination calendars.

(9) The rules of a chamber.

(10) A record of all recorded votes taken in a legislative session.

(11) Any administrative staff manuals or written policies.

(12) An audit report prepared pursuant to the act of June 30, 1970 (P.L.442, No.151) entitled, "An act implementing the provisions of Article VIII, section 10 of the Constitution of Pennsylvania, by designating the Commonwealth officers who shall be charged with the function of auditing the financial transactions after the occurrence thereof of the Legislative and Judicial branches of the government of the Commonwealth, establishing a Legislative Audit Advisory Commission, and imposing certain powers and duties on such commission."

(13) Final or annual reports required by law to be submitted to the General Assembly.

(14) Legislative Budget and Finance Committee reports.

(15) Daily Legislative Session Calendars and marked calendars.

(16) A record communicating to an agency the official appointment of a legislative appointee.

(17) A record communicating to the appointing authority the resignation of a legislative appointee.

(18) Proposed regulations, final-form regulations and final-omitted regulations submitted to a legislative agency.

(19) The results of public opinion surveys, polls, focus groups, marketing research or similar efforts designed to measure public opinion funded by a legislative agency.

"Local agency." Any of the following:

(1) Any political subdivision, intermediate unit, charter school, cyber charter school or public trade or vocational school.

(2) Any local, intergovernmental, regional or municipal agency, authority, council, board, commission or similar governmental entity.

"Office of Open Records." The Office of Open Records established in section 1310.

"Personal financial information." An individual's personal credit, charge or debit card information; bank account information; bank, credit or financial statements; account or PIN numbers and other information relating to an individual's personal finances.

"Privilege." The attorney-work product doctrine, the attorney-client privilege, the doctor-patient privilege, the speech and debate privilege or other privilege recognized by a court interpreting the laws of this Commonwealth.

"Public record." A record, including a financial record, of a Commonwealth or local agency that:

(1) is not exempt under section 708;

(2) is not exempt from being disclosed under any other Federal or State law or regulation or judicial order or decree; or

(3) is not protected by a privilege.

"Record." Information, regardless of physical form or characteristics, that documents a transaction or activity of an agency and that is created, received or retained pursuant to law or in connection with a transaction, business or activity of the agency. The term includes a document, paper, letter, map, book, tape, photograph, film or sound recording, information stored or maintained electronically and a data-processed or image- processed document.

"Requester." A person that is a legal resident of the United States and requests a record pursuant to this act. The term includes an agency.

"Response." Access to a record or an agency's written notice to a requester granting, denying or partially granting and partially denying access to a record.

"Social services." Cash assistance and other welfare benefits, medical, mental and other health care services, drug and alcohol treatment, adoption services, vocational services and training, occupational training, education services, counseling services, workers' compensation services and unemployment compensation services, foster care services, services for the elderly, services for individuals with disabilities and services for victims of crimes and domestic violence.

"State-affiliated entity." A Commonwealth authority or Commonwealth entity. The term includes the Pennsylvania Higher Education Assistance Agency and any entity established thereby, the Pennsylvania Gaming Control Board, the Pennsylvania Game Commission, the Pennsylvania Fish and Boat Commission, the Pennsylvania Housing Finance Agency, the Pennsylvania Municipal Retirement Board, the State System of Higher Education, a community college, the Pennsylvania Turnpike Commission, the Pennsylvania Public Utility Commission, the Pennsylvania Infrastructure Investment Authority, the State Public School Building Authority, the Pennsylvania Interscholastic Athletic Association and the Pennsylvania Educational Facilities Authority. The term does not include a State-related institution.

"State-related institution." Includes:

(1) Temple University.

(2) The University of Pittsburgh.

(3) The Pennsylvania State University.

(4) Lincoln University.

"Terrorist act." A violent or life-threatening act that violates the criminal laws of the United States or any state and appears to be intended to:

(1) intimidate or coerce a civilian population;

(2) influence the policy of a government; or

(3) affect the conduct of a government by mass destruction, assassination or kidnapping.

"Trade secret." Information, including a formula, drawing, pattern, compilation, including a customer list, program, device, method, technique or process that:

(1) derives independent economic value, actual or potential, from not being generally known to and not being readily ascertainable by proper means by other persons who can obtain economic value from its disclosure or use; and

(2) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.

The term includes data processing software obtained by an agency under a licensing agreement prohibiting disclosure.

CHAPTER 3. REQUIREMENTS AND PROHIBITIONS

Section 301. Commonwealth agencies.

(a) Requirement. — A Commonwealth agency shall provide public records in accordance with this act.

(b) Prohibition. — A Commonwealth agency may not deny a requester access to a public record due to the intended use of the public record by the requester unless otherwise provided by law.

Section 302. Local agencies.

(a) Requirement. — A local agency shall provide public records in accordance with this act.

(b) Prohibition. — A local agency may not deny a requester access to a public record due to the intended use of the public record by the requester unless otherwise provided by law.

Section 303. Legislative agencies.

(a) **Requirement.** — A legislative agency shall provide legislative records in accordance with this act.

(b) **Prohibition.** — A legislative agency may not deny a requester access to a legislative record due to the intended use of the legislative record by the requester.

Section 304. Judicial agencies.

(a) **Requirement.** — A judicial agency shall provide financial records in accordance with this act or any rule or order of court providing equal or greater access to the records.

(b) **Prohibition.** — A judicial agency may not deny a requester access to a financial record due to the intended use of the financial record by the requester.

Section 305. Presumption.

(a) **General rule.** — A record in the possession of a Commonwealth agency or local agency shall be presumed to be a public record. The presumption shall not apply if:

(1) the record is exempt under section 708;

(2) the record is protected by a privilege; or

(3) the record is exempt from disclosure under any other Federal or State law or regulation or judicial order or decree.

(b) **Legislative records and financial records.** — A legislative record in the possession of a legislative agency and a financial record in the possession of a judicial agency shall be presumed to be available in accordance with this act. The presumption shall not apply if:

(1) the record is exempt under section 708;

(2) the record is protected by a privilege; or

(3) the record is exempt from disclosure under any other Federal or State law, regulation or judicial order or decree.

Section 306. Nature of document.

Nothing in this act shall supersede or modify the public or nonpublic nature of a record or document established in Federal or State law, regulation or judicial order or decree.

CHAPTER 5. ACCESS

Section 501. Scope of chapter.

This chapter applies to all agencies.

Section 502. Open-records officer.

(a) **Establishment.** —

(1) An agency shall designate an official or employee to act as the open-records officer.

(2) For a legislative agency other than the Senate or the House of Representatives, the open-records officer designated by the Legislative Reference Bureau shall serve as the open-records officer. Notwithstanding paragraph (1), a political party caucus of a legislative agency may appoint an open-records officer under this section.

(b) **Functions.** —

(1) The open-records officer shall receive requests submitted to the agency under this act, direct requests to other appropriate persons within the agency or to appropriate persons in another agency, track the agency's progress in responding to requests and issue interim and final responses under this act.

(2) Upon receiving a request for a public record, legislative record or financial record, the open-records officer shall do all of the following:

(i) Note the date of receipt on the written request.

(ii) Compute the day on which the five-day period under section 901 will expire and make a notation of that date on the written request.

(iii) Maintain an electronic or paper copy of a written request, including all documents submitted with the request until the request has been fulfilled. If the request is denied, the written request shall be maintained for 30 days or, if an appeal is filed, until a final determination is issued under section 1101(b) or the appeal is deemed denied.

(iv) Create a file for the retention of the original request, a copy of the response, a record of written communications with the requester and a copy of other communications. This subparagraph shall only apply to Commonwealth agencies.

Section 503. Appeals officer.

(a) **Commonwealth agencies and local agencies.** — Except as provided in subsection (d), the Office of Open Records established under section 1310 shall designate an appeals officer under section 1101(a)(2) for all:

(1) Commonwealth agencies; and

(2) local agencies.

(b) **Judicial agencies.** — A judicial agency shall designate an appeals officer to hear appeals under Chapter 11.

(c) **Legislative agencies.** —

(1) Except as set forth in paragraph (2), the Legislative Reference Bureau shall designate an appeals officer to hear appeals under Chapter 11 for all legislative agencies.

(2) Each of the following shall designate an appeals officer to hear appeals under Chapter 11:

(i) The Senate.

(ii) The House of Representatives.

(d) **Law enforcement records and Statewide officials.** —

(1) The Attorney General, State Treasurer and Auditor General shall each designate an appeals officer to hear appeals under Chapter 11.

(2) The district attorney of a county shall designate one or more appeals officers to hear appeals under Chapter 11 relating to access to criminal investigative records in possession of a local agency of that county. The appeals officer designated by the district attorney shall determine if the record requested is a criminal investigative record.

Section 504. Regulations and policies.

(a) **Authority.** — An agency may promulgate regulations and policies necessary for the agency to implement this act. The Office of Open Records may promulgate regulations relating to appeals involving a Commonwealth agency or local agency.

(b) **Posting.** — The following information shall be posted at each agency and, if the agency maintains an Internet website, on the agency's Internet website:

(1) Contact information for the open-records officer.

(2) Contact information for the Office of Open Records or other applicable appeals officer.

(3) A form which may be used to file a request.

(4) Regulations, policies and procedures of the agency relating to this act.

Section 505. Uniform form.

(a) **Commonwealth and local agencies.** — The Office of Open Records shall develop a uniform form which shall be accepted by all Commonwealth and local agencies in addition to any form used by the agency to file a request under this act. The uniform form shall be published in the Pennsylvania Bulletin and on the Office of Open Record's Internet website.

(b) **Judicial agencies.** — A judicial agency or the Administrative Office of Pennsylvania Courts may develop a form to request financial records or may accept a form developed by the Office of Open Records.

(c) **Legislative agencies.** — A legislative agency may develop a form to request legislative records or may accept the form developed by the Office of Open Records.

Section 506. Requests.

(a) **Disruptive requests.** —

(1) An agency may deny a requester access to a record if the requester has made repeated requests for that same record and the repeated requests have placed an unreasonable burden on the agency.

(2) A denial under this subsection shall not restrict the ability to request a different record.

(b) **Disaster or potential damage.** —

(1) An agency may deny a requester access:

(i) when timely access is not possible due to fire, flood or other disaster; or

(ii) to historical, ancient or rare documents, records, archives and manuscripts when access may, in the professional judgment of the curator or custodian of records, cause physical damage or irreparable harm to the record.

(2) To the extent possible, the contents of a record under this subsection shall be made accessible to a requester even when the record is physically unavailable.

(c) **Agency discretion.** — An agency may exercise its discretion to make any otherwise exempt record accessible for inspection and copying under this chapter, if all of the following apply:

(1) Disclosure of the record is not prohibited under any of the following:

(i) Federal or State law or regulation.

(ii) Judicial order or decree.

(2) The record is not protected by a privilege.

(3) The agency head determines that the public interest favoring access outweighs any individual, agency or public interest that may favor restriction of access.

(d) **Agency possession.** —

(1) A public record that is not in the possession of an agency but is in the possession of a party with whom the agency has contracted to perform a governmental function on behalf of the agency, and which directly relates to the governmental function and is not exempt under this act, shall be considered a public record of the agency for purposes of this act.

(2) Nothing in this act shall be construed to require access to any other record of the party in possession of the public record.

(3) A request for a public record in possession of a party other than the agency shall be submitted to the open records officer of the agency. Upon a determination that the record is subject to access under this act, the open records officer shall assess the duplication fee established under section 1307(b) and upon collection shall remit the fee to the party in possession of the record if the party duplicated the record.

Section 507. Retention of records.

Nothing in this act shall be construed to modify, rescind or supersede any record retention policy or disposition schedule of an agency established pursuant to law, regulation, policy or other directive.

CHAPTER 7 PROCEDURE

Section 701. Access.

(a) **General rule.** — Unless otherwise provided by law, a public record, legislative record or financial record shall be accessible for inspection and duplication in accordance with this act. A record being provided to a requester shall be provided in the medium requested if it exists in that medium; otherwise, it shall be provided in the medium in which it exists. Public records, legislative records or financial records shall be available for access during the regular business hours of an agency.

(b) **Construction.** — Nothing in this act shall be construed to require access to any computer either of an agency or individual employee of an agency.

Section 702. Requests.

Agencies may fulfill verbal, written or anonymous verbal or written requests for access to records under this act. If the requester wishes to pursue the relief and remedies provided for in this act, the request for access to records must be a written request.

Section 703. Written requests.

A written request for access to records may be submitted in person, by mail, by e-mail, by facsimile or, to the extent provided by agency rules, any other electronic means. A written request must be addressed to the open-records officer designated pursuant to section 502. Employees of an agency shall be directed to forward requests for records to the open-records officer. A written request should identify or describe the records sought with sufficient specificity to enable the agency to ascertain which records are being requested and shall include the name and address to which the agency should address its response. A written request need not include any explanation of the requester's reason for requesting or intended use of the records unless otherwise required by law.

Section 704. Electronic access.

(a) **General rule.** — In addition to the requirements of section 701, an agency may make its records available through any publicly accessible electronic means.

(b) **Response.** —

(1) In addition to the requirements of section 701, an agency may respond to a request by notifying the requester that the record is available through publicly accessible electronic means or that the agency will provide access to inspect the record electronically.

(2) If the requester is unwilling or unable to access the record electronically, the requester may, within 30 days following receipt of the agency notification, submit a written request to the agency to have the record converted to paper. The agency shall provide access to the record in printed form within five days of the receipt of the written request for conversion to paper.

Section 705. Creation of record.

When responding to a request for access, an agency shall not be required to create a record which does not currently exist or to compile, maintain, format or organize a record in a manner in which the agency does not currently compile, maintain, format or organize the record.

Section 706. Redaction.

If an agency determines that a public record, legislative record or financial record contains information which is subject to access as well as information which is not subject to access, the agency's response shall grant access to the information which is subject to access and deny access to the information which is not subject to access. If the information which is not subject to access is an integral part of the public record, legislative record or financial record and cannot be separated, the agency shall redact from the record the information which is not subject to access, and the response shall grant access to the information which is subject to access. The agency may not deny access to the record if the information which is not subject to access is able to be redacted. Information which an agency redacts in accordance with this subsection shall be deemed a denial under Chapter 9.

Section 707. Production of certain records.

(a) **General rule.** — If, in response to a request, an agency produces a record that is not a public record, legislative record or financial record, the agency shall notify any third party that provided the record to the agency, the person that is the subject of the record and the requester.

(b) **Requests for trade secrets.** — An agency shall notify a third party of a request for a record if the third party provided the record and included a written statement signed by a representative of the third party that the record contains a trade secret or confidential proprietary information.

Notification shall be provided within five business days of receipt of the request for the record. The third party shall have five business days from receipt of notification from the agency to provide input on the release of the record. The agency shall deny the request for the record or release the record within ten business days of the provision of notice to the third party and shall notify the third party of the decision.

(c) **Transcripts.** —

(1) Prior to an adjudication becoming final, binding and nonappealable, a transcript of an administrative proceeding shall be provided to a requester by the agency stenographer or a court reporter, in accordance with agency procedure or an applicable contract.

(2) Following an adjudication becoming final, binding and nonappealable, a transcript of an administrative proceeding shall be provided to a requester in accordance with the duplication rates established in section 1307(b).

Section 708. Exceptions for public records.

(a) **Burden of proof.** —

(1) The burden of proving that a record of a Commonwealth agency or local agency is exempt from public access shall be on the Commonwealth agency or local agency receiving a request by a preponderance of the evidence.

(2) The burden of proving that a legislative record is exempt from public access shall be on the legislative agency receiving a request by a preponderance of the evidence.

(3) The burden of proving that a financial record of a judicial agency is exempt from public access shall be on the judicial agency receiving a request by a preponderance of the evidence.

(b) **Exceptions.** — Except as provided in subsections (c) and (d), the following are exempt from access by a requester under this act:

(1) A record the disclosure of which:

(i) would result in the loss of Federal or State funds by an agency or the Commonwealth; or

(ii) would be reasonably likely to result in a substantial and demonstrable risk of physical harm to or the personal security of an individual.

(2) A record maintained by an agency in connection with the military, homeland security, national defense, law enforcement or other public safety activity that if disclosed would be reasonably likely to jeopardize or threaten public safety or preparedness or public protection activity or a record that is designated classified by an appropriate Federal or State military authority.

(3) A record, the disclosure of which creates a reasonable likelihood of endangering the safety or the physical security of a building, public utility, resource, infrastructure, facility or information storage system, which may include:

(i) documents or data relating to computer hardware, source files, software and system networks that could jeopardize computer security by exposing a vulnerability in preventing, protecting against, mitigating or responding to a terrorist act;

(ii) lists of infrastructure, resources and significant special events, including those defined by the Federal Government in the National Infrastructure Protections, which are deemed critical due to their nature and which result from risk analysis; threat assessments; consequences assessments; antiterrorism protective measures and plans; counterterrorism measures and plans; and security and response needs assessments; and

(iii) building plans or infrastructure records that expose or create vulnerability through disclosure of the location, configuration or security of critical systems, including public utility systems, structural elements, technology, communication, electrical, fire suppression, ventilation, water, wastewater, sewage and gas systems.

(4) A record regarding computer hardware, software and networks, including administrative or technical records, which, if disclosed, would be reasonably likely to jeopardize computer security.

(5) A record of an individual's medical, psychiatric or psychological history or disability status, including an evaluation, consultation, prescription, diagnosis or treatment; results of tests, including drug tests; enrollment in a health care program or program designed for participation by persons with disabilities, including vocation rehabilitation, workers' compensation and unemployment compensation; or related information that would disclose individually identifiable health information.

(6) (i) The following personal identification information:

(A) A record containing all or part of a person's Social Security number; driver's license number; personal financial information; home, cellular or personal telephone numbers; personal e-mail addresses; employee number or other confidential personal identification number.

(B) A spouse's name; marital status, beneficiary or dependent information.

(C) The home address of a law enforcement officer or judge.

(ii) Nothing in this paragraph shall preclude the release of the name, position, salary, actual compensation or other payments or expenses, employment contract, employment-related contract or agreement and length of service of a public official or an agency employee.

(iii) An agency may redact the name or other identifying information relating to an individual performing an undercover or covert law enforcement activity from a record.

(7) The following records relating to an agency employee:

(i) A letter of reference or recommendation pertaining to the character or qualifications of an identifiable individual, unless it was prepared in relation to the appointment of an individual to fill a vacancy in an elected office or an appointed office requiring Senate confirmation.

(ii) A performance rating or review.

(iii) The result of a civil service or similar test administered by a Commonwealth agency, legislative agency or judicial agency. The result of a civil service or similar test administered by a local agency shall not be disclosed if restricted by a collective bargaining agreement. Only test scores of individuals who obtained a passing score on a test administered by a local agency may be disclosed.

(iv) The employment application of an individual who is not hired by the agency.

(v) Workplace support services program information.

(vi) Written criticisms of an employee.

(vii) Grievance material, including documents related to discrimination or sexual harassment.

(viii) Information regarding discipline, demotion or discharge contained in a personnel file. This subparagraph shall not apply to the final action of an agency that results in demotion or discharge.

(ix) An academic transcript.

(8) (i) A record pertaining to strategy or negotiations relating to labor relations or collective bargaining and related arbitration proceedings. This subparagraph shall not apply to a final or executed contract or agreement between the parties in a collective bargaining procedure.

(ii) In the case of the arbitration of a dispute or grievance under a collective bargaining agreement, an exhibit entered into evidence at an arbitration proceeding, a transcript of the arbitration or the opinion. This subparagraph shall not apply to the final award or order of the arbitrator in a dispute or grievance procedure.

(9) The draft of a bill, resolution, regulation, statement of policy, management directive, ordinance or amendment thereto prepared by or for an agency.

(10) (i) A record that reflects:

(A) The internal, predecisional deliberations of an agency, its members, employees or officials or predecisional deliberations between agency members, employees or officials and members, employees or officials of another agency, including predecisional deliberations relating to a budget recommendation, legislative proposal, legislative amendment, contemplated or proposed policy or course of action or any research, memos or other documents used in the predecisional deliberations.

(B) The strategy to be used to develop or achieve the successful adoption of a budget, legislative proposal or regulation.

(ii) Subparagraph (i)(A) shall apply to agencies subject to 65 Pa.C.S. Ch. 7 (relating to open meetings) in a manner consistent with 65 Pa.C.S. Ch. 7. A record which is not otherwise exempt from access under this act and which is presented to a quorum for deliberation in accordance with 65 Pa.C.S. Ch. 7 shall be a public record.

(iii) This paragraph shall not apply to a written or Internet application or other document that has been submitted to request Commonwealth funds.

(iv) This paragraph shall not apply to the results of public opinion surveys, polls, focus groups, marketing research or similar effort designed to measure public opinion.

(11) A record that constitutes or reveals a trade secret or confidential proprietary information.

(12) Notes and working papers prepared by or for a public official or agency employee used solely for that official's or employee's own personal use, including telephone message slips, routing slips and other materials that do not have an official purpose.

(13) Records that would disclose the identity of an individual who lawfully makes a donation to an agency unless the donation is intended for or restricted to providing remuneration or personal tangible benefit to a named public official or employee of the agency, including lists of potential donors compiled by an agency to pursue donations, donor profile information or personal identifying information relating to a donor.

(14) Unpublished lecture notes, unpublished manuscripts, unpublished articles, creative works in progress, research-related material and scholarly correspondence of a community college or an institution of the State System of Higher Education or a faculty member, staff employee, guest speaker or student thereof.

(15) (i) Academic transcripts

(ii) Examinations, examination questions, scoring keys or answers to examinations. This subparagraph shall include licensing and other examinations relating to the qualifications of an individual and to examinations given in primary and secondary schools and institutions of higher education.

(16) A record of an agency relating to or resulting in a criminal investigation, including:

(i) Complaints of potential criminal conduct other than a private criminal complaint.

(ii) Investigative materials, notes, correspondence, videos and reports.

(iii) A record that includes the identity of a confidential source or the identity of a suspect who has not been charged with an offense to whom confidentiality has been promised.

(iv) A record that includes information made confidential by law or court order.

(v) Victim information, including any information that would jeopardize the safety of the victim.

(vi) A record that, if disclosed, would do any of the following:

(A) Reveal the institution, progress or result of a criminal investigation, except the filing of criminal charges.

(B) Deprive a person of the right to a fair trial or an impartial adjudication.

(C) Impair the ability to locate a defendant or codefendant.

(D) Hinder an agency's ability to secure an arrest, prosecution or conviction.

(E) Endanger the life or physical safety of an individual.

This paragraph shall not apply to information contained in a police blotter as defined in 18 Pa.C.S. § 9102 (relating to definitions) and utilized or maintained by the Pennsylvania State Police, local, campus, transit or port authority police department or other law enforcement agency or in a traffic report except as provided under 75 Pa.C.S. § 3754(b) (relating to accident prevention investigations).

(17) A record of an agency relating to a noncriminal investigation, including:

(i) Complaints submitted to an agency.

(ii) Investigative materials, notes, correspondence and reports.

(iii) A record that includes the identity of a confidential source, including individuals subject to the act of December 12, 1986 (P.L.1559, No.169), known as the Whistleblower Law.

(iv) A record that includes information made confidential by law.

(v) Work papers underlying an audit.

(vi) A record that, if disclosed, would do any of the following:

(A) Reveal the institution, progress or result of an agency investigation, except the imposition of a fine or civil penalty, the suspension, modification or revocation of a license, permit, registration, certification or similar authorization issued by an agency or an executed settlement agreement unless the agreement is determined to be confidential by a court.

(B) Deprive a person of the right to an impartial adjudication.

(C) Constitute an unwarranted invasion of privacy.

(D) Hinder an agency's ability to secure an administrative or civil sanction.

(E) Endanger the life or physical safety of an individual.

(18) (i) Records or parts of records, except time response logs, pertaining to audio recordings, telephone or radio transmissions received by emergency dispatch personnel, including 911 recordings.

(ii) This paragraph shall not apply to a 911 recording, or a transcript of a 911 recording, if the agency or a court determines that the public interest in disclosure outweighs the interest in nondisclosure.

(19) DNA and RNA records.

(20) An autopsy record of a coroner or medical examiner and any audiotape of a postmortem examination or autopsy, or a copy, reproduction or facsimile of an autopsy report, a photograph, negative or print, including a photograph or videotape of the body or any portion of the body of a deceased person at the scene of death or in the course of a postmortem examination or autopsy taken or made by or caused to be taken or made by the coroner or medical examiner. This exception shall not limit the reporting of the name of the deceased individual and the cause and manner of death.

(21) (i) Draft minutes of any meeting of an agency until the next regularly scheduled meeting of the agency.

(ii) Minutes of an executive session and any record of discussions held in executive session.

(22) (i) The contents of real estate appraisals, engineering or feasibility estimates, environmental reviews, audits or evaluations made for or by an agency relative to the following:

(A) The leasing, acquiring or disposing of real property or an interest in real property.

(B) The purchase of public supplies or equipment included in the real estate transaction.

(C) Construction projects.

(ii) This paragraph shall not apply once the decision is made to proceed with the lease, acquisition or disposal of real property or an interest in real property or the purchase of public supply or construction project.

(23) Library and archive circulation and order records of an identifiable individual or groups of individuals.

(24) Library archived and museum materials, or valuable or rare book collections or documents contributed by gift, grant, bequest or devise, to the extent of any limitations imposed by the donor as a condition of the contribution.

(25) A record identifying the location of an archeological site or an endangered or threatened plant or animal species if not already known to the general public.

(26) A proposal pertaining to agency procurement or disposal of supplies, services or construction prior to the award of the contract or prior to the opening and rejection of all bids; financial information of a bidder or offeror requested in an invitation for bid or request for proposals to demonstrate the bidder's or offeror's economic capability; or the identity of members, notes and other records of agency proposal evaluation committees established under 62 Pa.C.S. § 513 (relating to competitive sealed proposals).

(27) A record or information relating to a communication between an agency and its insurance carrier, administrative service organization or risk management office. This paragraph shall not apply to a contract with an insurance carrier, administrative service organization or risk management office or to financial records relating to the provision of insurance.

(28) A record or information:

(i) identifying an individual who applies for or receives social services; or

(ii) relating to the following:

(A) the type of social services received by an individual;

(B) an individual's application to receive social services, including a record or information related to an agency decision to grant, deny, reduce or restrict benefits, including a quasi-judicial decision of the agency and the identity of a caregiver or others who provide services to the individual; or

(C) eligibility to receive social services, including the individual's income, assets, physical or mental health, age, disability, family circumstances or record of abuse.

(29) Correspondence between a person and a member of the General Assembly and records accompanying the correspondence which would identify a person that requests assistance or constituent services. This paragraph shall not apply to correspondence between a member of the General Assembly and a principal or lobbyist under 65 Pa.C.S. Ch. 13A (relating to lobbyist disclosure).

(30) A record identifying the name, home address or date of birth of a child 17 years of age or younger.

(c) Financial records. — The exceptions set forth in subsection (b) shall not apply to financial records, except that an agency may redact that portion of a financial record protected under subsection (b)(1), (2), (3), (4), (5), (6), (16) OR (17). An agency shall not disclose the identity of an individual performing an undercover or covert law enforcement activity.

(d) Aggregated data. — The exceptions set forth in subsection (b) shall not apply to aggregated data maintained or received by an agency, except for data protected under subsection (b)(1), (2), (3), (4) or (5).

(e) Construction. — In determining whether a record is exempt from access under this section, an agency shall consider and apply each exemption separately.

CHAPTER 9 AGENCY RESPONSE

Section 901. General rule.

Upon receipt of a written request for access to a record, an agency shall make a good faith effort to determine if the record requested is a public record, legislative record or financial record and whether the agency has possession, custody or control of the identified record, and to respond as promptly as possible under the circumstances existing at the time of the request. All applicable fees shall be paid in order to receive access to the record requested. The time for response shall not exceed five business days from the date the written request is received by the open-records officer for an agency. If the agency fails to send the response within five business days of receipt of the written request for access, the written request for access shall be deemed denied.

Section 902. Extension of time.

(a) **Determination.** — Upon receipt of a written request for access, the open-records officer for an agency shall determine if one of the following applies:

(1) the request for access requires redaction of a record in accordance with section 706;

(2) the request for access requires the retrieval of a record stored in a remote location;

(3) a timely response to the request for access cannot be accomplished due to bona fide and specified staffing limitations;

(4) a legal review is necessary to determine whether the record is a record subject to access under this act;

(5) the requester has not complied with the agency's policies regarding access to records;

(6) the requester refuses to pay applicable fees authorized by this act; or

(7) the extent or nature of the request precludes a response within the required time period.

(b) **Notice.** —

(1) Upon a determination that one of the factors listed in subsection (a) applies, the open-records officer shall send written notice to the requester within five business days of receipt of the request for access under subsection (a).

(2) The notice shall include a statement notifying the requester that the request for access is being reviewed, the reason for the review, a reasonable date that a response is expected to be provided and an estimate of applicable fees owed when the record becomes available. If the date that a response is expected to be provided is in excess of 30 days, following the five business days allowed for in section 901, the request for access shall be deemed denied unless the requester has agreed in writing to an extension to the date specified in the notice.

(3) If the requester agrees to the extension, the request shall be deemed denied on the day following the date specified in the notice if the agency has not provided a response by that date.

Section 903. Denial.

If an agency's response is a denial of a written request for access, whether in whole or in part, the denial shall be issued in writing and shall include:

(1) A description of the record requested.

(2) The specific reasons for the denial, including a citation of supporting legal authority.

(3) The typed or printed name, title, business address, business telephone number and signature of the open-records officer on whose authority the denial is issued.

(4) Date of the response.

(5) The procedure to appeal the denial of access under this act.

Section 904. Certified copies.

If an agency's response grants a request for access, the agency shall, upon request, provide the requester with a certified copy of the record if the requester pays the applicable fees under section 1307.

Section 905. Record discard.

If an agency response to a requester states that copies of the requested records are available for delivery at the office of an agency and the requester fails to retrieve the records within 60 days of the agency's response, the agency may dispose of any copies which have not been retrieved and retain any fees paid to date.

CHAPTER 11. APPEAL OF AGENCY DETERMINATION

Section 1101. Filing of appeal.

(a) **Authorization.** —

(1) If a written request for access to a record is denied or deemed denied, the requester may file an appeal with the Office of Open Records or judicial, legislative or other appeals officer designated under section 503(d) within 15 business days of the mailing date of the agency's response or within 15 business days of a deemed denial. The appeal shall state the grounds upon which the requester asserts that the record is a public record, legislative record or financial record and shall address any grounds stated by the agency for delaying or denying the request.

(2) Except as provided in section 503(d), in the case of an appeal of a decision by a Commonwealth agency or local agency, the Office of Open Records shall assign an appeals officer to review the denial.

(b) **Determination.** —

(1) Unless the requester agrees otherwise, the appeals officer shall make a final determination which shall be mailed to the requester and the agency within 30 days of receipt of the appeal filed under subsection (a).

(2) If the appeals officer fails to issue a final determination within 30 days, the appeal is deemed denied.

(3) Prior to issuing a final determination, a hearing may be conducted. The determination by the appeals officer shall be a final order. The appeals officer shall provide a written explanation of the reason for the decision to the requester and the agency.

(c) **Direct interest.** —

(1) A person other than the agency or requester with a direct interest in the record subject to an appeal under this section may, within 15 days following receipt of actual knowledge of the appeal but no later than the date the appeals officer issues an order, file a written request to provide information or to appear before the appeals officer or to file information in support of the requester's or agency's position.

(2) The appeals officer may grant a request under paragraph (1) if:

(i) no hearing has been held;

(ii) the appeals officer has not yet issued its order; and

(iii) the appeals officer believes the information will be probative.

(3) Copies of the written request shall be sent to the agency and the requester.

Section 1102. Appeals officers.

(a) **Duties.** — An appeals officer designated under section 503 shall do all of the following:

(1) Set a schedule for the requester and the open- records officer to submit documents in support of their positions.

(2) Review all information filed relating to the request. The appeals officer may hold a hearing. A decision to hold or not to hold a hearing is not appealable. The appeals officer may admit into evidence testimony, evidence and documents that the appeals officer believes to be reasonably probative and relevant to an issue in dispute. The appeals officer may limit the nature and extent of evidence found to be cumulative.

(3) Consult with agency counsel as appropriate.

(4) Issue a final determination on behalf of the Office of Open Records or other agency.

(b) **Procedures.** — The Office of Open Records, a judicial agency, a legislative agency, the Attorney General,

Auditor General, State Treasurer or district attorney may adopt procedures relating to appeals under this chapter.

(1) If an appeal is resolved without a hearing, 1 Pa. Code Pt. II (relating to general rules of administrative practice and procedure) does not apply except to the extent that the agency has adopted these chapters in its regulations or rules under this subsection.

(2) If a hearing is held, 1 Pa. Code Pt. II shall apply unless the agency has adopted regulations, policies or procedures to the contrary under this subsection.

(3) In the absence of a regulation, policy or procedure governing appeals under this chapter, the appeals officer shall rule on procedural matters on the basis of justice, fairness and the expeditious resolution of the dispute.

CHAPTER 13. JUDICIAL REVIEW

Section 1301. Commonwealth agencies, legislative agencies and judicial agencies.

(a) **General rule.** — Within 30 days of the mailing date of the final determination of the appeals officer relating to a decision of a Commonwealth agency, a legislative agency or a judicial agency issued under section 1101(b) or the date a request for access is deemed denied, a requester or the agency may file a petition for review or other document as might be required by rule of court with the Commonwealth Court. The decision of the court shall contain findings of fact and conclusions of law based upon the evidence as a whole. The decision shall clearly and concisely explain the rationale for the decision.

(b) **Stay.** — A petition for review under this section shall stay the release of documents until a decision under subsection (a) is issued.

Section 1302. Local agencies.

(a) **General rule.** — Within 30 days of the mailing date of the final determination of the appeals officer relating to a decision of a local agency issued under section 1101(b) or of the date a request for access is deemed denied, a requester or local agency may file a petition for review or other document as required by rule of court with the court of common pleas for the county where the local agency is located. The decision of the court shall contain findings of fact and conclusions of law based upon the evidence as a whole. The decision shall clearly and concisely explain the rationale for the decision.

(b) **Stay.** — A petition for review under this section shall stay the release of documents until a decision under subsection (a) is issued.

Section 1303. Notice and records.

(a) **Notice.** — An agency, the requester and the Office of Open Records or designated appeals officer shall be served notice of actions commenced in accordance with section 1301 or 1302 and shall have an opportunity to respond in accordance with applicable court rules.

(b) **Record on appeal.** — The record before a court shall consist of the request, the agency's response, the appeal filed under section 1101, the hearing transcript, if any, and the final written determination of the appeals officer.

Section 1304. Court costs and attorney fees.

(a) **Reversal of agency determination.** — If a court reverses the final determination of the appeals officer or grants access to a record after a request for access was deemed denied, the court may award reasonable attorney fees and costs of litigation or an appropriate portion thereof to a requester if the court finds either of the following:

(1) the agency receiving the original request willfully or with wanton disregard deprived the requester of access to a public record subject to access or otherwise acted in bad faith under the provisions of this act; or

(2) the exemptions, exclusions or defenses asserted by the agency in its final determination were not based on a reasonable interpretation of law.

(b) **Sanctions for frivolous requests or appeals.** — The court may award reasonable attorney fees and costs of litigation or an appropriate portion thereof to an agency or the requester if the court finds that the legal challenge under this chapter was frivolous.

(c) **Other sanctions.** — Nothing in this act shall prohibit a court from imposing penalties and costs in accordance with applicable rules of court.

Section 1305. Civil penalty.

(a) **Denial of access.** — A court may impose a civil penalty of not more than $1,500 if an agency denied access to a public record in bad faith.

(b) **Failure to comply with court order.** — An agency or public official who does not promptly comply with a court order under this act is subject to a civil penalty of not more than $500 per day until the public records are provided.

Section 1306. Immunity.

(a) **General rule.** — Except as provided in sections 1304 and 1305 and other statutes governing the release of records, no agency, public official or public employee shall be liable for civil penalties resulting from compliance or failure to comply with this act.

(b) **Schedules.** — No agency, public official or public employee shall be liable for civil or criminal damages or penalties under this act for complying with any written public record retention and disposition schedule.

Section 1307. Fee limitations.

(a) **Postage.** — Fees for postage may not exceed the actual cost of mailing.

(b) **Duplication.** —

(1) Fees for duplication by photocopying, printing from electronic media or microfilm, copying onto electronic media, transmission by facsimile or other electronic means and other means of duplication shall be established:

(i) by the Office of Open Records, for Commonwealth agencies and local agencies;

(ii) by each judicial agency; and

(iii) by each legislative agency.

(2) The fees must be reasonable and based on prevailing fees for comparable duplication services provided by local business entities.

(3) Fees for local agencies may reflect regional price differences.

(4) The following apply to complex and extensive data sets, including geographic information systems or integrated property assessment lists.

(i) Fees for copying may be based on the reasonable market value of the same or closely related data sets.

(ii) Subparagraph (i) shall not apply to:

(A) a request by an individual employed by or connected with a newspaper or magazine of general circulation, weekly newspaper publication, press association or radio or television station, for the purpose of obtaining information for publication or broadcast; or

(B) a request by a nonprofit organization for the conduct of educational research.

(iii) Information obtained under subparagraph (ii) shall be subject to paragraphs (1), (2) and (3).

(c) **Certification.** — An agency may impose reasonable fees for official certification of copies if the certification is at the behest of the requester and for the purpose of legally verifying the public record.

(d) **Conversion to paper.** — If a record is only maintained electronically or in other nonpaper media, duplication fees shall be limited to the lesser of the fee for duplication on paper or the fee for duplication in the original media as provided by subsection (b) unless the requester specifically requests for the record to be duplicated in the more expensive medium.

(e) **Enhanced electronic access.** — If an agency offers enhanced electronic access to records in addition to making the records accessible for inspection and duplication by a requester as required by this act, the agency may establish user fees specifically for the provision of the enhanced electronic access, but only to the extent that the enhanced electronic access is in addition to making the records accessible for inspection and duplication by a requester as required by this act. The user fees for enhanced electronic access may be a flat rate, a subscription fee for a period of time, a per-transaction fee, a fee based on the cumulative time of system access or any other reasonable method and any combination thereof. The user fees for enhanced electronic access must be reasonable, must be approved by the Office of Open Records and may not be established with the intent or effect of excluding persons from access to records or duplicates thereof or of creating profit for the agency.

(f) **Waiver of fees.** — An agency may waive the fees for duplication of a record, including, but not limited to, when:

(1) the requester duplicates the record; or

(2) the agency deems it is in the public interest to do so.

(g) **Limitations.** — Except as otherwise provided by statute, no other fees may be imposed unless the agency necessarily incurs costs for complying with the request, and such fees must be reasonable. No fee may be imposed for an agency's review of a record to determine whether the record is a public record, legislative record or financial record subject to access in accordance with this act.

(h) **Prepayment.** — Prior to granting a request for access in accordance with this act, an agency may require a requester to prepay an estimate of the fees authorized under this section if the fees required to fulfill the request are expected to exceed $100.

Section 1308. Prohibition.

A policy or regulation adopted under this act may not include any of the following:

(1) A limitation on the number of records which may be requested or made available for inspection or duplication.

(2) A requirement to disclose the purpose or motive in requesting access to records.

Section 1309. Practice and procedure.

The provisions of 2 Pa.C.S. (relating to administrative law and procedure) shall not apply to this act unless specifically adopted by regulation or policy.

Section 1310. Office of Open Records.

(a) **Establishment.** — There is established in the Department of Community and Economic Development an Office of Open Records.

The office shall do all of the following:

(1) Provide information relating to the implementation and enforcement of this act.

(2) Issue advisory opinions to agencies and requesters.

(3) Provide annual training courses to agencies, public officials and public employees on this act and 65 Pa.C.S. Ch. 7 (relating to open meetings).

(4) Provide annual, regional training courses to local agencies, public officials and public employees.

(5) Assign appeals officers to review appeals of decisions by Commonwealth agencies or local agencies, except as provided in section 503(d), filed under section 1101 and issue orders and opinions. The office shall employ or contract with attorneys to serve as appeals officers to review appeals and, if necessary, to hold hearings on a regional basis under this act. Each appeals officer must comply with all of the following:

(i) Complete a training course provided by the Office of Open Records prior to acting as an appeals officer.

(ii) If a hearing is necessary, hold hearings regionally as necessary to ensure access to the remedies provided by this act.

(iii) Comply with the procedures under section 1102(b).

(6) Establish an informal mediation program to resolve disputes under this act.

(7) Establish an Internet website with information relating to this act, including information on fees, advisory opinions and decisions and the name and address of all open records officers in this Commonwealth.

(8) Conduct a biannual review of fees charged under this act.

(9) Annually report on its activities and findings to the Governor and the General Assembly. The report shall be posted and maintained on the Internet website established under paragraph (7).

(b) **Executive director.** — Within 90 days of the effective date of this section, the Governor shall appoint an executive director of the office who shall serve for a term of six years. Compensation shall be set by the Executive Board established under section 204 of the act of April 9, 1929 (P.L.177, No.175), known as The Administrative Code of 1929. The executive director may serve no more than two terms.

(c) **Limitation.** — The executive director shall not seek election nor accept appointment to any political office during his tenure as executive director and for one year thereafter.

(d) **Staffing.** — The executive director shall appoint attorneys to act as appeals officers and additional clerical, technical and professional staff as may be appropriate and may contract for additional services as necessary for the performance of the executive director's duties. The compensation of attorneys and other staff shall be set by the Executive Board. The appointment of attorneys shall not be subject to the act of October 15, 1980 (P.L.950, No.164), known as the Commonwealth Attorneys Act.

(e) **Duties.** — The executive director shall ensure that the duties of the Office of Open Records are carried out and shall monitor cases appealed to the Office of Open Records.

(f) **Appropriation.** — The appropriation for the office shall be in a separate line item and shall be under the jurisdiction of the executive director.

CHAPTER 15. STATE-RELATED INSTITUTIONS

Section 1501. Definition.

As used in this chapter, "State-related institution" means any of the following:

(1) Temple University.

(2) The University of Pittsburgh.

(3) The Pennsylvania State University.

(4) Lincoln University.

Section 1502. Reporting.

No later than May 30 of each year, a State-related institution shall file with the Governor's Office, the General Assembly, the Auditor General and the State Library the information set forth in section 1503.

Section 1503. Contents of report.

The report required under section 1502 shall include the following:

(1) Except as provided in paragraph (4), all information required by Form 990 or an equivalent form, of the United States Department of the Treasury, Internal Revenue Service, entitled the Return of Organization Exempt From Income Tax, regardless of whether the State-related institution is required to file the form by the Federal Government.

(2) The salaries of all officers and directors of the State-related institution.

(3) The highest 25 salaries paid to employees of the institution that are not included under paragraph (2).

(4) The report shall not include information relating to individual donors.

Section 1504. Copies and posting.

A State-related institution shall maintain, for at least seven years, a copy of the report in the institution's library and shall provide free access to the report on the institution's Internet website.

CHAPTER 17. STATE CONTRACT INFORMATION

Section 1701. Submission and retention of contracts.

(a) **General rule.** — Whenever any Commonwealth agency, legislative agency or judicial agency shall enter into any contract involving any property, real, personal or mixed of any kind or description or any contract for personal services where the consideration involved in the contract is $5,000 or more, a copy of the contract shall be filed with the Treasury Department within ten days after the contract is fully executed on behalf of the Commonwealth agency, legislative agency or judicial agency or otherwise becomes an obligation of the Commonwealth agency, legislative agency or judicial agency. The provisions of this chapter shall not apply to contracts for services protected by a privilege. The provisions of this chapter shall not apply to a purchase order evidencing fulfillment of an existing contract but shall apply to a purchase order evidencing new obligations. The following shall apply:

(1) Each Commonwealth agency, legislative agency and judicial agency shall submit contracts in a form and structure mutually agreed upon by the Commonwealth agency, legislative agency or judicial agency and the State Treasurer.

(2) The Treasury Department may require each Commonwealth agency, legislative agency or judicial agency to provide a summary with each contract, which shall include the following:

(i) Date of execution.

(ii) Amount of the contract.

(iii) Beginning date of the contract.

(iv) End date of the contract, if applicable.

(v) Name of the agency entering into the contract.

(vi) The name of all parties executing the contract.

(vii) Subject matter of the contract.

Each agency shall create and maintain the data under this paragraph in an ASCII-delimited text file, spreadsheet file or other file provided by Treasury Department regulation.

(b) **Retention.** — Every contract filed pursuant to subsection (a) shall remain on file with the Treasury Department for a period of not less than four years after the end date of the contract.

(c) **Accuracy.** — Each Commonwealth agency, legislative agency and judicial agency is responsible for verifying the accuracy and completeness of the information that it submits to the State Treasurer. The contract provided to the Treasury Department pursuant to this chapter shall be redacted in accordance with applicable provisions of this act by the agency filing the contract to the Treasury Department.

(d) **Applicability.** — The provisions of this act shall not apply to copies of contracts submitted to the Treasury Department, the Office of Auditor General or other agency for purposes of audits and warrants for disbursements under section 307, 401, 402 or 403 of the act of April 9, 1929 (P.L.343, No.176), known as The Fiscal Code.

Section 1702. Public availability of contracts.

(a) **General rule.** — The Treasury Department shall make each contract filed pursuant to section 1701 available for public inspection either by posting a copy of the contract on the Treasury Department's publicly accessible Internet website or by posting a contract summary on the department's publicly accessible Internet website.

(b) **Posting.** — The Treasury Department shall post the information received pursuant to this chapter in a manner that allows the public to search contracts or contract summaries by the categories enumerated in section 1701(a)(2).

(c) **Request to review or receive copy of contract.** — The Treasury Department shall maintain a page on its publicly accessible Internet website that includes instructions on how to review a contract on the Internet website.

(d) **Paper copy.** — A paper copy of a contract may be requested from the agency that executed the contract in accordance with this act.

CHAPTER 31. MISCELLANEOUS PROVISIONS

Section 3101. Applicability.

This Act shall apply to requests for information made after December 31, 2008.

Section 3101.1. Relation to other laws.

If the provisions of this act regarding access to records conflict with any other federal or state law, the provisions of this act shall not apply.

Section 3101.2. Severability.

All provisions of this act are severable.

Section 3102. Repeals.

Repeals are as follows:

(1) The General Assembly declares as follows:

(i) The repeal under paragraph (2)(i) is necessary to effectuate Chapter 17.

(ii) The repeals under paragraph (2)(ii) and (iii) are necessary to effectuate this act.

(2) The following acts and parts of acts are repealed:

(i) Section 1104 of the act of April 9, 1929 (P.L.177, No.175), known as The Administrative Code of 1929.

(ii) The act of June 21, 1957 (P.L.390, No.212), referred to as the Right-to-Know Law.

(iii) 62 Pa.C.S. § 106.

Section 3103. References.

Notwithstanding 1 PA.C.S. § 1937(B), a reference in a statute or regulation to the act of June 21, 1957 (P.L.390, No.212), referred to as the Right-to-Know Law, shall be deemed a reference to this act.

Section 3104. Effective date.

This act shall take effect as follows:

(1) The following provisions shall take effect immediately:

(i) Sections 101, 102 and 1310.

(ii) This section.

(2) Chapters 15 and 17 and sections 3102(1)(I) and 3102(2)(I) shall take effect July 1, 2008.

(3) The remainder of this act shall take effect January 1, 2009.

###

Greeley and Hansen LLC
1700 Market Street, Suite 2130
Philadelphia, PA 19103
(215) 563-3460
www.greeley-hansen.com

GREELEY AND HANSEN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

APR 28 2016

CERTIFIED MAIL

Mr. Robert Willert, Executive Director
Delaware County Regional Quality Control Authority
100 East Fifth Street
Chester, PA 19013

RE: Civil Action 2:15-cv-04652-RB

Dear Mr. Willert:

The United States Environmental Protection Agency (EPA) has received the revised Delaware County Regional Quality Control Authority (DELCORA) Public Participation Plan (PPP) dated April 14, 2016. EPA has consulted with the Pennsylvania Department of the Environment (PADEP). EPA accepts the revised PPP and therefore it is now approved.

Sincerely,

Andrew F. Seligman, Environmental Scientist
Water Enforcement Branch

cc: R. Smolski, EPA
P. Yeany, EPA
M. DeSantis, DELCORA
Jen Field, PADEP, SERO

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Customer Service Hotline: 1-800-438-2474

APPENDIX M

Public Meeting Notes, Presentations and Comments

- DELCORA Public Meeting No. 1
  - Public Meeting No. 1 Notice - Tuesday, March 15, 2016
  - Meeting Notes
  - Responses to Public Comments
  - Sign-In Sheet
  - Public Comment Form
  - Presentation
- DELCORA Public Meeting No. 2
  - Public Meeting No. 2 Notice - Tuesday, June 27, 2017
  - Meeting Notes
  - Responses to Public Comments
  - Sign-In Sheet
  - Public Comment Form
  - Presentation
- DELCORA Public Meeting No. 3
  - Public Meeting Notice No. 3 - Tuesday, December 5, 2017
  - Meeting Notes
  - Responses to Public Comments
  - Sign-In Sheet
  - Public Comment Form
  - Presentation
- DELCORA Meeting No. 4
  - Public Meeting Notice No. 4 - Wednesday, September 26, 2018
  - Meeting Notes
  - Sign-In Sheet
  - Public Comment Form
  - Presentation

COMBINED SEWER OVERFLOW (CSO)
LONG-TERM CONTROL PLAN UPDATE (LTCPU)
PUBLIC MEETINGS

Please join DELCORA for a series of public meetings on our Combined Sewer Overflow Long-Term Control Plan Update.

Learn about DELCORA's combined sewer system and the proposed strategies for significantly reducing combined sewer overflows to our rivers and streams. Please give us your feedback on items discussed at the scheduled meeting below.

1ST MEETING

TOPIC: Scope and Purpose of the Study
WHEN: Tuesday, March 15, 2016 at 6:00 PM (EST)
WHERE: Chester City Hall
Community Room (Room entrance facing Rt 291)
1 E. 4th Street, Chester, PA - 19013

General Email: ltcpinfo@delcora.org
General Phone Number: 610-876-5523

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 1 NOTES

Meeting Title: PUBLIC MEETING NO 1

Date / Time: March 15, 2016 6:00 PM

Prepared By: Marlene Finizio

Location: Chester City Hall

Reviewed By: Michael Hope

Distributed: 4/12/16

Attendees:
Edwin Bothwell, DELCORA
Michael DiSantis, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
Lindsey Isler, DELCORA
Michael Hope, Greeley and Hansen
Marlene Finizio, Greeley and Hansen
See also Public Sign in Sheet

DELCORA held the first of a series of Long Term Control Plan Update (LTCPU) Public Meetings on Tuesday, March 15, 2016. The first public meeting was held to present to the public the Scope of Work and Purpose of the LTCP Update. DELCORA's goal of each public meeting is to inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The public meeting was held to as part of the Public Participation Plan. There were approximately 6 individuals from the public in attendance.

The following items were discussed and presented at the first public meeting:

- DELCORA General Introduction and Opening Remarks
- DELCORA Public Participation Plan Program Goals
- Review of DELCORA Service Area
- Combined Sewer Overflow (CSO) Definition and History
- History of Other USEPA LTCPs
- Background of DELCORA Long-Term Control Plan (LTCP)
- Review of DELCORA Consent Decree (CD) Requirements
- Financial Capabilities Assessment (FCA)
- Summary of Where We Are and Next Phase
- Listing of Future Public Meetings
- Public Locations for Review of Available Literature and Documentation
- Contact Information for DELCORA, Questions and DELCORA Website

A representative from the Chester Environmental Planning (CEP) was in attendance and commented on the meeting schedule. DELCORA indicated to the Chester Environmental Planning (CEP) that another meeting may be scheduled in May. **See the attached Public Comment and Response sheet.**

OTHER:
DELCORA will check other meeting locations to make sure that a screen is available.

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 1 NOTES

ACTION ITEMS:

1. DELCORA will make the schedule for the LTCP Update Program available on their website.
2. DELCORA will upload the public meeting notes with sign in sheet to their website.
3. DELCORA will check other meeting locations to make sure that a screen is available.

ATTACHMENTS

- Responses to Public Comments
- Public Sign-In Sheet
- Handouts - Comment Form
- Public Meeting Powerpoint Presentation

DELAWARE COUNTY REGIONAL WATER QUALITY AUTHORITY

LONG TERM CONTROL PLAN UPDATE

PUBLIC PARTICIPATION MEETING NO. 1
LTCPU SCOPE AND PURPOSE
March 15, 2016

RESPONSES TO PUBLIC COMMENTS

1. Comment: Why is there so much time between First and Second Public meetings?

   Response: ***The DELCORA Long Term Control Plan Update program was initiated in August 2015 along with the lodging of the DELCORA USEPA Consent Decree. Each Public Meeting was scheduled in coordination with Milestones in the program.***

   The first public meeting was held in March 2016 to allow time to develop substantial documentation and a schedule for discussion and presentation. The March 15th LTCPU kick-off meeting was to introduce the LTCPU program scope and purpose to the public.

   The second public meeting is scheduled in the 3rd quarter of 2017 to coincide with the system characterization milestone. Per the Public Participation Plan, DELCORA will hold a minimum of four (4) public meetings; however, other meetings will be scheduled as needed. DELCORA indicated that another meeting may be held in May 2016.

   The most important public meeting will be the third meeting to get input from the public on the LTCPU alternatives. This third meeting will be held in Chester City. The first meeting with USEPA was in January 2016.

2. Comment: Will there be timeline in the document handout?

   Response: ***A basic project schedule showing the timeline will be posted on the DELCORA website.***

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
CSO Long Term Control Plan Update

DELCORA Public Participation Meeting #1 — Tuesday, March 15, 2016 Chester City Hall, Chester Pa.

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
1	Irena R. Byrd	3033 W. 6th St	Chester	PA	19013	freebee0908@gmail	x	
2	John Pileggi	512 E. 19TH ST	Chester	PA	19013			x
3	John Johnson	2539 Lindsay St	Chester	PA	19013	john.johnson19013@yahoo.com	✓	
4	John Delores Shelton	138 E 18 St	Chester	PA	19013	drsdst720@hotmail		x
5	LULA SMITH	1 Fourth St	Chester	PA	19013	lsmith@chestercity.com	✓	
6	Erin Smist	100 Deerfield Ln.	Malvern	PA	19355	esmist@suburbanrealtors alliance.com		
7	S.J. Dennis		Chester	PA	19013			
8								
9								
10								
11								
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17								
18								
19								
20								
21								
22								

Date Rec'd.:		Log No.:		Comment No.:	

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

Public Participation Meeting No. 1
LTCPU Scope and Purpose
March 15, 2016

CLOSING DATE: All Comments Must Be Received 30 calendar days from Public Meeting Date (by April 14, 2016)

1) Responses to public comments will be published within 60 days of the public meeting date (by May 15, 2016). Responses will be posted on the DELCORA Website. Comments may be submitted at the public meeting or by one of the following options:

Email: ltcpinfo@delcora.org

On the WEB: www.delcora.org

Phone: (610) 876-5523

Mail Address: DELCORA
P.O. Box 999
Chester, PA 19016-0999

2) **PLEASE TYPE OR PRINT CLEARLY**. Forms will be returned if they contain unreadable information.

Name:				Date:	
Jurisdiction/Company:					
Address:					
City:		State:		Zip:	
Phone:		Ext:		Fax:	
Email:					

3) Signature: _____

4). Please provide comments below. Provide additional sheets as needed.

Comment 1 _____

Comment 2 _____

Comment 3 _____

Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

Combined Sewer Overflow - Long Term Control Plan Update

DELCORA

Public Participation Meeting No. 1

LTCPU Scope and Purpose

March 15, 2016

Chester City Hall Community Room

1 E. 4th Street, Chester, PA

Delaware County Regional Water Quality Control Authority
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Delaware County, PA

Public Participation Plan Goals

- DELCORA's goals and objectives for the Public Participation Program are to :
  - Inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies
  - Educate the public
  - Address public concerns

Delaware County Regional Water Quality Control Authority
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Delaware County, PA

General Information

- DELCORA is the Delaware County Regional Water Quality Authority, established in 1971, responsible for collecting, conveying and treating wastewater in the greater Philadelphia Area including 42 Municipalities in Delaware and Chester County.

DELCORA Mission

"Provide environmentally responsible and cost effective wastewater management services to the citizens, businesses, and industries of Southeastern Pennsylvania"

Delaware County Regional Water Quality Control Authority
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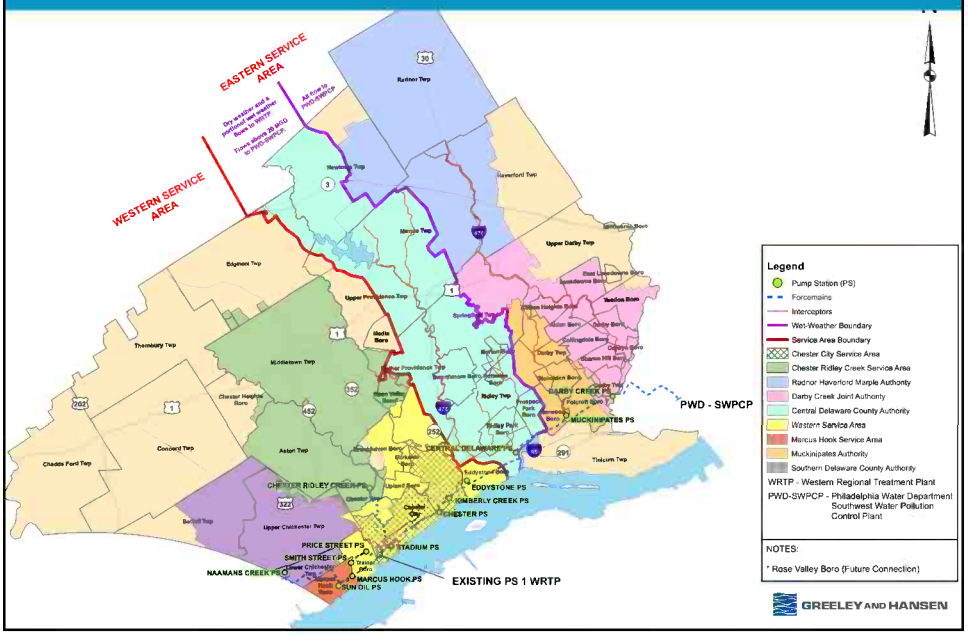
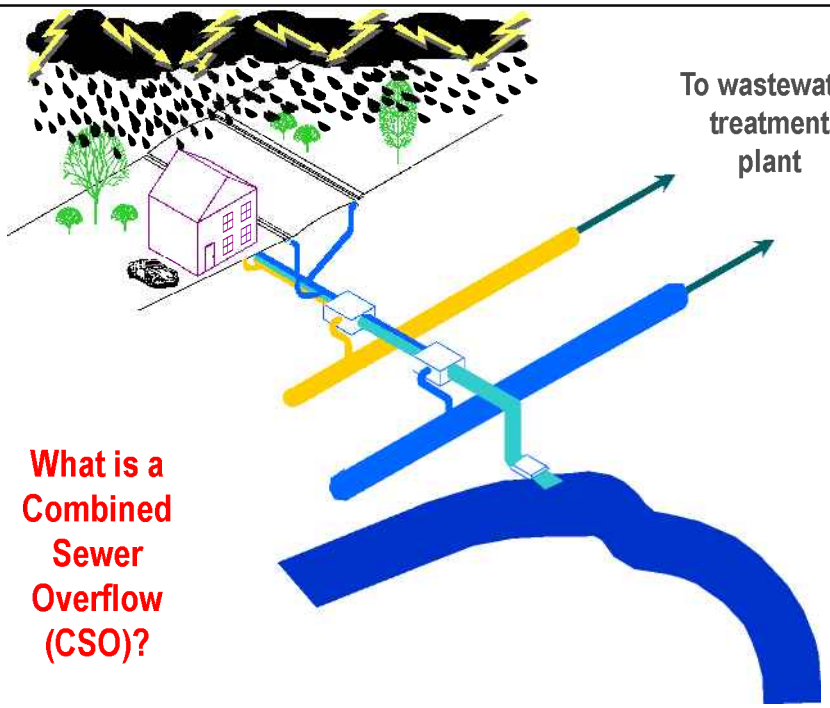
DELCORA Service Area





DELCORA

Definitions

- **LTCP:** The Long Term Control Plan is the document that lays out how DELCORA will maintain the outfalls and reduce the flow and/or treat the discharge from the outfalls to the water ways to meet the requirements of the Clean Water Act.
- **Sanitary Sewer:** The system that contains only waste from bathrooms, sinks, washers etc.
- **Storm Sewer:** Run off from streets.
- **Combined Sewer System:** Pipe that has both sanitary sewage and storm water in it.
- **Combined Sewer Overflow:** An overflow is the relief point in the combined sewer system that allows the extra flow when it rains to be discharged directly to streams and rivers.
- EPA: United States Environmental Protection Agency
- DEP: Pennsylvania Department of Environmental Protection

Delaware County Regional Water Quality Control Authority
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Delaware County, PA

History of Combined Sewer System

- In the early 1900's the City of Chester's Combined Sewer System was constructed.
  - This was, at the time, a typical engineering practice in Urban areas.
- In 1971 DELCORA became the owner of the existing Sanitary and Combined Sewer System in the City of Chester.
- Discharges from CSOs are authorized through the National Pollutants Discharge Elimination System (NPDES) permit during Wet Weather Flow.

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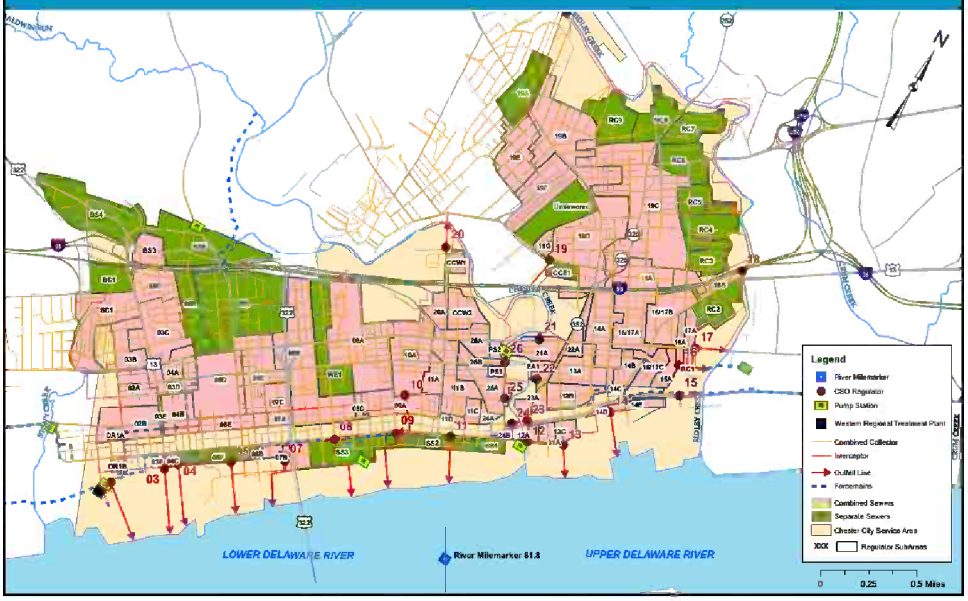
DELCORA Combined Sewer Area



Delaware County Regional Water Quality Control Authority
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History of EPA LTCPs

- LTCP Consent Decrees/Order for various wastewater systems not only throughout Pennsylvania, but the entire country.
  - Washington DC, New York City, Richmond,
- Current Pennsylvania communities already impacted by LTCP Consent Decree Costs & Fines:
  - Williamsport
  - Scranton
  - Harrisburg
  - Pittsburgh

Delaware County Regional Water Quality Control Authority
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Philadelphia LTCP

- DELCORA is currently contributing to the Philadelphia LTCP.
  - Philadelphia's LTCP has an overall price tag of over $2 Billion over 25 years.
  - DELCORA's proportionate share of the Philadelphia LTCP is $178 million over 15 years due to the term of our contract with Philadelphia.

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DELCORA LTCP Background

- In 1999 in response to increased environmental regulations, DELCORA implemented an LTCP for the DELCORA Combined Sewer System in the City of Chester.
- The LTCP identified capital improvements and operation and maintenance practices to reduce overflows.
- From 1999-2009 DELCORA spent in excess of $5 million on improvements and contributions to the City of Chester that resulted in decreased volume of overflows, reduced debris in overflows, provided remote monitoring of the system, and improved routine maintenance.
- In 2009, the DEP and EPA determined that DELCORA's LTCP was no longer in compliance with increased regulations of the Clean Water Act. In response, DELCORA began working with DEP and EPA to update the LTCP.

Delaware County Regional Water Quality Control Authority
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Delaware County, PA

LTCP Background (Continued)

- In 2012, DELCORA submitted a revised LTCP to DEP and EPA.
- A key element in DELCORA's revised plan position was that the CSOs are only found in the City of Chester and the financial burden on the City of Chester residents must be considered.
- In 2014, DEP and EPA determined that DELCORA's revised LTCP required further evaluation and development so the Department of Justice was assigned to pursue a Consent Decree.

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DELCORA Consent Decree

- The Consent Decree was agreed to by DELCORA on July 1, 2015 and signed into effect by the Dept. of Justice (DOJ) in November 2015. The Consent Decree is a legally binding agreement between DELCORA, EPA , and DEP in which DELCORA agrees to update the current LTCP.
- Generally, the Consent Decree consists of:
  - Compliance Measures
  - Milestones for plan update and implementation
  - Civil penalty
  - Stipulated penalties for non-compliance
- DELCORA has been given 42 months (3½ years) to develop a plan and 20 total years to implement the plan. When projects are complete and on-line, sewer fee charges will include costs for the updated LTCP.

Delaware County Regional Water Quality Control Authority
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LTCPU Summary – Where We Are

- Hired expert consultants with a good track record as well as experience specifically related to the LTCP.
  - Greeley & Hansen: Engineering Consultant for the LTCP
  - Municipal & Financial Services Group: Rate Model Consultant
  - Blank Rome: Law Firm
- 100% compliance to date with Consent Decree
  - Submitted to date :
    - Public Participation Plan
    - Hydrologic and Hydraulic Model Update and Calibration Plan
    - Typical Hydrologic Period Plan
    - Semi-Annual Report
    - Sensitive Areas and Pollutants of Concern Report
  - To be Submitted by May 17, 2016
    - Draft FCA and Alternative Evaluation Report

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Financial Capability Assessment (FCA)

- The Consent Decree requires DELCORA to submit a DRAFT FCA by May 17, 2016 and FINAL FCA at the end of the project.
- Financial Capability Assessment's (FCA's) purpose is to determine the affordability of the LTCP.
- Develop fair, equitable, and legal cost share for conveyance, storage, and treatment of wet weather flows

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Financial Capability Assessment (FCA)

Financial Capability Matrix

Permittee Financial Capability Indicators Score (Socioeconomic, Debt & Financial Indicators)	Residential Indicator (Cost Per Household as a % of MHI)		
	Low (1.0% and Below)	Mid-Range (Between 1.0% and 2.0%)	High (2.0% and Above)
Weak (1.5 and Below)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (2.5 and Above)	Low Burden	Low Burden	Medium Burden

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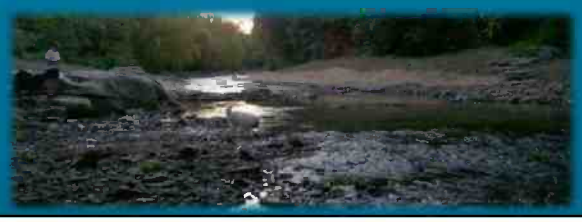
LTCPU Summary – Next Phase

- Sampling
- Flow Monitoring and Precipitation Monitoring Installation
- Data Analysis
- Model Development
- System Characterization
- Development and Evaluation of Alternatives for CSO Controls
- Selection and Implementation of the Long-Term Plan
- Continued Public and Stakeholder Involvement



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Delaware County, PA

Future Public Meetings

- **2nd Meeting**

  Topic: System Characterization
  When: 3rd Quarter 2017
  Where: Ridley Township Municipal Building
  100 MacDade Boulevard; Folsom, PA 19033

- **3rd Meeting**

  Topic: Development and Evaluation of Alternatives for CSO Controls
  When: 4th Quarter 2017
  Where: Chester City Hall
  1 E. 4th Street; Chester, PA 19103

Delaware County Regional Water Quality Control Authority
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Delaware County, PA

Public Meetings (Continued)

- **4th Meeting**

  Topic: Selection and Implementation of the Long-Term Plan
  When: 3rd Quarter 2018
  Where: Aston Township Administration Building
  5021 Pennell Road; Aston, PA 19014

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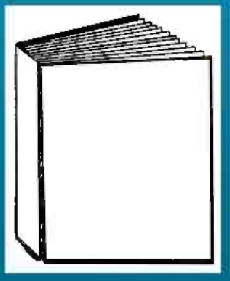
Literature and Documentation

- Literature and documentation will be made available by DELCORA at the following public locations and on the DELCORA website:
  - **DELCORA Administration Building**
    100 East Fifth Street; Chester, PA 19013
  - **Lewis Crozer Library**
    620 Engle Street; Chester, PA 19013
  - **Marcus Hook Municipal Building**
    1015 Green Street; Marcus Hook, PA 19061
  - **Ridley Township Building**
    100 MacDade Blvd.; Folsom, PA 19033
  - **Upland Borough Office**
    224 Castle Avenue; Brookhaven, PA 19015
  - **Chester Township**
    1150 Engle Street; Chester, PA 19013



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DELCORA WEBSITE

www.delcora.org

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CONTACT DELCORA

- Mail Address:
  - DELCORA
    P.O. Box 999
    Chester, PA 19016-0999
- Email: ltcpinfo@delcora.org
- On the WEB: www.delcora.org
- General Phone Number: 610-876-5523
- Newsletter
- Sign-Up Sheet

-Thank You-

DELCORA

Discussion - Q&A

COMBINED SEWER OVERFLOW (CSO)
LONG-TERM CONTROL PLAN UPDATE (LTCPU)
PUBLIC MEETINGS

Please join DELCORA for a series of public meetings on our Combined Sewer Overflow Long-Term Control Plan Update.

Learn about DELCORA's combined sewer system and the proposed strategies for significantly reducing combined sewer overflows to our rivers and streams. Please give us your feedback on items discussed at the scheduled meeting below.

2ND MEETING

TOPIC: Scope and Purpose of the Study
WHEN: Tuesday, June 27, 2017 at 6:00 PM (EST)
WHERE: Ridley Township Municipal Building
100 MacDade Boulevard, Folsom, PA 19033

General Email: ltcpinfo@delcora.org
General Phone Number: 610-876-5523

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 2 NOTES

Meeting Title: PUBLIC MEETING NO 2

Date / Time: June 27, 2017 6:00 PM

Prepared By: Marlene Finizio

Location: **Ridley Township Municipal Building**
100 E. MacDade Boulevard
Folsom, PA

Reviewed By: Michael Hope

Distributed: 7/12/17

Attendees:
Robert Willert, DELCORA
Charles Hurst, DELCORA
Michael DiSantis, DELCORA
John Pileggi, DELCORA
Lindsey Isler, DELCORA
Michael Hope, Greeley and Hansen
Marlene Finizio, Greeley and Hansen
See also Public Sign in Sheet

DELCORA held the Second of a series of Long Term Control Plan Update (LTCPU) Public Meetings on Tuesday, June 27, 2017 at the Ridley Township Municipal Building, 100 E. MacDade Boulevard, Folsom, PA. The second public meeting was held to present to the public the LTCPU System Characterization for the LTCP Update. DELCORA's goal of each public meeting is to inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The public meeting was held to as part of the Public Participation Plan. There were approximately 6 individuals from the public in attendance. One representative from the University of Pennsylvania was present at the meeting.

The following items were discussed and presented at the first public meeting:

- DELCORA General Introduction and Opening Remarks
- DELCORA Public Participation Plan Program Goals
- Review of DELCORA Service Area
- Combined Sewer Overflow (CSO) Definition and History
- History of Other USEPA LTCPs
- Background of DELCORA Long-Term Control Plan (LTCP)
- Review of DELCORA Consent Decree (CD) Requirements
- Financial Capabilities Assessment (FCA)
- Summary of Where We Are and Next Phase
- LTCPU System Characterization
- LTCPU Sensitive Areas
- Listing of Future Public Meetings
- Public Locations for Review of Available Literature and Documentation
- Contact Information for DELCORA, Questions and DELCORA Website

Poster Boards were situated at the door of the Ridley Township Municipal Building to encourage public attendance and direct the public to the meeting room. Photos of Public Meeting No. 2 are shown below. **See the attached Public Comment and Response sheet.**

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 2 NOTES

ACTION ITEMS:

1. DELCORA will upload the public meeting notes with sign in sheet to their website.

ATTACHMENTS

- Public Sign-In Sheet
- Handouts at the meeting
- Responses to Public Comments
- Posterboards
- Public Meeting No. 2 PowerPoint Presentation

DELAWARE COUNTY REGIONAL WATER QUALITY AUTHORITY

LONG TERM CONTROL PLAN UPDATE

PUBLIC PARTICIPATION MEETING NO. 2
LTCPU DEVELOPMENT AND EVALUATION OF ALTERNATIVES FOR CSO CONTROLS
June 27, 2017

RESPONSES TO PUBLIC COMMENTS

1. Comment: How often does it happen that flow is sent to the WRTP from Central Pump Station?

   Response: ***Only when it rains and the flow is over 20 MGD at the Pump Station.***

2. Comment: Are any of the industrial users such as Kimberly Clark or Sun Oil impacting the CSO's System?

   Response: ***All Industries connect to the WRTP via force main. No, the industrial discharges do not have an impact on the CSO area or contribute to the CSOs.***

3. Comment: There is no primary contact on the Delaware? I have seen water skiing in this area.

   Response: ***South of mile marker 81.8, the Delaware River is designated for primary contact. The Delaware River is designated for secondary contact north of mile marker 81.8.***

4. Comment: Is fishing allowed from the embankment?

   Response: ***The Coast Guard does not allow fishing in this area.***
   (Doctor Marilyn Howarth): The Delaware River is not a body of water that fish should be eaten from.

5. Comment: Is there contact at the boat dock?

   Response: ***The boat launch is in the primary contact area of the Delaware River.***

6. Comment: Are water sampling results from both wet and dry weather sampling available for public review?

   Response: ***Sampling results are not currently available but will be published in the Water Quality Modeling Report when it is completed. The report will be available to the public on the DELCORA website.***

7. Comment: You mentioned that water quality information was gathered from the community groups. Which ones were used and how did you reach out?

   Response: ***The information is available on STORIT website.***

8. Comment: Did you ask Sierra Club for Data?

   Response: ***Only Federal or State databases were used.***

9. Comment: What are the beneficial uses of the receiving streams?

   Response: ***The Ridley and Chester Creeks are both designated for secondary contact.***

10. Comment: Is there swimming or drinking water use?

    Response: ***There are no drinking water intakes in the streams. Also, no swimming or full body immersion is allowed.***

11. Comment: Are the Chester and Ridley Creeks impaired by nutrients?

    Response: ***They are impaired by siltation.***

12. Comment: Are you going to continue rainfall and flow monitoring?

    Response: ***DELCORA is not anticipating doing any additional flow monitoring at this time. Sampling will resume after the CSO controls are implemented, to verify that the alternatives are reducing the quantity and frequency of CSOs.***

13. Comment: Philadelphia's LTCP that promotes the use of green infrastructure has gotten a lot of positive recognition. Are these types of projects good for Chester?

    Response: ***Yes. DELCORA is working with the City of Chester to develop a GI plan. Their consultant is working with DELCORA to evaluate Green Infrastructure. Green Infrastructure is required to be evaluated by the Consent Decree. At this time, we are not sure how many alternatives will be Green Infrastructure, but it is an option that is being looked at.***

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
CSO Long Term Control Plan Update

DELCORA Public Participation Meeting #2 — Tuesday, June 27, 2017 Ridley Township Municipal Bldg.; Folsom, PA

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
1	MICHAEL HOPE					mhope@greeley-hansen.com		
2	Thomas McKeon					mckeont@ee.penn.edu		
3	Marilyn Howarth	VPEIVN	Phila	PA		howarthmv@gmail.com		
4	Charles Hurst							
5	John Pilegge		Chester	PA				
6	John Scott	/				jscott@coventer.com jjohnscott@cgtlaw.com		
7	Erin Smist					esmist@suburbanrealtorsalliance.com		
8	Ann Tawil	1350 Edgmont Ave	Chester	PA		AMF12@PSU.EDU		
9	Jaclyn Rhoads	VI	Chester	PA		jmd61@psu.edu		
10	MARLENE FINIZIO					MFinizio@greeley-hansen.com		
11								
12								
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17								
18								
19								
20								
21								
22								

Date Rec'd.:		Log No.:		Comment No.:	

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

Public Participation Meeting No. 2
LTCPU System Characterization
June 27, 2017

CLOSING DATE: All Comments Must Be Received 30 calendar days from Public Meeting Date (by July 27, 2017)

1) Responses to public comments will be published within 60 days of the public meeting date (by May 15, 2016). Responses will be posted on the DELCORA Website. Comments may be submitted at the public meeting or by one of the following options:

Email: ltcpinfo@delcora.org

On the WEB: www.delcora.org

Phone: (610) 876-5523

Mail Address: DELCORA
P.O. Box 999
Chester, PA 19016-0999

2) **PLEASE TYPE OR PRINT CLEARLY**. Forms will be returned if they contain unreadable information.

Name:				Date:	
Jurisdiction/Company:					
Address:					
City:		State:		Zip:	
Phone:		Ext:		Fax:	
Email:					

3) Signature: _____

4). Please provide comments below. Provide additional sheets as needed.

Comment 1 _____

Comment 2 _____

Comment 3 _____

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Combined Sewer Overflow - Long Term Control Plan Update

DELCORA

Public Participation Meeting No. 2

LTCPU System Characterization

June 27, 2017

Ridley Township Municipal Building

100 East MacDade Boulevard, Folsom, PA

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Public Participation Plan Goals

- DELCORA's Goals and Objectives for the Public Participation Program are to :
  - Inform and Solicit Input to Updated LTCP from Stakeholders, including Public, Customer Communities and Regulatory Agencies
  - Educate the Public
  - Address Public Concerns

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General Information

- DELCORA is the Delaware County Regional Water Quality Control Authority, established in 1971, responsible for collecting, conveying and treating wastewater in the greater Philadelphia Area including 42 Municipalities in Delaware and Chester County.

DELCORA Mission

"Provide environmentally responsible and cost effective wastewater management services to the citizens, businesses, and industries of Southeastern Pennsylvania"

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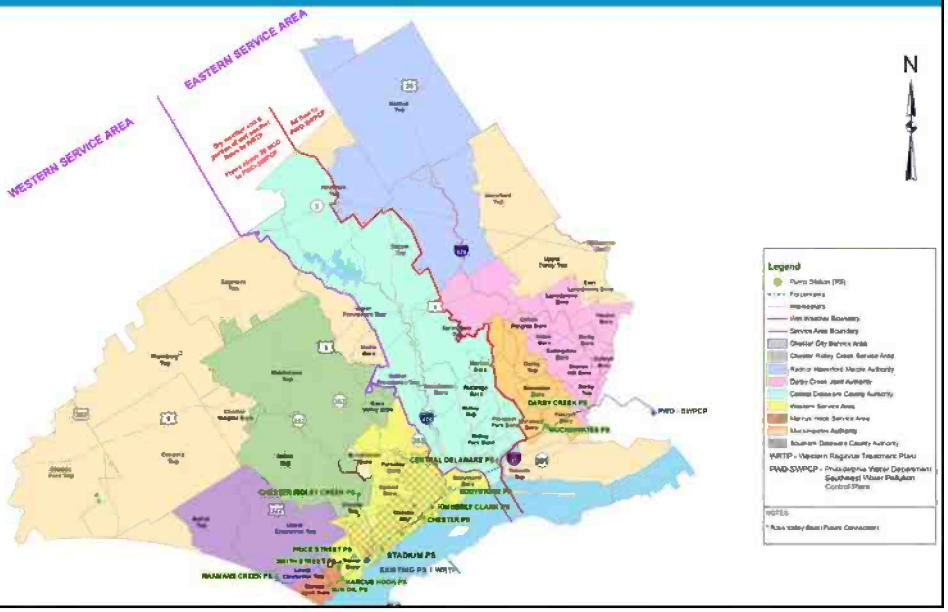
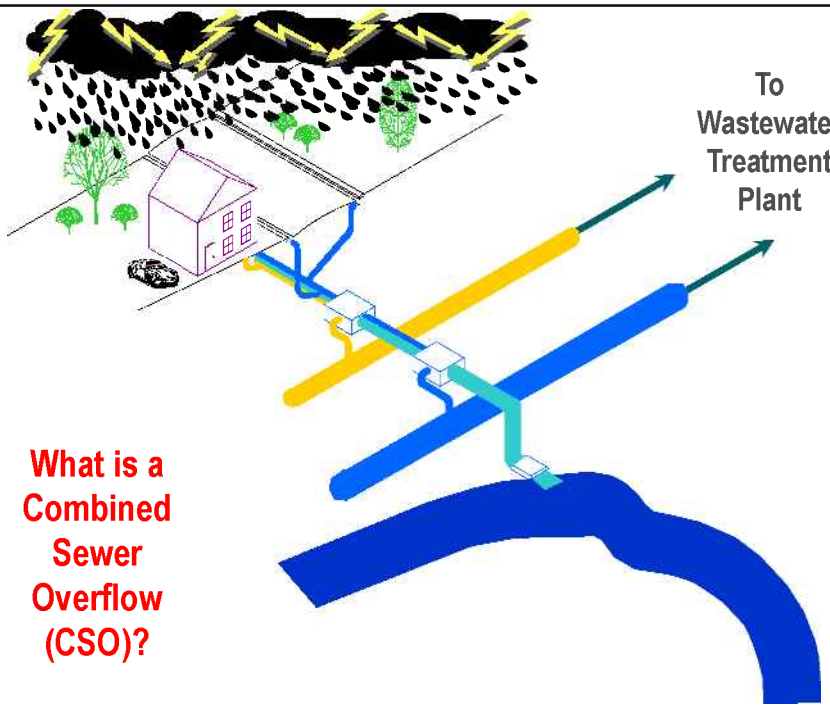
DELCORA Service Area





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Definitions

- **LTCP:** The Long Term Control Plan is the document that lays out how DELCORA will maintain the outfalls and reduce the flow and/or treat the discharge from the outfalls to the water ways to meet the requirements of the Clean Water Act.
- **Sanitary Sewer:** The system that contains only waste from bathrooms, sinks, washers etc.
- **Storm Sewer:** Run off from streets.
- **Combined Sewer System:** Pipe that has both sanitary sewage and storm water in it.
- **Combined Sewer Overflow:** An overflow is the relief point in the combined sewer system that allows the extra flow when it rains to be discharged directly to streams and rivers.
- USEPA: United States Environmental Protection Agency
- PADEP: Pennsylvania Department of Environmental Protection

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History of Combined Sewer System

- In the early 1900's the City of Chester's Combined Sewer System was constructed.
  - This was, at the time, a typical engineering practice in Urban areas.
- In 1971 DELCORA became the owner of the existing Sanitary and Combined Sewer System in the City of Chester.
- Discharges from CSOs are authorized through the National Pollutants Discharge Elimination System (NPDES) permit during Wet Weather Flow.

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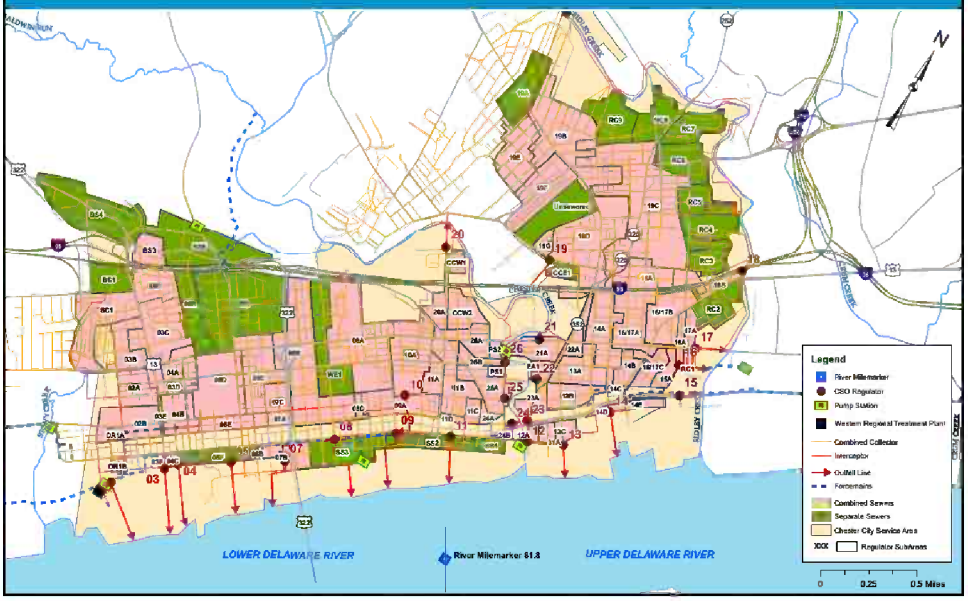
DELCORA Combined Sewer Area



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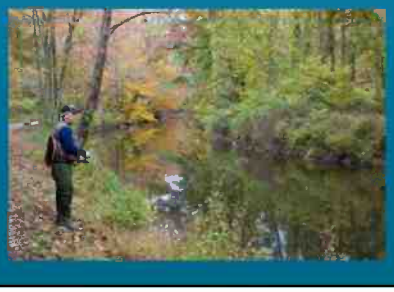
History of EPA LTCPs

- LTCP Consent Decrees/Order for Various Wastewater Systems not only Throughout Pennsylvania, but Entire Country
  - Washington DC, New York City, Richmond
- Current Pennsylvania Communities Already Impacted by LTCP Consent Decree Costs & Fines:
  - Williamsport
  - Scranton
  - Harrisburg
  - Pittsburgh



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Philadelphia LTCP

DELCORA is Currently Contributing to Philadelphia LTCP

- *The Philadelphia LTCP is currently being re-negotiated with EPA. The initial amount of the Philadelphia LTCP was approximately $2.2 billion. A recent Philadelphia bond document stated that the revised cost could be around $4.5 billion. It is uncertain what the outcome of the negotiations will be.*
- *DELCORA's proportionate share of Philadelphia's LTCP is dependent on the results of the Philadelphia – EPA negotiation. DELCORA's initial share as of 2013 was approximately $175 million. DELCORA is waiting for Philadelphia to confirm its revised cost. The term of the DELCORA - PWD contract runs from 2013 to 2028.*

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DELCORA LTCP Background

- In 1999 in response to increased environmental regulations, DELCORA implemented an LTCP for the DELCORA Combined Sewer System in the City of Chester.
- The LTCP identified capital improvements and operation and maintenance practices to reduce overflows.
- From 1999-2009 DELCORA spent in excess of $5 million on improvements and contributions to the City of Chester that resulted in decreased volume of overflows, reduced debris in overflows, provided remote monitoring of the system, and improved routine maintenance.
- In 2009, the DEP and EPA determined that DELCORA's LTCP was no longer in compliance with increased regulations of the Clean Water Act. In response, DELCORA began working with DEP and EPA to update the LTCP.

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LTCP Background (Continued)

- In 2012, DELCORA submitted a revised LTCP to DEP and EPA.
- A key element in DELCORA's revised plan position was that the CSOs are only found in the City of Chester and the financial burden on the City of Chester residents must be considered.
- In 2014, DEP and EPA determined that DELCORA's revised LTCP required further evaluation and development so the Department of Justice was assigned to pursue a Consent Decree.

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DELCORA Consent Decree

- The Consent Decree was agreed to by DELCORA on July 1, 2015 and signed into effect by the Dept. of Justice (DOJ) in November 2015. The Consent Decree is a legally binding agreement between DELCORA, EPA , and DEP in which DELCORA agrees to update the current LTCP.
- Generally, the Consent Decree consists of:
  - Compliance Measures
  - Milestones for Plan Update and Implementation
  - Civil Penalty
  - Stipulated Penalties for Non-Compliance
- DELCORA has been given 42 months (3½ years) to develop a plan and 20 total years to implement the plan. When projects are complete and on-line, sewer fee charges will include costs for the updated LTCP.

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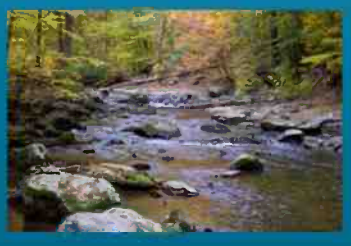
LTCPU Summary – Where We Are

- Hired Expert Consultants with Good Track Records as Well as Experience Specifically Related to LTCP
  - Greeley & Hansen: Engineering Consultant for the LTCP
  - Municipal & Financial Services Group: Rate Model Consultant
  - Blank Rome: Law Firm
- 100% Compliance to Date with Consent Decree
  - Reports Submitted to Date :
    - Public Participation Plan
    - Hydrologic and Hydraulic Model Update and Calibration Plan
    - Typical Hydrologic Period Plan
    - Semi-Annual Reports for 2015 and 2016
    - Sensitive Areas and Pollutants of Concern Report



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LTCPU Summary – Where We Are

- 100% Compliance to Date with Consent Decree (Continued)
  - Reports Submitted to Date (Continued):
    - Draft Financial Capabilities Assessment (FCA) Report
    - Alternative Evaluation Approach
    - Rainfall and Flow Monitoring Quarterly Reports for 1st , 2nd, 3rd, and 4th Quarters
    - Water Quality Monitoring and Modeling Work Plan
    - Water Quality Monitoring and Modeling Quality Assurance Project Plan

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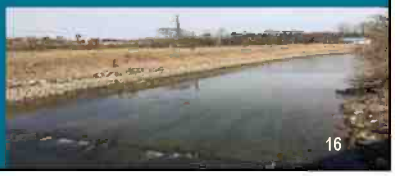
Financial Capability Assessment (FCA)

- The Consent Decree Requires DELCORA to Submit a DRAFT FCA by May 17, 2016 and a FINAL FCA at End of Project. The Draft FCA was submitted on May 13, 2016.
- FCA's Purpose is to Determine Affordability of LTCP
- Develop Fair, Equitable, and Legal Cost Share for Conveyance, Storage and Treatment of Wet Weather Flows



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Financial Capability Assessment (FCA)

Financial Capability Matrix

Permittee Financial Capability Indicators Score (Socioeconomic, Debt & Financial Indicators)	Residential Indicator (Cost Per Household as a % of MHI)		
	Low (1.0% and Below)	Mid-Range (Between 1.0% and 2.0%)	High (2.0% and Above)
Weak (1.5 and Below)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (2.5 and Above)	Low Burden	Low Burden	Medium Burden

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LTCPU Status – Next Phase

- Rainfall and Flow Monitoring - **Completed**
- Dry Weather and Wet Weather Water Quality Sampling - **Completed**
- Data Analysis - **Under Development**
- Hydrologic and Hydraulic Model Development - **Under Development**
- Water Quality Model Development - **Under Development**
- System Characterization - **Under Development**
- Development and Evaluation of Alternatives for CSO Controls - **Under Development**
- Selection and Implementation of the Long Term Plan Alternatives – **2018**
- Continued Public and Stakeholder Involvement – **Ongoing**

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LTCPU System Characterization

- Regulatory Requirements
- DELCORA Model Area
- Model Area Characteristics
- Receiving Water Characteristics
- Combined Sewer System Modeling
- Water Quality Modeling

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LTCPU System Characterization

- Regulatory Requirements
  - Consent Decree: *"Not later than two years (24) months after the Date of Lodging of the Consent Decree, DELCORA shall submit a characterization of the Model Area that includes all of the information required by CSO Control Policy Section II.C.1 and associated guidance…"*
  - CSO Control Policy (USEPA, 1994). Section II.C.1 of the CSO Control Policy: *"In order to design a CSO control plan to adequately meet the requirements of the CWA, a permittee should have a thorough understanding of its sewer system, the response of the system to various precipitation events, the characteristics of the overflows, and the water quality impacts that result from CSOs. The permittee should adequately characterize through monitoring, modelling, and other means as appropriate, for a range of storm events, the response of its sewer system to wet weather events including the number, location and frequency of CSOs volume, concentration and mass of pollutants discharged and the impacts of the CSOs on the receiving waters and their designated uses."*

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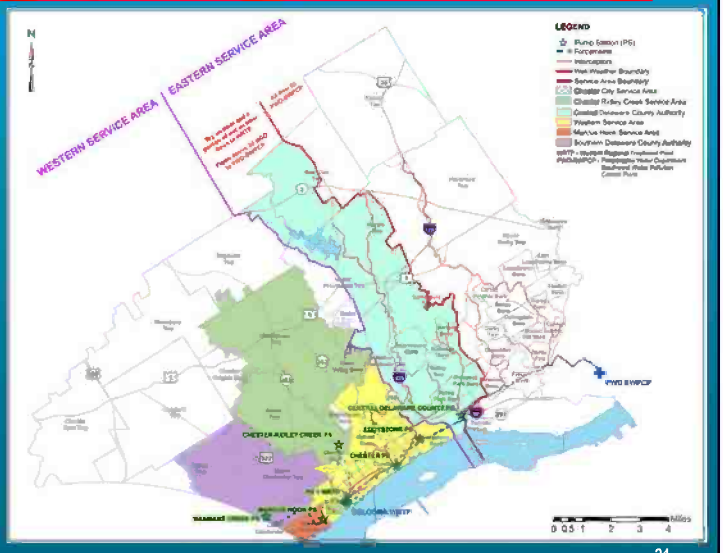
LTCPU System Characterization

Model Area

- Combined Sewer Area – Chester City
- Separated Sewer Areas – Separate Sanitary Sewer System and Separate Storm Water include Western and Central



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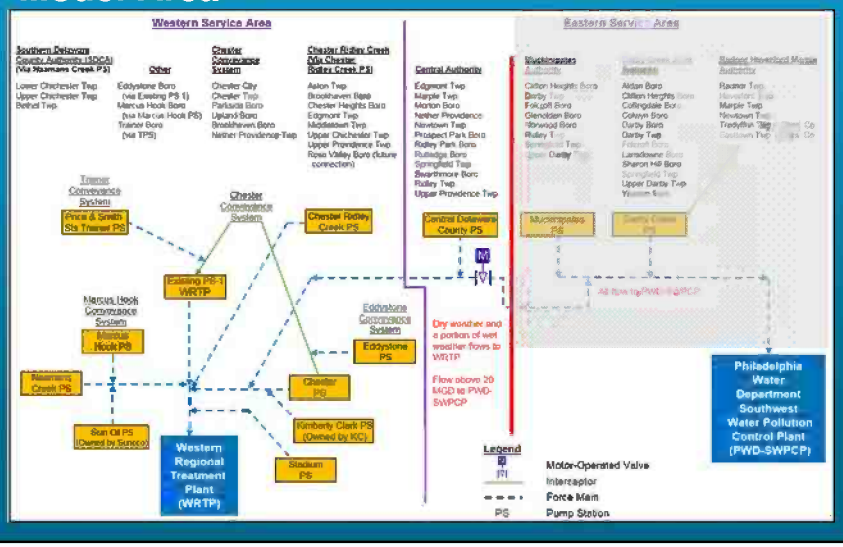
LTCPU System Characterization

Model Area



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LTCPU System Characterization

Model Area Characteristics

- Land Characteristics
  - Pervious vs. Impervious
  - Storm Water Infiltration vs. Runoff
- Obtain Collection System Data - DELCORA Existing Sewer Maps, Design Drawings and Field Surveys
- Collection System Piping
- Collection System Pump Stations – 7 Pump Stations
- Collection System Subcatchments – 55 CSO Subcatchments, 56 Separated Sewer Subcatchments
- Collection System CSO Regulator Structures
- CSO Regulator Improvement Program - 80% of Regulators Upgraded

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LTCPU System Characterization

26 Regulators and 25 CSO Outfalls

Name of Receiving Stream	CSO Regulator/Outfall	Interceptor/CSO Regulator Location
Delaware River	002	Front and Booth
Delaware River	003	Front and Highland
Delaware River	004	Front and Haves
Delaware River	005	Front and Townsend
Delaware River	007	Delaware and Reaney
Delaware River	008	2nd and Tilghman
Delaware River	009	2nd and Lloyd
Delaware River(1)	010	5th and Pusey
Delaware River	011	2nd and Parker
Delaware River	013	2nd and Welsh
Delaware River	014	3rd and Upland
Delaware River(2)	032	2nd and Avenue of The States
Chester Creek	012	2nd and Edgmont
Chester Creek	019	14th and Crozer Hospital
Chester Creek	020	Kerlin and Finland
Chester Creek	021	9th and Sproul
Chester Creek	022	6th and Sproul
Chester Creek	023	3rd and Edgmont
Chester Creek	024	3rd and Dock
Chester Creek	025	5th and Penn
Chester Creek	026	7th and Penn
Ridley Creek	015	4th and Melrose
Ridley Creek	016	8th and McDowell
Ridley Creek	017	9th and Campbell
Ridley Creek	018	Sun Drive and Hancock Street
Ridley Creek(2)	033	Elkington Boulevard and Ridley Creek

Notes:
(1) CSO Regulator #010 Discharges to Delaware River through CSO Outfall #009
(2) No Mechanical Regulator Used for this Outfall
(3) Regulator No Longer Connected to Combined Sewer System, but has not yet been Deleted from NPDES Permit

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LTCPU System Characterization

- Receiving Water Characteristics
- Receiving Waters: Delaware River (Downstream of R.M. 81.8), Delaware River (Upstream of R.M. 81.8), Chester Creek, and Ridley Creek
- Parameters Considered: DRBC WQR, PA Code, NPDES Permit, CSO Guidance Document, 303(d) List, Detected at Plant Influent.
- Identified Pollutants of Concern (POCs) for each Receiving Water Body
  - Fecal Coliform Bacteria
  - Enterococcus Bacteria
  - Escherichia Coli (E. Coli) Bacteria

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LTCPU System Characterization

- Combined Sewer System Modeling
  - Based on EPA Storm Water Management Model (SWMM)
- Simulates Runoff and Flow of Sewage Through Collection System During Storm Events
- Used to Estimate Existing (Baseline) CSO Discharge Volume to Receiving Water Bodies
- Used to Evaluate Effect of Proposed CSO Control Alternatives on CSO Discharge Volume
  - Helps Evaluate Effectiveness of Proposed Alternative

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LTCPU System Characterization

- Water Quality Modeling
  - Software - Environmental Fluid Dynamics Code (EFDC)
- Simulate Effect of CSOs on Water Quality of Receiving Streams under Existing Conditions (Baseline)
- Used to Evaluate Effect of Proposed CSO Control Alternatives on Water Quality

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LTCPU System Characterization

- Final System Characterization Report
  - Submit Report to USEPA by August 2017
  - Baseline H&H Modeling Results
- Final Water Quality Modeling Results Report Complete and Submitted by February 2018

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LTCPU Sensitive Areas

- Sensitive Areas
- Conducted Survey to Assist in Designated Use Determination Per Consent Decree
- The CSO Control Policy states the six (6) criteria for defining an area as a "Sensitive Area" include:
  1. Designated Outstanding National Resource Waters
  2. National Marine Sanctuaries
  3. Waters with Threatened or Endangered Species and Their Habitat
  4. Waters with Primary Contact Recreation
  5. Public Drinking Water Intakes or Their Designated Protected Areas
  6. Shellfish Beds

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Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

LTCPU Sensitive Areas

Sensitive Areas

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Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

Future Public Meetings

- **3nd Meeting – December 5, 2017**
  - Topic: **Development and Evaluation of Alternatives for CSO Controls**
  - When: 4th Quarter 2017
  - Where: Chester City Hall
    1 E. 4th Street; Chester, PA 19103
- **4th Meeting**
  - Topic: **Selection and Implementation of the Long-Term Plan**
  - When: 3rd Quarter 2018
  - Where: Aston Township Administration Building
    5021 Pennell Road; Aston, PA 19014

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Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

Literature and Documentation

- Literature and Documentation will be Made Available by DELCORA at the Following Public Locations and on the DELCORA Website:
  - **DELCORA Administration Building**
    100 East Fifth Street; Chester, PA 19013
  - **Lewis Crozer Library**
    620 Engle Street; Chester, PA 19013
  - **Marcus Hook Municipal Building**
    1015 Green Street; Marcus Hook, PA 19061
  - **Ridley Township Building**
    100 MacDade Blvd.; Folsom, PA 19033
  - **Upland Borough Office**
    224 Castle Avenue; Brookhaven, PA 19015
  - **Chester Township**
    1150 Engle Street; Chester, PA 19013

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Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

DELCORA WEBSITE

www.delcora.org

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Delaware County Regional Water Quality Control Authority
DELCORA
Delaware County, PA

CONTACT DELCORA

- Mail Address:
  - DELCORA
    P.O. Box 999
    Chester, PA 19016-0999
- Email: ltcpinfo@delcora.org
- On the WEB: www.delcora.org
- General Phone Number: 610-876-5523
- Newsletter
- Sign-Up Sheet

-Thank You-

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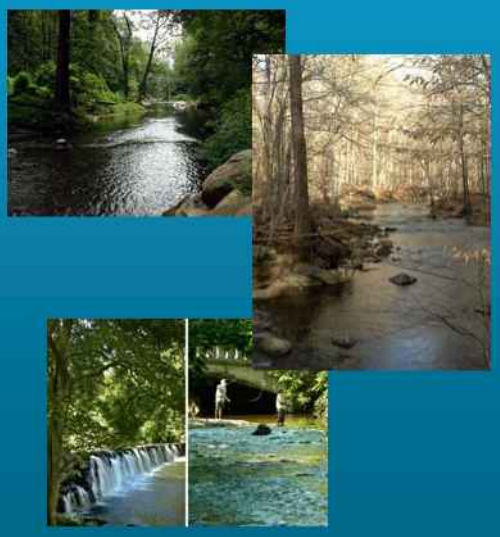
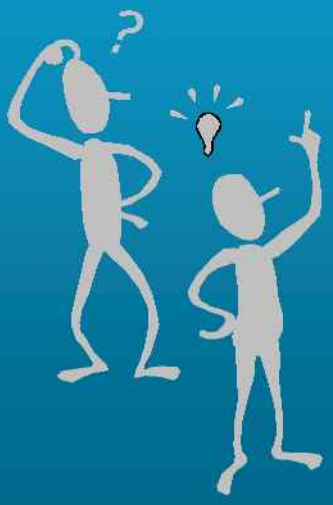
DELCORA

Discussion - Q&A





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COMBINED SEWER OVERFLOW (CSO)
LONG-TERM CONTROL PLAN UPDATE (LTCPU)
PUBLIC MEETINGS

Please join DELCORA for a series of public meetings on our Combined Sewer Overflow Long-Term Control Plan Update.

Learn about DELCORA's combined sewer system and the proposed strategies for significantly reducing combined sewer overflows to our rivers and streams. Please give us your feedback on items discussed at the scheduled meeting below.

3rd MEETING

TOPIC:	**Development and Evaluation of Alternatives for CSO Controls**
WHEN:	**Tuesday, December 5, 2017 at 6:00 PM (EST)**
WHERE:	**Chester City Hall** **Community Room (Room entrance facing Rt 291)** **1 E. 4th Street, Chester, PA - 19013**

General Email: ltcpinfo@delcora.org
General Phone Number: 610-876-5523

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 3 NOTES

Meeting Title: PUBLIC MEETING NO 3

Date / Time: December 05, 2017 6:00 PM

Prepared By: Marlene Finizio

Location: Chester City Hall

Reviewed By: Michael Hope

Distributed: 12/13/17

Attendees:

Charles Hurst, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
Lindsey Isler, DELCORA
Michael Hope, Greeley and Hansen
Marlene Finizio, Greeley and Hansen
See Attached Public Sign in Sheet

DELCORA held the 3rd Long Term Control Plan Update (LTCPU) Public Meetings on Tuesday, December 05, 2017. The third public meeting was held to present to the public LTCPU Development and Evaluation of Alternatives for CSO Controls of the LTCP Update. DELCORA's goal of each public meeting is to inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The public meeting was held to as part of the Public Participation Plan.

The following items were discussed and presented at the third public meeting:

1. DELCORA General Introduction and Opening Remarks
2. DELCORA Public Participation Plan Program Goals
3. Review of DELCORA Service Area and Combined Sewer Area
4. Chester City Municipal Separate Storm Sewer System (MS$) area
5. Combined Sewer System VS separate Sewer system
6. LTCP Summary – Completed
7. LTCPU 42-Month Program Schedule & Milestones
8. LTCPU Alternative Evaluation
9. Review of National CSO policy Requirements
10. Review of DELCORA Consent Decree (CD) Requirements
11. Review of USEPA CSO Guidance for LTCP's
12. Review of the Preliminary Screening purpose and methodology
13. Preliminary Screening requirements of the Consent Decree. Retain technologies as required by Consent Order regardless of ranking.
    - Partial and Complete Separation of Sewer
    - Deep Tunnel Storage
    - Expansion of Primary and Secondary Capacity of WRTP
    - Green Infrastructure
14. Alternatives Evaluation and Next Steps
15. LTCP Program Schedule
16. LTCPU Consent Decree Early Action Item
17. Future Public Meetings
18. Literature and Documentation –
    - Listing of Future Public Meetings
    - Public Locations for Review of Available Literature and Documentation

19. DELCORA Website Information address and information available on their website.
20. Contact Information for DELCORA, Questions and DELCORA Website

A lengthy question and comments session occurred after the presentation was completed. The list of questions/ comments with responses to comments is attached.

There were approximately 37 individuals from the public in attendance including Mayor of the Chester City. Individuals from Chester City Council, Chester City Engineer and Chester

See attached Public Comment and Response sheet.

ACTION ITEMS:

1. DELCORA will make the schedule for the LTCP Update Program available on their website.
2. DELCORA will upload the public meeting notes with sign in sheet to their website.

ATTACHMENTS

- Responses to Public Comments
- Public Sign-In Sheet
- Handouts - Comment Form
- Public Meeting PowerPoint Presentation

DELAWARE COUNTY REGIONAL WATER QUALITY AUTHORITY

LONG TERM CONTROL PLAN UPDATE

PUBLIC PARTICIPATION MEETING NO. 3
LTCPU DEVELOPMENT AND EVALUATION OF ALTERNATIVES FOR CSO CONTROLS
December 5, 2017

RESPONSES TO PUBLIC COMMENTS

1. Comment: How is the City of Chester's stormwater management plan different from DELCORA's plan that was just presented?

   Response: ***The green area on the right of the figure is the separate sewer area. The City of Chester owns the stormwater infrastructure in this area and it is controlled by The City's Stormwater Authority. The pink area on the left of the figure is the combined sewer area. DELCORA owns and operates the combined sewers and is responsible for treating the combined sewage that enters this system. DELCORA is tasked with reducing combined sewer overflows from the EPA and PADEP, which is the purpose of the Long Term Control Plan presented at this meeting. DELCORA is not involved with controlling separated stormwater.***

2. Comment: Where does the new [City of Chester] Stormwater Authority come into play?

   Response: ***DELCORA is charged with operating and maintaining the combined sewers and cannot answer for the Stormwater Authority.***

3. Comment: Will a percentage of what is paid on our sewer bills go toward the DELCORA CSO Long Term Control Plan?

   Response: ***Yes. Development and implementation of the LTCP has a financial cost. We are working with EPA to determine what those costs will be, but we expect them to be significant. As a proactive measure, DELCORA is putting money aside to pay for the LTCP now and using come of that money to upgrade the pump station.***

4. Comment: That makes sense. So, in other words the rates will go up over time?

   Response: ***That is correct.***

5. Comment: Does the City have a stormwater plan?

   Response: ***Yes, but only the Chester City Stormwater Authority can speak to their plan. DELCORA coordinated with the Chester City Engineer to delineate the separated sewer areas from the combined sewer areas using various field techniques. This work was mandated by the EPA and DOJ as part of the Consent Decree.***

6. Comment: Thank you for the presentation, it was very informative. How did the Long Term Control Plan come about? Was it mandated by the EPA and the Department of Justice that you do this? Was there a fine involved?

   Response: ***As mentioned at the top of the presentation, DELCORA reached a consent decree with the USEPA and PADEP and enforced by the DOJ, requiring DELCORA to submit an updated Long Term Control Plan. DELCORA did receive fines, but they were revised. CSO remediation can become very costly, so DELCORA has consistently advocated for the residents and businesses of Chester. At the same time, DELCORA is working toward meeting the requirements of the Consent Decree.***

7. Comment: If expansion at the WRTP was a viable option and was approved by the EPA and DEP, where would the funding come from? Would the cost be spread across customers?

   Response: ***DELCORA will examine many options for funding, but it usually falls on the customers. And it's not just the City of Chester customers, but any customer who is connected to DELCORA's sewer system.***

8. Comment: With DELCORA's nearly 50 years' experience it seems like the perfect option is to expand.

   Response: ***Plant expansion is one of many options that DELOCRA is looking at. It may seem like the most appropriate option on the surface, but a deeper understanding of all alternatives is needed first. That is the purpose of this meeting: to inform the public of the options that DELCORA is looking at for CSO control. Many of these alternatives may be more than DELCORA is capable of implementing. So the next step is to examine each option that is acceptable to the EPA and DEP and narrow down the list by performance and cost effectiveness. It's not the just City of Chester, but it's all of Delaware County that will be charged with this cost. That is the basis for how much money we need to spend according to the EPA and PADEP.***

9. Comment: I agree that the best option seems like expanding the WRTP. It makes a lot more sense because citizens can see where you are investing their money and it is a lot more tangible than some other options.

   Response: ***DELCORA is seriously looking at that option and has discussed it with several consulting engineers.***

10. Comment: Could you give a better estimate of the cost to install separate lines throughout the city?

Response: ***It would be a large number. Factored in with the geography of the City and the configuration of the system means that actually implementing this solution would be very difficult. Across the country there are hundreds of communities like Chester with combined systems. By and large these communities don't really separate unless it's a really conducive situation for separation. For instance, the area by Memorial park would be a good area for it because it can be done without a lot of impact on the neighborhood and the cost would be manageable. But most of the CSO communities, they're building tunnels, storage tanks, and some of the other things we talked about because separation is costly and can have a huge community impact.***

11. Comment: Which is safer to citizens' health, a combined sewer system or a separated system? What causes a 'Flint' problem? Is living in a combined sewer area a cause for concern?

Response: ***Flint is on everyone's minds right now. The good news for the City of Chester is that its drinking water comes from miles away. From a public health perspective, there are hundreds of communities that have combined systems. The mere presence of a combined system doesn't pose a public health threat. What poses a significant health risk in Flint is bad chemistry corroding existing drinking water distribution pipes. As you can see on this map of Delaware County, Chester is the only part of Delaware County that has these combined sewers and they are not used to convey drinking water.***

12. Comment: Is stormwater coming from upstream communities affecting runoff in the City of Chester because we are downstream from those communities?

Response: ***Stormwater from upstream communities generally does not make it into Chester or into the combined sewer system. For instance Ridley is prone to flooding during heavy rainfall but drains to Darby Creek, which runs right into the Delaware. The stormwater runoff from these areas does not run along the ground and make it into Chester's system. They have a separate pipe system that takes it to the creeks. These communities have MS4 permits to discharge stormwater into the creeks and are responsible to make sure that their wastewater is not getting into the stormwater system.***

13. Comment: If the plant were expanded, would the entire service area be part of the payment?

Response: ***It depends on which residents and businesses would be tied in to the system. DELCORA has been looking at different options. Although there would be a certain cost to build facilities, the thought is that a portion of that cost would be offset by redirecting the flow from the Central and Eastern Service areas that currently goes to Philadelphia.***

14. Comment: Where is your plant located?

Response: ***On the Delaware River waterfront at Booth Street.***

15. Comment: What is the focus of this plan for Chester?

Response: ***With this LTCP DELCORA's main focus is on the health and financial stability of its stakeholders. The focus for Chester is to limit the CSOs, which will in turn limit the amount of bacteria that goes into the streams, by capturing more flow and treating it safely and economically. Untreated wastewater can make you sick and hurt your pocketbooks.***

16. Comment: There is talk about cutting regulations at the federal level. What if they cut back your regulations?

Response: ***The bottom line is that we are bound by EPA and PADEP regulations. We need to work with these regulators to allow us to implement innovative solutions, such as blending at the WRTP. There are examples of that in other states. So if it is a safe, effective, and cost-effective solution we need to work with the regulators to advocate for what makes sense for our stakeholders, regardless of the political climate.***

17. Comment: What's the ratio of the area DELCORA is handling versus the City of Chester?

Response: ***We have been working very well with the City of Chester. Starting five years ago, DELCORA has had regular meetings with the City to collaborate and work on different projects to separate sewers. An example is the [Route] 291 project that was completed by DELCORA and the City of Chester. Working together allows us to get more bang for our buck.***

18. Comment: How much are we paying for Long Term Control currently?

Response: ***Right now DELCORA is just paying for the engineering cost to come up with all of these alternatives and produce a finished Long Term Control Plan. The capital cost of the LTCP will be determined when the LTCP is finished.***

19. Comment: How much of the engineering cost is being charged back to your customers?

Response: ***So far, none of it is because it's a capital plan with a capital cost. We are waiting for the project to be finished before we start charging the customers.***

20. Comment: What did Chester do with the $750,000 you gave them to put in new stormwater inlets?

Response: ***As part of the 1999 Long Term Control Plan we had in place, DELCORA paid the City $75,000 a year over a number of years to replace the stormwater inlets. So, from 1999 to about 2009-2010 at $75,000 a year, that totaled approximately $750,000. With that money the City replaced a certain amount of stormwater inlets per year. The new inlets have grates over them which are designed to prevent trash such as water bottles from going into the sewers and going into the streams. Once trash collects in these areas it is very difficult and costly to clean.***

Response: *(City Engineer) As the City engineer, I administered one year of that project myself. And we replaced about 16 inlets with that $75,000.*

21. Comment: What's going on with the pollution reduction plan?

Response: *(City Engineer): There is a pollution reduction plan, yes. The city has adopted a pollution reduction plan. It was presented in July and sent to the state in September.*

Response: ***If you have those types of questions, you can go to the city and they have those types of documents. They have an open records policy, so can look at the documents firsthand.***

22. Comment: Who cleans the stormwater inlets/grates?

Response: ***The City cleans the box [inlet] and grate. DELCORA cleans the CSO regulators and combined sewers.***

23. Comment: Unfortunately from the perspective of the residents, everything seems like it is addressing the same problem but each entity is charging a different fee. I understand there is storm sewers and combined sewers. But I do not understand why there is a City stormwater fee if we are paying DELCORA to address the stormwater issue in these areas.

Response: ***DELCORA is trying to address the stormwater that is going into its combined sewer collection system that causes CSOs. DELCORA cannot speak to the questions relating to the City of Chester Stormwater Authority or other entities.***

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
CSO Long Term Control Plan Update
Public Participation Meeting #3

Tuesday, December 5, 2017
Chester City Hall Community Room, 1 E. 4th Street, Chester, PA 19013

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
1	John Pileggi	512 E. 19TH St	Chester	PA	19013			X
2	JAY VASELL	7 PEMBROKE	MEDIA	PA	19063	JPvaselle@gmail.com	✓	
3	MONIR Z AHMED	783 E. 24th St	Chester	PA	19013	———	—	X
4	Pamela Caulk	100 Grant St, Chester	Chester	PA	19013	———		
5	Gabriel INGram	2218 W 2nd ST	Chester twp	PA	19013	———	—	✓
6	Marguerite Statum	465 Jeffrey St	Chester	Pa	19013			
7	Barbara Pahanman	615 Jeffrey St	Chester	PA	19013	barbmcb50@yahoo.com		V
8	Elroy A LEWIS	702 Villa Drive	Chester	PA	19013	elroylewis@comcast.net	✓	
9	Vince DeL Rossi	100 [illegible]	Chester	PA	1901B	VINCE@HEALTHNET.com	✓	
10	Annette Pyatt	2503 Bethel Rd	Chester	PA	1913	adpyatt@comcast.net	✓	
11	Lisa Gaffney	1 Fourth Street	Chester	PA	19013	LRG@CEDA.cc	✓	
12	Leonna Jones	1111 Ferrill St	Chester	PA	19013	———		
13	Willie Hatcher	717 Villa Dr.	Chester	PA	19013	WJHatcher@AOL.		
14	Pete Littleton	419 Avenue of States	Chester	PA	19013	Pete.Littleton@Corvias.com		
15	TROY Hunt	419 AVENUE of STATES	Chester	PA	19013	TROY.Hunt@CORVIAS.com		
16	GEORGE HASSEL	ONE UNI(VERSITY) PLACE	CHESTER	PA	19013	GEHASSEL@WIDENER.EDU	✓	
17	YANNEISIS Johnson	W 6th St	Chester	PA	19013	yanneisis.johnson79@gmail.	✓	
18	Karla Beaver	914 Butler St	Chester	PA	19013	Beaverkarla		—
19	Jayne Beaver	"	"	"	"	Jazyladyl64@gmail.com	—	
20	Adora Purnell	706 Ward St	Chester	PA	19013	apurnell.ap@gmail.com		
21	Charles Hurst	113 Fawn Cir	Havertown	PA	19041	hurstc@delcora.org		

Tuesday, December 5, 2017

Chester City Hall Community Room, 1 E. 4th Street, Chester, PA 19013

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
22	Portia West	1 Fourth St	Chester	Pa	19013	pwest@chestercity.com		
23	Thelma Spikes	1037 1/2 W 8th St.	Chester	Pa	19013	tkoakland@chestercity.com		
24	Joan Neal	1704 W. 7th St.	Chester	PA	19013	JNEAL@Chestercity.com		
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Tuesday, December 5, 2017

Chester City Hall Community Room, 1 E. 4th Street, Chester, PA 19013

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
46	[illegible]	[illegible]	[illegible]	Pa				
47	Bob Bradam	214 Dock St	Chester	Pa				
48	Darrell Jones	City Hall	Chester	Pa				
49	[illegible]	City Hall	Chester	Pa				
50	John & Delores Shelton	"	"	"				
51	Elizabeth Williams	304 [illegible]	Chester	Pa.				
52	Robert Smallwood	308 W 24th ST	Chester	PA				
53	S.J. Dennis	218 Arbor Circle	Chester	PA				
54	LIVIA SMITH	930 E 18th St	Chester	PA				
55	Trena R. Byrd	3033 W. 6th St	Chester	PA				
56	James Hatcher	1835 W 6th Street	Chester	PA				
57	MICHAEL O. REDDISH	2201 W 3RD STREET	CHESTER,	PA				
58	Shakuna Randolph	633. E. 19th street	Chester	PA				
59	MIKE HOPE							
60	MARLENE FLYNN							
61	LINDSEY ISLER							
62	ROBERT WILLERT							
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Date Rec'd.:		Log No.:		Comment No.:	

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

Public Participation Meeting No. 3

LTCPU Development and Evaluation of Alternatives for CSO Controls

December 5, 2017

CLOSING DATE: All Comments Must Be Received 30 calendar days from Public Meeting Date (by January 5, 2018)

1) Responses to public comments will be published within 60 days of the public meeting date (by February 5, 2018). Responses will be posted on the DELCORA Website. Comments may be submitted at the public meeting or by one of the following options:

Email: ltcpinfo@delcora.org

On the WEB: www.delcora.org

Phone: (610) 876-5523

Mail Address: DELCORA
P.O. Box 999
Chester, PA 19016-0999

2) **PLEASE TYPE OR PRINT CLEARLY**. Forms will be returned if they contain unreadable information.

Name:				Date:	
Jurisdiction/Company:					
Address:					
City:		State:		Zip:	
Phone:		Ext:		Fax:	
Email:					

3) Signature: _____

4). Please provide comments below. Provide additional sheets as needed.

Comment 1 _____

Comment 2 _____

Comment 3 _____

Combined Sewer Overflow - Long Term Control Plan Update

DELCORA

Public Participation Meeting No. 3

LTCPU Development and Evaluation of Alternatives for CSO Controls

December 5, 2017

Chester City Hall Community Room

1 E. 4th Street, Chester, PA

General Information

- DELCORA is the Delaware County Regional Water Quality Control Authority, established in 1971, responsible for collecting, conveying and treating wastewater in the greater Philadelphia Area including 42 Municipalities in Delaware and Chester County.

DELCORA Mission

"Provide environmentally responsible and cost effective wastewater management services to the citizens, businesses, and industries of Southeastern Pennsylvania"

Why Are We Here?

- From 1999-2009 DELCORA spent in excess of $5 million on improvements and contributions to the City of Chester that resulted in decreased volume of overflows, reduced debris in overflows, provided remote monitoring of the system, and improved routine maintenance.
- In 2009, the DEP and EPA determined that DELCORA's LTCP was no longer in compliance with increased regulations of the Clean Water Act. In response, DELCORA began working with DEP and EPA to update the LTCP.
- In 2014, DEP and EPA determined that DELCORA's revised LTCP required further evaluation and development.
- In 2015 DELCORA signed with EPA the Long Term Control Plan Consent Decree.

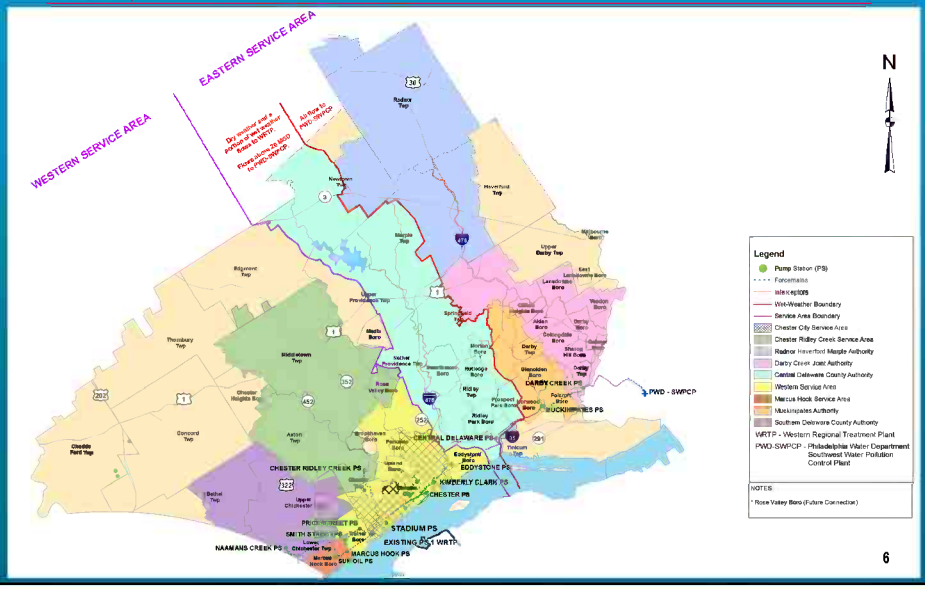
Public Participation Plan Goals

- DELCORA's Goals and Objectives for the Public Participation Program are to:
  - Inform and Solicit Input to Updated LTCP from Stakeholders, including Public, Customer Communities and Regulatory Agencies
  - Educate the Public
  - Address Public Concerns

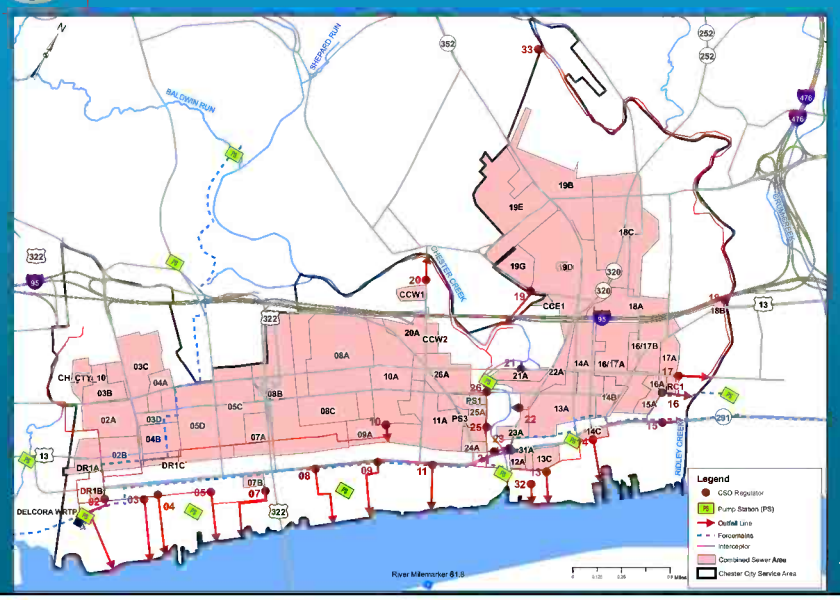
Scope of Meeting

- This Public Meeting (12/5/17) is to:
  - Review DELCORA Service Area
  - Summarize Current Status of LTCP
  - Describe CSO Control Technologies
  - Describe Next Steps Towards Development of Long Term Control Plan Update
  - Questions and Comments

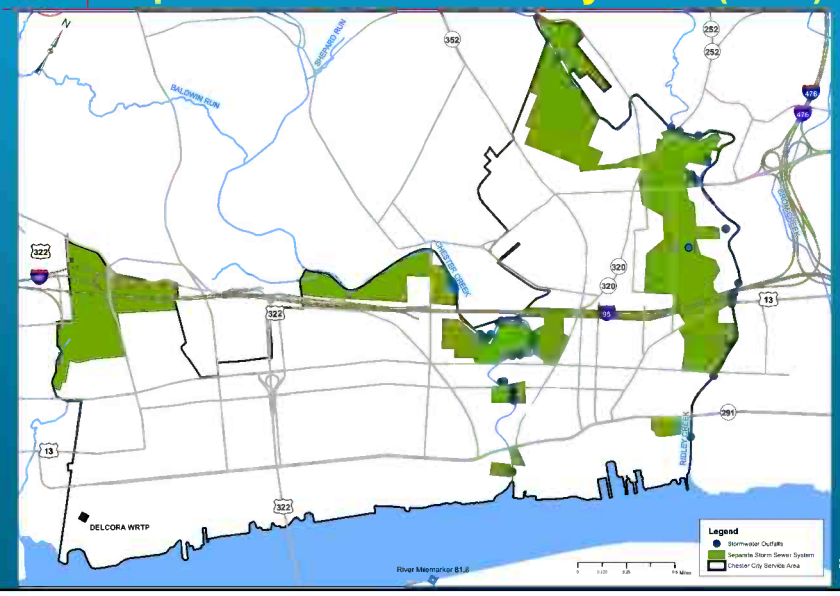
DELCORA Service Area



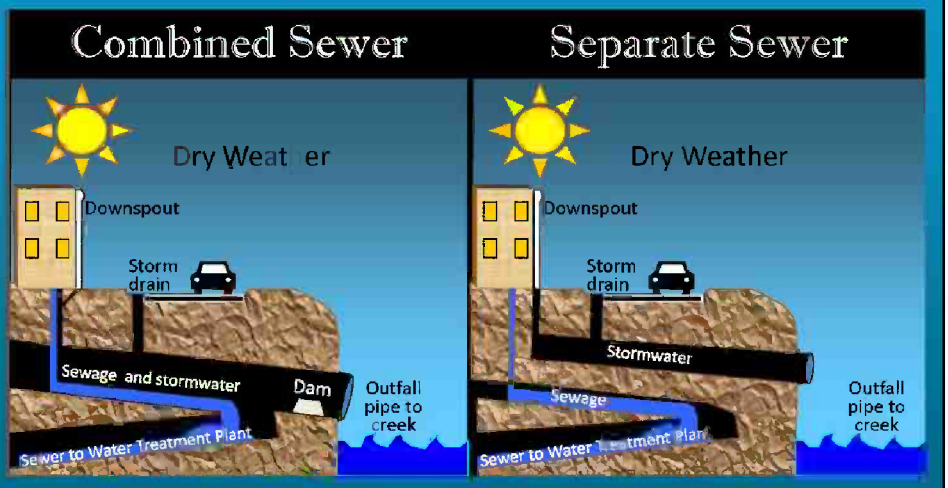
DELCORA Combined Sewer Area



Chester City Municipal Separate Storm Sewer System (MS4)

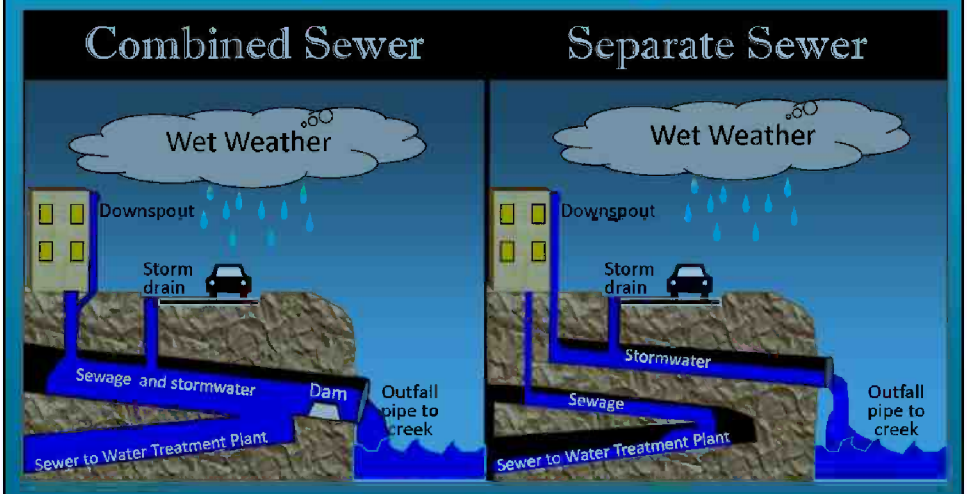


Combined Sewer System vs. Separated Sewer System



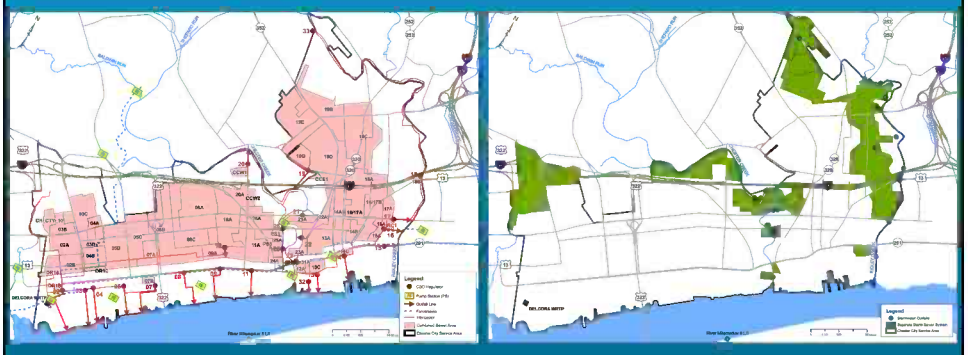
Source: City of Alexandria, https://www.alexandriava.gov/uploadedFiles/tes/oeq/CSSPermitInfoMeetingandPublicHearingPresentation08052013.pdf

Combined Sewer System vs. Separated Sewer System



Source: City of Alexandria, https://www.alexandriava.gov/uploadedFiles/tes/oeq/CSSPermitInfoMeetingandPublicHearingPresentation08052013.pdf

Combined Sewer vs. Storm Sewer System

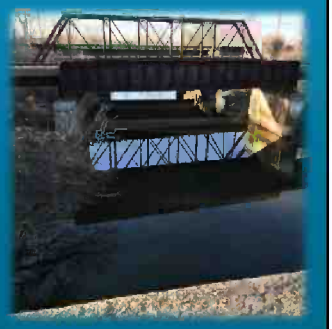


LTCPU Summary - Completed

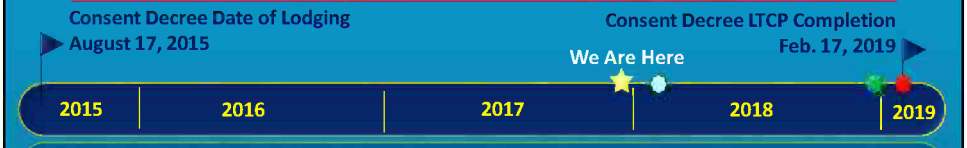
- Hired Expert Consultants with Good Track Records as Well as Experience Specifically Related to LTCP
  - Greeley & Hansen: Engineering Consultant for the LTCP
  - Municipal & Financial Services Group: Rate Model Consultant
  - Blank Rome: Law Firm
- **100% Compliant to Date with Consent Decree**
  - **Reports Submitted to Date**
    - ✓ Public Participation Plan
    - ✓ Hydrologic and Hydraulic (H&H) Model Update and Calibration Plan
    - ✓ Typical Hydrologic Period Plan
    - ✓ Semi-Annual Reports for 2015, 2016 & 2017
    - ✓ Sensitive Areas and Pollutants of Concern Report

LTCPU Summary - Completed

- 100% Compliant - Reports Submitted to Date (Continued):
  - ✓ Draft Financial Capabilities Assessment (FCA) Report
  - ✓ Alternative Evaluation Approach
  - ✓ Rainfall and Flow Monitoring Quarterly Reports for 1st , 2nd, 3rd, and 4th Quarters
  - ✓ Water Quality Monitoring and Modeling Work Plan
  - ✓ Water Quality Monitoring and Modeling Quality Assurance Project Plan
  - ✓ Study Area Collection System Model Report
  - ✓ Existing Service Area Characterization Report



LTCPU 42-Month Program Schedule & Milestones



Reports to Be Completed:

- ★ Public Participation Meeting - December 5, 2017
- ● Water Quality Monitoring and Modeling Report - Feb. 17, 2018
- ● Early Action Item, Complete PS-6 - December 2018
- ● Updated LTCP Final Report - Feb. 17, 2019
  - Includes Development and Comparison of Alternatives
- ● Updated Nine Minimum Controls Plan - Feb. 17, 2019

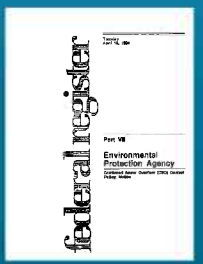
● Consent Decree Due Dates

LTCPU Alternatives Evaluation

- Review Regulatory Requirements
- Purpose of Preliminary Screening of CSO Alternatives
- Available Technologies
- Review Preliminary Screening Evaluation Method
- Alternatives Evaluation Next Steps
- Schedule
- Questions and Comments

National CSO Policy Requirements

- National CSO Policy
  - Consider reasonable range of alternatives.
  - Consider expansion of POTW secondary and primary capacity.
  - Sufficient to Make Reasonable Assessment of Cost and Performance
  - Selected Controls should be sufficient to meet CWA requirements.

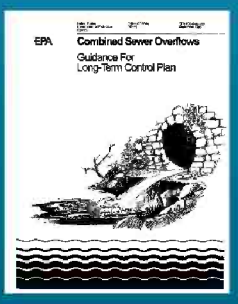


Consent Decree Requirements

- Consent Decree
  - *Consists of:*
    - *Technology screening process*
    - *Detailed evaluation of specific CSO control alternatives*
    - *Selection of an appropriate range of proposed CSO controls to achieve compliance with the Clean Water Act."*
    - *Does not consider cost-effectiveness (at the preliminary screening phase)*
- Specific technologies considered feasible by Consent Decree and must be carried forward for further evaluation.
  - Partial and Complete Separation of Sewers
  - Deep Tunnel Storage
  - Expansion of Primary and Secondary Capacity of WRTP
  - Green Infrastructure

USEPA CSO Guidance for LTCPs

- CSO Guidance for Long Term Control Plan
  - *"Can include technologies, operating strategies, public policies and regulations, or other measures that would contribute to some aspect of CSO control. Control measures can generally be classified under one of the following categories:*
    - *Source Controls*
    - *Collection System Controls*
    - *Storage Technologies*
    - *Treatment Technologies"*



Preliminary Screening

- Purpose of Preliminary Screening
  - Identify alternatives that best meet CSO Control Alternatives with least overall impacts and are worthy of additional evaluation.
    - Meet regulatory requirements.
    - Reduce Pollutants of Concern (bacteria) and/or volume reduction.

Preliminary Screening

- Pollutants of Concern (POCs) Approved by USEPA
- Bacteria: Fecal Coliform, E. Coli, and Enterococcus
- Other Sources of Bacteria from Tributary Flows to Chester and Ridley Creeks:
  - Pets, Wildlife, Livestock and Stormwater Runoff (Urban and Agricultural)

Preliminary Screening

- Methodology
  - Develop comprehensive list of technologies for each type of CSO Control Measure (Source, Collection System, Storage, Treatment).
  - Assign levels of effectiveness at reaching CSO Control Goals for reduction in bacteria or CSO volume

High Medium Low None

Preliminary Screening

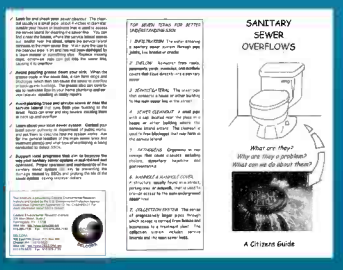
- High Significant Impact on CSO Control Goal and is Among Best Technologies Available
- Medium Effective at Achieving CSO Control Goal but is Not Considered Among Most Effective
- Low Minor Impact on CSO Control Goal
- None Zero or Negative Effect on CSO Control Goals

Preliminary Screening

- Retain technology if level of effectiveness is "HIGH" or "MEDIUM" based on volume or bacteria reduction.
- Retain technologies as required by Consent Order regardless of ranking.
  - Partial and Complete Separation of Sewers
  - Deep Tunnel Storage
  - Expansion of Primary and Secondary Capacity of WRTP
  - Green Infrastructure
- Develop alternatives from retained technologies.

Source Control

- Impact Quality or Quantity of Runoff Entering CSS; Reduce Volumes, Peak Flows or Pollutant Discharge
- Source Control Alternatives
  - Stormwater Management
  - Public Education and Outreach
  - Ordinance Enforcement
  - Good Housekeeping
  - Green Infrastructure
    - Buildings
    - Impervious Areas
    - Pervious Areas

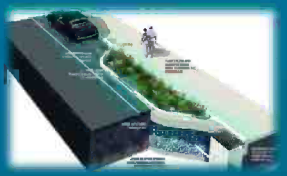


Green Infrastructure

- Green Infrastructure is an approach to water management that protects, restores or mimics the natural water cycle.
- Treats stormwater locally at the source.
- Includes rain gardens, bioswales, permeable pavement, green roofs, downspout disconnections, etc.

Green Infrastructure: Community Impacts

- **Environmental Impact:** Low Bacteria and Medium Volume Reduction
- **Social Impact**
  - Potential Development of Green Spaces in Areas Without It
  - Bioswales may reduce parking and narrow streets.
- **Financial Impact:** Costs of green infrastructure have been higher than gray; may have an impact on rates if used for LTCP compliance



Examples of Green Infrastructure Projects

Collection System Control Technology

- Reduce CSO volume and frequency by removing or diverting stormwater runoff to maximize capacity of collection system.
- Collection System Control Technology Alternatives
  - Inflow/Infiltration Control
  - Operation and Maintenance
  - Combined Sewer Separation
  - Combined Sewer Optimization

Inflow and Infiltration Reduction

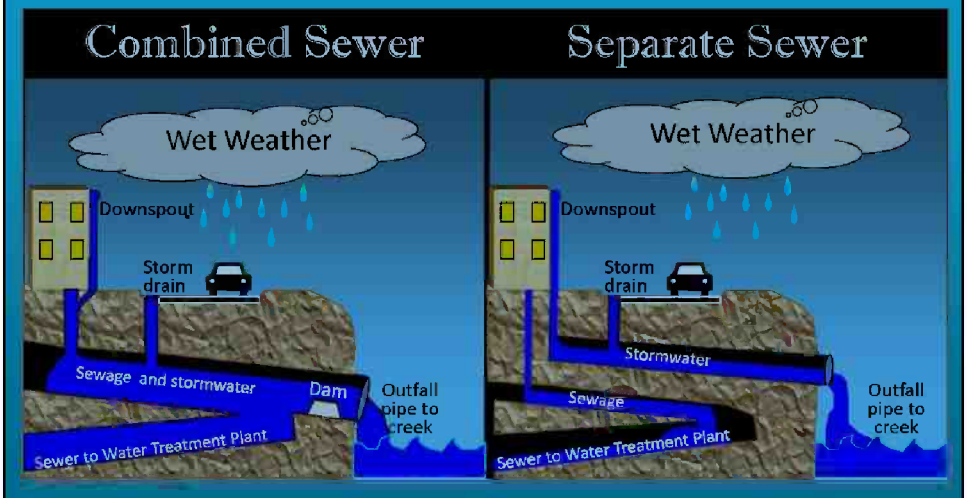
- I&I is water that enters Collection System through cracks, joints, etc.
- Rainfall and Groundwater Driven
- Some I&I is expected

- If removed, frees up capacity that would otherwise be available for combined sewage and adds to CSOs.

Inflow and Infiltration: Community Impacts

- **Environmental Impact:** Low Bacteria Reduction and Medium Volume Reduction
- **Social Impact:** Repairs on Private Property Required by Homeowners
- **Financial Impact:** Can be cost effective if sources of I/I are easily identified.

Combined Sewer Separation



Source: City of Alexandria, https://www.alexandriava.gov/uploadedFiles/tes/oeq/CSSPermitInfoMeetingandPublicHearingPresentation08052013.pdf

Combined Sewer Separation: Community Impacts

- **Environmental Impact:** Highly Effective in Reducing CSOs
- **Social Impact:** Disruptive to Affected Areas Due to Street Closures and Construction Access
- **Financial Impacts**
  - High Costs Due to Street Construction and Replacement
  - Long Construction Duration

Storage Technology

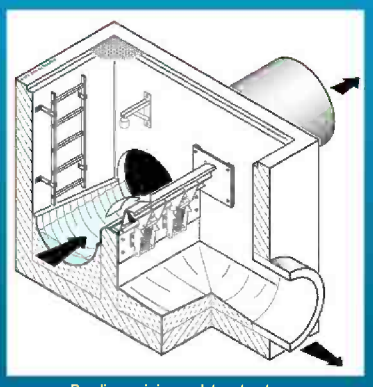
- Reduce overflows by capturing and storing excess wet weather flows.
- Control release of combined sewage back into system once treatment and conveyance capacity have been restored.
- Does not prevent water from entering Combined Sewer System or treat bacterial loads in CSO discharge; effective at reducing or eliminating CSO events.
- Storage Technology Alternatives
  - In Line Storage
  - Off Line Storage

Increased Collection System Storage

- Capture and hold volume until conveyance and treatment capacity return.
  - In line storage uses existing collection system for storage.
  - Off line storage includes the construction of Storage Tanks and Tunnels.

In Line Storage: Community Impacts

- **Environmental Impact:** High Bacteria and High Volume Reduction
- **Social Impact:** Minimal Impact on Community During Construction
- **Financial Impact:** Very Cost Effective Using Existing Infrastructure



Bending weir in regulator structure

Off-Line Storage: Community Impacts

Deep Tunnels

- **Environmental Impact:** Highly Effective in Reducing CSOs
- **Social Impact:** Construction Disturbances at Each Shaft Location which May be Sited in Locations to Minimize Public Disturbance
- **Financial Impact:** Cost Effective at High Removal Volumes

Off-Line Storage: Community Impacts

Storage Tanks

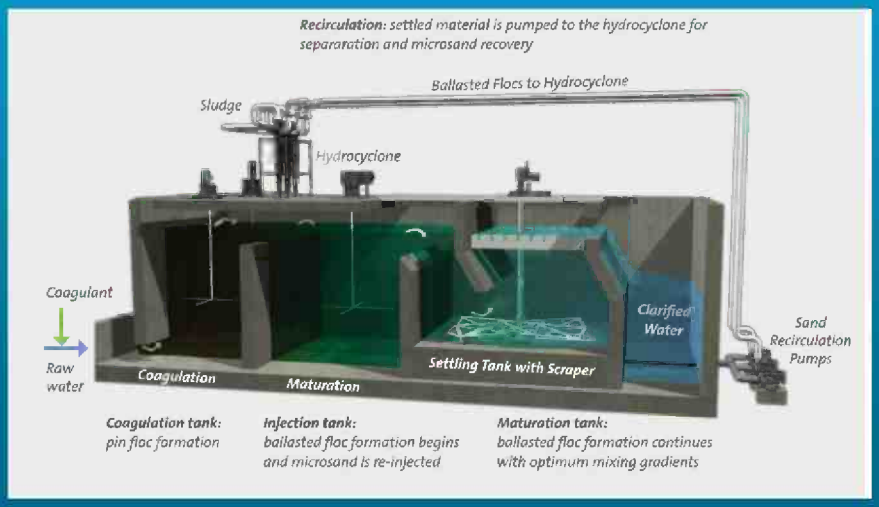
- **Environmental Impact:** Highly Effective in Reducing CSOs
- **Social Impact:**
  - Construction Disturbances at Tank Location Only
  - Can be Buried Under Playgrounds, Parking Lots or Other Community Structures
- Financial Impact: Cost Effective at High Removal Volumes

Examples of Storage Tank Projects from Methuen Construction Co.

Treatment Technology

- Reduce pollutant loads to receiving waters by treating wet weather flows.
- Addresses different pollutant constituents like settleable solids, floatables or bacteria.
- LTCPU will contain provisions for handling, treatment and ultimate disposal of sludge and residuals .
- Treatment Technology Alternatives
  - CSO Facility - Satellite Treatment
  - WRTP - Additional Treatment Plant Capacity, Wet Weather Blending
  - Industrial - Industrial Pretreatment

Satellite Treatment of CSO Discharge



Satellite Treatment Facility: Community Impacts

- **Environmental Impact:** High reduction of bacteria and CSO volume with disinfection
- **Social Impact:** Construction in collection system isolated to selected site.
- **Financial Impact:** Additional cost required for treatment equipment and disinfection.

Treatment or Storage at WRTP

- Convey additional flow to WRTP for treatment; Plant is already at Wet Weather Capacity so would require plant expansion.
- Use Study Area Collection System Model to evaluate sending additional flow to WRTP in order to consider potential overflow reduction.

Secondary Treatment Bypass

- Convey additional flow to WRTP for treatment.
- Blend primary treated effluent with secondary/biological treated effluent.
- Alleviates plant expansion needs to handle additional flows.
- Additional conveyance required.

Improvements at WRTP: Community Impacts

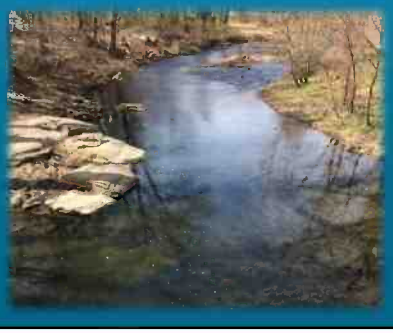
- Environmental Impact: High Bacteria and CSO volume reduction
- Social Impact:
  - No repairs on private property
  - Minimal street closures
- Financial Impact: Cost Effective Due to Available Land on Existing Plant Site and Shared Services with Existing Plant Operations

Alternatives Evaluation Next Steps

- LTCP CSO Control Alternative Evaluation
  - Alternatives Development and Modeling
  - Alternatives Cost / Performance Evaluation
  - Rating, Ranking and Recommendation
  - Financial Plan

LTCPU Program Schedule

- Consent Decree Deadlines and Schedule
  - Final Water Quality Monitoring and Modeling Report submitted by February 2018.
  - Final LTCPU Report due to USEPA by February 2019.
  - Early Action Items - End of 2018



LTCPU Consent Decree Early Action Item

- Consent Decree requires Early Action Combined Sewer Overflow Control Measures to reduce Combined Sewer Overflows.
  - New Pump Station - PS-6
    - Increased Capacity of Existing Pump Station at Western Regional Treatment Plant
    - Anticipated $15 Million Construction Cost
    - To be Completed by December 31, 2018

LTCPU Consent Decree Early Action Items

Future Public Meetings

- **4th Meeting**

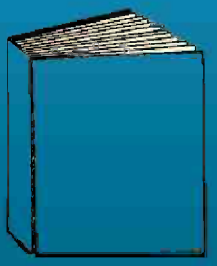
  Topic: **Selection and Implementation of the Long-Term Plan**

  When: 3rd Quarter 2018

  Where: Aston Township Administration Building
  5021 Pennell Road; Aston, PA 19014

Literature and Documentation

- Literature and Documentation will be Made available by DELCORA at the following public locations and on the DELCORA Website:
  - **DELCORA Administration Building**
    100 East Fifth Street; Chester, PA 19013
  - **Lewis Crozer Library**
    620 Engle Street; Chester, PA 19013
  - **Marcus Hook Municipal Building**
    1015 Green Street; Marcus Hook, PA 19061
  - **Ridley Township Building**
    100 MacDade Blvd.; Folsom, PA 19033
  - **Upland Borough Office**
    224 Castle Avenue; Brookhaven, PA 19015
  - **Chester Township**
    1150 Engle Street; Chester, PA 19013



DELCORA Website

www.delcora.org

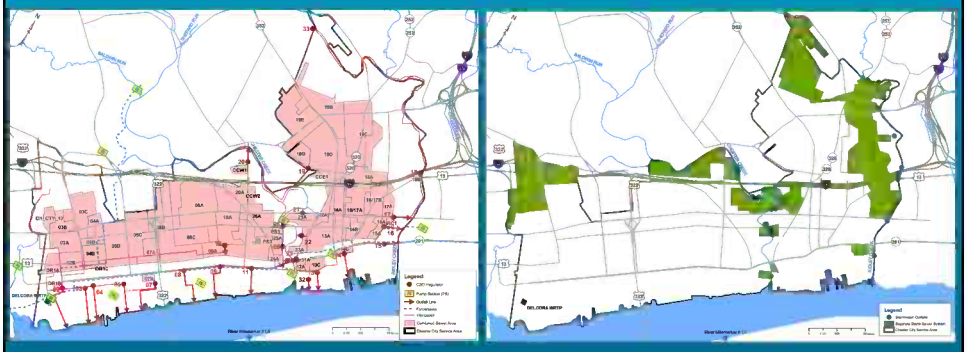
CONTACT DELCORA

- Mail Address
  - DELCORA
    P.O. Box 999
    Chester, PA 19016-0999
- Email: ltcpinfo@delcora.org
- On the WEB: www.delcora.org
- General Phone Number: 610-876-5523
- Newsletter
- Sign-Up Sheet

-Thank You-

Discussion - Q&A

Combined Sewer vs. Chester City's MS4



End of Presentation

COMBINED SEWER OVERFLOW (CSO)
LONG-TERM CONTROL PLAN UPDATE (LTCPU)
PUBLIC MEETINGS

Please join DELCORA for a series of public meetings on our Combined Sewer Overflow Long-Term Control Plan Update.

Learn about DELCORA's combined sewer system and the proposed strategies for significantly reducing combined sewer overflows to our rivers and streams. Please give us your feedback on items discussed at the scheduled meeting below.

4th MEETING

TOPIC:	**Selection and Implementation of the Long-Term Plan**
WHEN:	**Wednesday, September 26, 2018 at 5:00-6:30 PM EST)**
WHERE:	**Aston Township Administration Building**
	5021 Pennell Road, Aston, PA 19014
	General Email: ltcpinfo@delcora.org
	General Phone Number: 610-876-5523

DELCORA Long Term Control Plan Update
PUBLIC MEETING NO. 4 NOTES

Meeting Title: PUBLIC MEETING NO 4

Date / Time: September 26, 2018 5:00 PM

Prepared By: Marcus Mathieson

Location: Aston Township Admin. Bldg.

Reviewed By: Jean Malfronte

Distributed: 9/26/18

Attendees:

Charles Hurst, DELCORA
John Pileggi, DELCORA
Mike DiSantis, DELCORA
Lindsey Isler, DELCORA
Michael Hope, Greeley and Hansen
Jean Malafronte, Greeley and Hansen
Marcus Mathieson, Greeley and Hansen
See Attached Public Sign in Sheet

DELCORA held the 4th Long Term Control Plan Update (LTCPU) Public Meetings on Wednesday, September 26, 2018 at 5:00 PM at the Aston Township Admin. Bldg. The fourth Public was originally advertised as starting at 6:00 however the start time had to be adjusted to 5:00 PM. The meeting was re-advertised to inform residents that the start was adjusted to 5:00 PM. The forth public meeting was held to present to the public LTCPU Development and Evaluation of Alternatives for CSO Controls of the LTCP Update. DELCORA's goal of each public meeting is to inform and solicit input to its updated LTCP from stakeholders, including the public, customer communities and the regulatory agencies. The public meeting was held to as part of the Public Participation Plan.

The following items were discussed and presented at the fourth public meeting:

1. DELCORA General Introduction and Opening Remarks
2. DELCORA Public Participation Plan Program Goals
3. Review of DELCORA Service Area and Combined Sewer Area
4. Chester City Municipal Separate Storm Sewer System (MS4) area
5. Combined Sewer System VS separate Sewer system
6. LTCPU 42-Month Program Schedule & Milestones
7. LTCP Completed Early Action Items and System Improvements to Date
8. Review of National CSO Policy Requirements for the Alternative Analysis
9. LTCPU Alternative Analysis
10. "Knee-of-the-Curve" Analysis and the Recommended Plan for the Selected Alternative
11. LTCP Implementation Schedule and Milestones
12. Available Literature and Documentation Locations for Public Review
13. DELCORA Website Information address and information available on their website.
14. Contact Information for DELCORA, Questions and DELCORA Website

There were no individuals from the public in attendance. Meeting was adjourned at approximately 5:30. There were two DELCORA consultants that arrived at the meeting location after adjournment. DELCORA met separately with the two consultants on November 1, 2018 and provided a hardcopy of the Public Meeting No. 4 presentation and handout materials and reviewed the materials with them. They had no

questions or feedback that would influence the LTCPU. They signed the meeting sign-in sheet, see attached.

A Public Briefing Document was posted on the website and delivered to the repositories 2 weeks before this meeting. The Public Briefing Document summarized the DELCORA Recommended Long Term Control Plan to address Combined Sewer Overflows in Chester, Pennsylvania where necessary. Also covered in the summary were the following key issues: (1) an overview of the DELCORA System and Wet Weather Issues, (2) a summary of progress to date, (3) response to public comments to date, (4) review of sensitive areas, (5) the range of alternatives considered, (6) DELCORA's recommended overflow control plan, (7) the implementation schedule and, (8) post construction monitoring of the overflow control program.

There were no questions from the public relating to the public briefing document posted on the Website or mailed.

ACTION ITEMS:

1. DELCORA will upload the public meeting notes with sign in sheet to their website.

ATTACHMENTS

- Public Sign-In Sheet
- Handouts - Comment Form
- Public Meeting Powerpoint Presentation

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
CSO Long Term Control Plan Update
Public Participation Meeting #4

Wednesday, September 26, 2018

Aston Township Administration Building, 5021 Pennell Road, Aston, PA 19014

	Name (First & Last)	Street Address	City	State	ZIP Code	Email Address	Receive Updates EMAIL	Receive Updates MAIL
1	John Pileggi	512 E. 19TH ST	Chester	PA	19013	jpileggi2011@gmail.com		
2	Charles Hurst	113 Fawn Cir	Haverstown	PA	19041	charlesnhurst@gmail.com		
3	Jean Reichert	118 Fenwick Rd	Cherry Hill	NJ	08034	jean.reich@yahoo.com		
4	Lindsey Amadio	100 E. 5TH ST	Chester	PA	19013			
5	Marcus Mathieson	207 Walnut Hill Ln	Havertown	PA	19083	mr.marcusmathieson@gmail.com		
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Date Rec'd.:		Log No.:		Comment No.:	

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

Public Participation Meeting No. 4

Selection and Implementation of the Long-Term Plan

September 26, 2018

CLOSING DATE: All Comments Must Be Received 30 calendar days from Public Meeting Date (by October 26, 2018)

1) Responses to public comments will be published within 60 days of the public meeting date (by November 26, 2018). Responses will be posted on the DELCORA Website. Comments may be submitted at the public meeting or by one of the following options:

Email: ltcpinfo@delcora.org

On the WEB: www.delcora.org

Phone: (610) 876-5523

Mail Address: DELCORA
P.O. Box 999
Chester, PA 19016-0999

2) **PLEASE TYPE OR PRINT CLEARLY**. Forms will be returned if they contain unreadable information.

Name:				Date:	
Jurisdiction/Company:					
Address:					
City:		State:		Zip:	
Phone:		Ext:		Fax:	
Email:					

3) Signature: _____

4). Please provide comments below. Provide additional sheets as needed.

Comment 1 _____

_____

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Comment 2 _____

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Comment 3 _____

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Combined Sewer Overflow - Long Term Control Plan Update

DELCORA

Public Participation Meeting No. 4

LTCPU Development and Evaluation of Alternatives for CSO Controls

September 26, 2018

Aston Township Administration Building

5021 Pennell Road, Aston, PA 19014

General Information

- DELCORA is the Delaware County Regional Water Quality Control Authority, established in 1971, responsible for collecting, conveying and treating wastewater in the greater Philadelphia Area including 42 Municipalities in Delaware and Chester County.

DELCORA Mission

"Provide environmentally responsible and cost effective wastewater management services to the citizens, businesses, and industries of Southeastern Pennsylvania"

2

Why Are We Here?

- In April 1999, DELCORA adopted their Long Term Control Plan (LTCP) to comply with the Clean Water Act requirements for the Combined Sewer Overflow (CSO) control policy.
- In 2009, the Department of Environmental Protection (DEP) and Environmental Protection Agency (EPA) determined that DELCORA's LTCP was no longer in compliance with increased regulations of the Clean Water Act. In response, DELCORA began working with DEP and EPA to update the LTCP.
- In 2014, DEP and EPA determined that DELCORA's revised LTCP required further evaluation and development.
- In 2015 DELCORA signed with EPA the Long Term Control Plan Consent Decree.

3

Public Participation Plan Goals

- DELCORA's Goals and Objectives for the Public Participation Program are to:
  - Inform and Solicit Input to Updated LTCP from Stakeholders, including Public, Customer Communities and Regulatory Agencies
  - Educate the Public
  - Address Public Questions/Comments

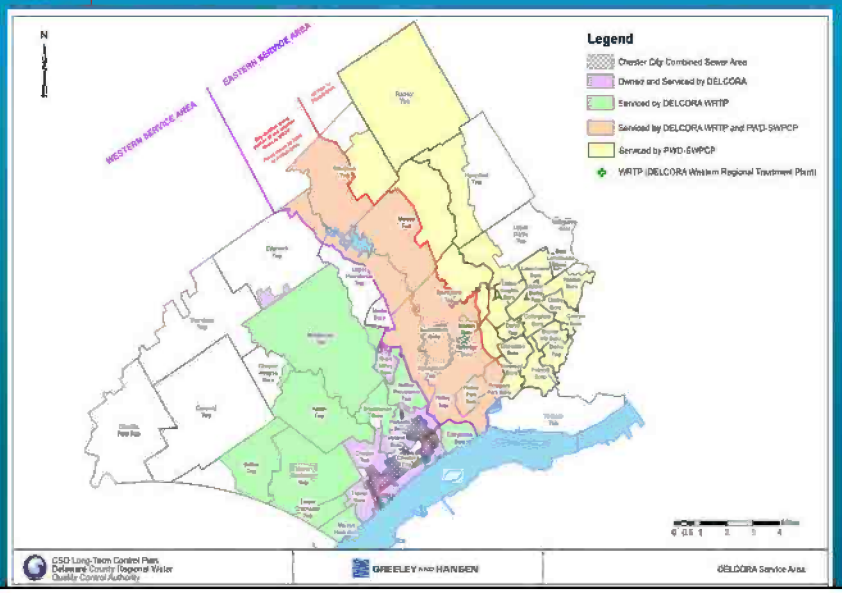
4

Scope of Meeting

- This Public Meeting (9/26/18) is to:
  - Overview DELCORA Service Area
  - Summarize Work of LTCP Addressing Wet Weather Issues Up to this Point
  - Describe CSO Control Alternatives Evaluation
  - Describe Next Steps Towards Development of Long Term Control Plan Update (LTCPU)
  - Questions and Comments

5

DELCORA Service Area



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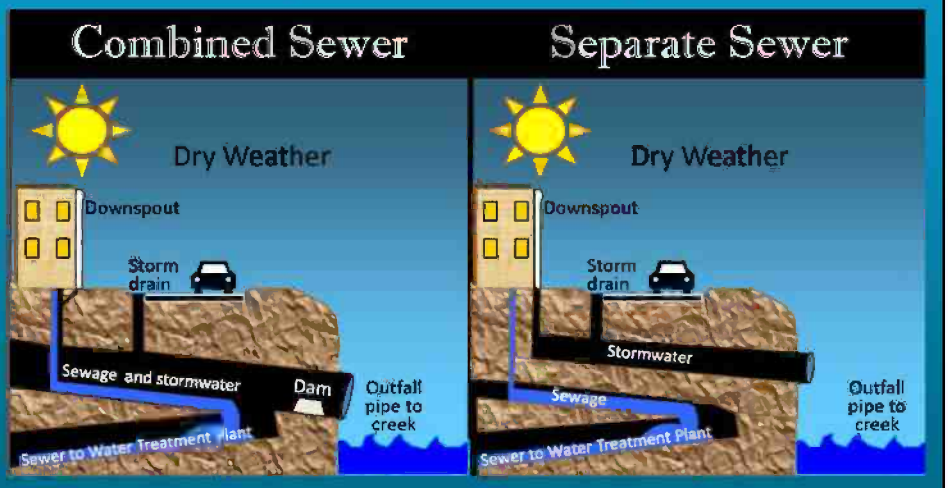
Chester City Service Area

7

Combined Sewer System vs. Separated Sewer System



Source: City of Alexandria, https://www.alexandriava.gov/uploadedFiles/tes/oeq/CSSPermitInfoMeetingandPublicHearingPresentation09052013.pdf

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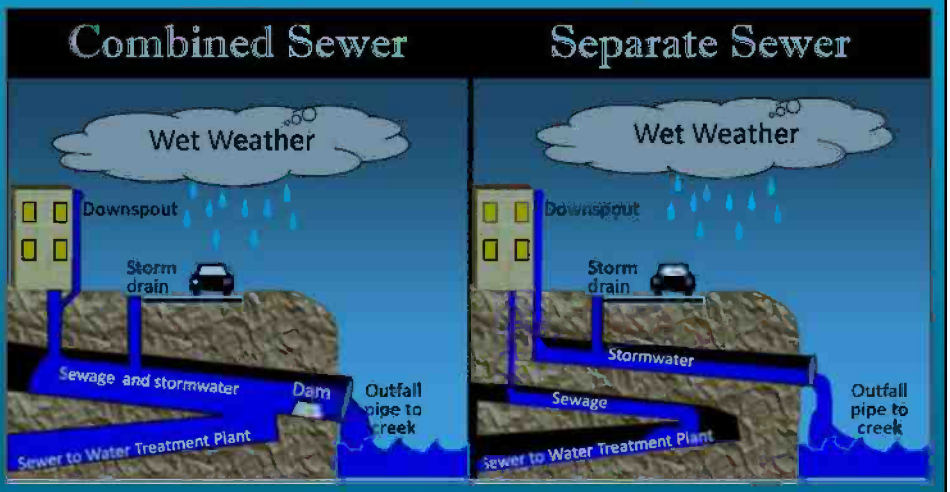
Combined Sewer System vs. Separated Sewer System



Source: City of Alexandria, https://www.alexandriava.gov/uploadedFiles/tes/oeq/CSSPermitInfoMeetingandPublicHearingPresentation08052013.pdf

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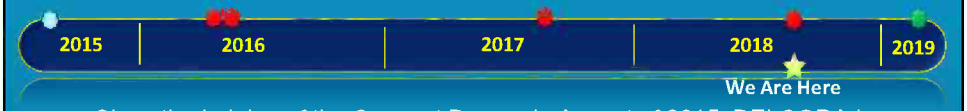
LTCPU 42-Month Program Schedule

Consent Decree Date of Lodging
August 17, 2015

Consent Decree LTCP Completion
Feb. 17, 2019



Since the lodging of the Consent Decree in August of 2015, DELCORA has met important milestones in the program:

2016
- Selected a plan to decrease CSOs and evaluated the financial ability of the community to pay for it.
- Identified the bacteria responsible for the pollution, and high-priority areas for CSO reduction.

2017
- An evaluation of historical rainfall on the existing sewer system was conducted. This would help identify the impacts of new technologies.

2018
- Pump Station "PS-6" completed and held last public meeting.

2019
- Submit final reports to the EPA.

10

Early Action Items

- A new pump station near the DELCORA treatment plant was required to be placed in operation by Dec 2018.
  - New Pump Station PS-6 was placed in operation on September 5th, 2018

- Over $150M has been spent on system improvement projects since the original LTCP in 1999.

11

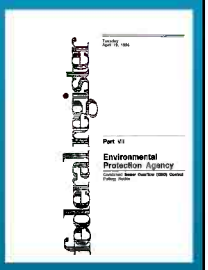
Improvement Costs to Date

- From 1999-2018 DELCORA spent in excess of $150 Million on overall system improvements and contributions to the City of Chester that resulted in decreased volume of overflows, reduced debris in overflows, provided remote monitoring of the system, and improved routine maintenance.
  - Partially separating flow to a CSO regulator
  - Purchasing property for further plant expansion
  - Replacement of older CSO regulator models
  - Research, repair, & replacement for leaking pipes
  - Annual informational flyers mailed to customers

12

National CSO Policy Requirements

- National CSO Policy pertaining to the Alternatives Analysis provides guidance to develop the LTCPU:
  - To meet one of the following (Presumption Approach):
    - No more than an average of 4 overflows a year
    - *Elimination or capture for treatment of at least 85% of combined sewage volume during wet weather events*
    - Elimination or removal of pollutants identified causing water quality impairment during wet weather events



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LTCPU Alternatives Analysis

- Review Regulatory Requirements
- Describe, screen and compare technologies that can be used to achieve the most economically feasible approach to reducing CSOs that meets water quality standards
- Specific technologies must be considered

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LTCPU Alternatives Analysis

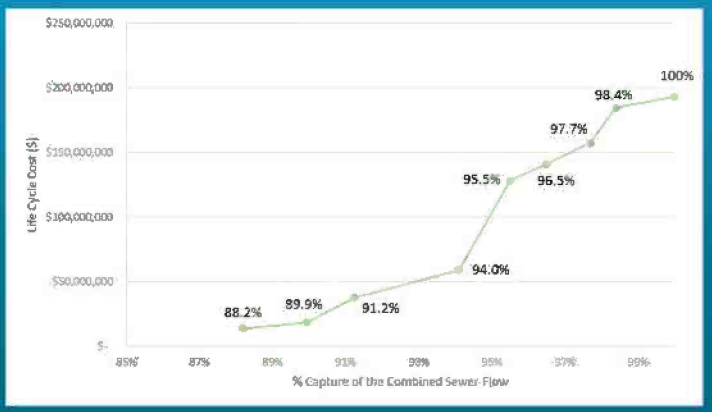
- Elimination or capture of 85% of wet weather flows entering the collection system on a system wide, typical year basis.
  - This level of control is presumed to meet WQS (subject to verification monitoring post-construction).
- Looked at 15 combinations of technologies to reduce CSOs (includes required technologies as per consent order)
- The costs associated for completing all projects in an alternative, as well as their upkeep and operation for 20 years was estimated – this is called the Life Cycle Cost

15

"Knee-of-the-Curve" Analysis

Capture % vs Cost

Knee-of-the Curve Graph for Selected Alternatives



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Selected CSO Control Technologies

- DELCORA's recommended plan has 3 parts based on the Knee-of-the-Curve Analysis:
  - **88% - Regulator Control Improvements** - Regulator Modifications alone will provide enough CSO control to meet 85% wet weather capture.
  - **94% - Targeted Overflow Reduction** - Further CSO control technologies can target the most frequent CSO areas, but is dependent on financing and plant expansion. Address continued minimization of excessive I/I in areas upstream of the CSO system.
  - **Adaptive Management** - Adapting future projects based on the performance of the completed control technologies.

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Components of the Selected Alternative

- The alternative providing over 90% capture costs $59.3M ($101M inclusive of 20 year life cycle costs) with:
  - Regulator Modifications
  - Rehabilitation & extension of the West End Interceptor
  - Building a parallel Delaware River Interceptor
  - Partially separating combined sewers north of Veterans Memorial Park
  - Green Stormwater Infrastructure in high frequency CSO areas
- This alternative provides the most affordable and cost-effective CSO control benefits.
- The boat ramp along the Delaware River is a public access point and the wet weather discharge from the adjacent outfall is addressed in this alternative.

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Selected CSO Control Technologies

Regulator Control Improvements	Life Cycle Costs (Millions $)
Regulator Modifications Estimate	$ 14.2
Targeted Overflow Reduction	
Parallel Delaware River Interceptor	$ 3.6
WE Interceptor Rehab & Extension	$ 2.5
CSO-5 Partial Sewer Separation	$ 4.5
CSO 18 & 19 Green Infrastructure	$ 11.8
Arboretum Tank	$ 10.0
Monitoring and Modeling	$ 5.0
Public Outreach	$ 3.0
Plant Expansion/Upgrade	$ 28.8
Real-Time Control	$ 2.9
Adaptive Management	
Adaptive Management Estimate	$ 10.0
Program Operation Costs	$ 5.0
Total	$ 101.3

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Implementation of the LTCPU

- Regulator Control Improvements are ongoing.
- Targeted Overflow Reduction projects can be fully implemented within the next 10 years, but depend on:
  - If excessive upstream flow into leaking pipes can be affordably addressed.
  - Eastern Service Area costs do not upset Chester's financial capability.
  - Recommended DELCORA treatment plant expansion approval by the PADEP and USEPA.

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LTCPU 20-Year Implementation Schedule & Milestones

Consent Decree Date of Lodging
August 17, 2015

Consent Decree LTCP Completion
August 17, 2035

2020 2025 2030 2035

Milestones:

- Early Action Item, Completed PS-6 - September 2018
- Public Participation Meeting - September 26, 2018
- Updated LTCP Final Report & Update NMCs Plan - Feb. 17, 2019
- Regulator Control Improvements and Targeted Overflow Reduction Projects Complete – completed within10 years from regulatory approval
- All projects complete and fully operational; DELCORA is meeting all requirements of the Consent Decree - August 17, 2035

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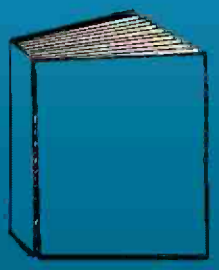
Literature and Documentation

- Literature and Documentation will be Made available by DELCORA at the following public locations and on the DELCORA Website:
  - **DELCORA Administration Building**
    100 East Fifth Street; Chester, PA 19013
  - **Lewis Crozer Library**
    620 Engle Street; Chester, PA 19013
  - **Marcus Hook Municipal Building**
    1015 Green Street; Marcus Hook, PA 19061
  - **Ridley Township Building**
    100 MacDade Blvd.; Folsom, PA 19033
  - **Upland Borough Office**
    224 Castle Avenue; Brookhaven, PA 19015
  - **Chester Township**
    1150 Engle Street; Chester, PA 19013



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DELCORA Website

www.delcora.org

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CONTACT DELCORA

- Mail Address
  - DELCORA
    100 East 5th Street
    Chester, PA 19013
- Email: ltcpinfo@delcora.org
- On the WEB: www.delcora.org
- General Phone Number: 610 876-5523
- Newsletter
- Sign-Up Sheet

-Thank You-

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Discussion - Q&A

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End of Presentation

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APPENDIX N

Corvias Green Stormwater Infrastructure Evaluation

- DELCORA Corvias Green Stormwater Infrastructure (GSI) Evaluation dated November 2017

DELCORA

SAC Corvias

Green Stormwater Infrastructure (GSI) Evaluation

Delaware County Regional Water Quality Control Authority (DELCORA)

November
2017

Executive Summary

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal wastewater authority that owns, operates, and maintains collection systems that serve southeastern Pennsylvania, including the City of Chester. In 2015, DELCORA and the United States Environmental Protection Agency (EPA) entered a consent decree which mandated DELCORA to develop and implement a Long Term Control Plan (LTCP) to control combined sewer overflow (CSO) discharges. The LTCP strategy requires an evaluation of all CSO control options, including green stormwater infrastructure (GSI).

This report identifies potential areas that are suitable for implementation of GSI and evaluates the areas based on several factors such as life-cycle costs, the ability to develop effective GSI, availability of land, and combined sewer overflow control levels achieved. As part of a parallel effort by the Stormwater Authority of the City of Chester (SAC), additional factors were investigated such as environmental and socioeconomic impacts and benefits to minority and low income neighborhoods. This evaluation includes an applicability and performance assessment of proposed GSI control measures that considers unique sewershed-specific features such as diversion structures/outfalls, receiving waters, and land uses. Finally, this evaluation accounts for and assesses long-term, continual operation and maintenance of proposed GSI.

The top-scoring GSI sites resulting from the evaluation are summarized below, together with the estimated footprint areas, storage volumes, and construction and O&M costs:

Summary of Top-Scoring GSI Sites					
	Providence Avenue Regional Management (CSO 18)	Crozer Street Green Street (CSO 19)	Widener University & Walnut Street (CSO 18)	Edgmont Avenue Green Street (CSO 19)	Estimated Totals
GSI Footprint Area	5,500 sq ft	18,100 sq ft	65,306 sq ft	36,875 sq ft	125,781 sq ft
GSI Storage Volume	31,350 cu ft	33,405 cu ft	60,544 cu ft	67,042 cu ft	192,341 cu ft
Construction Cost Estimate	$600,000	$1.9M	$3.6M	$3.9M	$10.0M
Annual O&M Cost Estimate	$15,000	$15,000	$50,000	$30,000	$110,000

The work described in this report was performed by HDR Engineering, Inc. (HDR) for DELCORA and in conjunction with SAC and Corvias, a private entity assisting SAC to implement a Community-Based Public Private Partnership (CBP3) for their Stormwater Controls Program.

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Acronyms and Abbreviations

CBP3	Community-Based Public-Private Partnership
CSO	Combined Sewer Overflow
DELCORA	Delaware County Regional Water Quality Control Authority
DVRPC	Delaware Valley Regional Planning Commission
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GSI	Green Stormwater Infrastructure
GIS	Geographic Information Systems
LiDAR	Light Detection and Ranging
LTCP	Long Term Control Plan
MS4	Municipal Separate Storm Sewer System
NCSS	National Cooperative Soil Survey
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
PADEP	Pennsylvania Department of Environmental Protection
SAC	Stormwater Authority of Chester

1.0 Introduction

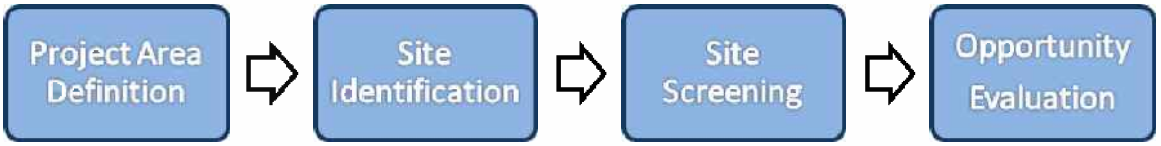
The Delaware County Regional Water Quality Control Authority (DELCORA) operates and maintains publicly-owned treatment works in the City of Chester, Pennsylvania, which collects stormwater and wastewater from residential, commercial, and industrial sources. The collection system has 28 combined sewer overflow (CSO) outfalls that discharge into the Delaware River, Chester Creek, and Ridley Creek.

In 2015, a United States Environmental Protection Agency (EPA) consent decree required DELCORA to evaluate and implement measures to reduce CSO discharges to improve water quality in the Delaware River, Chester Creek, and Ridley Creek.

Concurrently, a Community-Based Public-Private Partnership (CBP3) is being established between the Stormwater Authority of the City of Chester (SAC) and Corvias to plan, design, manage, operate, maintain, and finance the retrofitting of impervious surfaces through the use of integrated green stormwater infrastructure (GSI) practices for a planned 30-year period.

This report summarizes the investigation and evaluation tasks carried out to identify GSI projects in combined sewer system areas of Chester that will help DELCORA meet its consent decree goals.

The evaluation steps detailed in this report and illustrated below were primarily desktop analyses which included collecting baseline data for the project area, identifying and screening parcels with the highest potential for GSI, and evaluating and scoring the top sites.



The following sections detail the opportunity evaluation procedure and the steps undertaken to develop concepts for the sites with the highest potential for GSI.

2.0 Project Area Definition

For the initial evaluation, DELCORA advised that reducing the CSO volumes of outfalls 18, 19, and 22 is the highest priority. The tributary areas to these outfalls are shown in Figure 1 below. During a project meeting held on September 15, 2017, DELCORA shared their plans to separate the tributary to CSO 22 and eventually eliminate the outfall altogether. To prevent any conflict with the separation effort, this report focuses only on opportunities within the tributary areas of CSO 18 and 19.

Source: CSO Tributary Boundary GIS Layer (DELCORA/Greeley and Hansen, 2017)

Figure 1: CSO 18, 19, and 22 Tributary Areas

Reports, documents, and Geographic Information System (GIS) data, as shown in Table 1, were collected from multiple sources to form a baseline understanding of the project area and DELCORA's infrastructure.

It is understood that GIS information for catch basins is not available. Additional information can be collected, as feasible and necessary, during subsequent site investigations if these concepts are advanced to the design phase.

In general, the information received was adequate to carry out the evaluation steps and develop the concepts detailed in this report.

Table 1: Project Area Data Received		
Data/Document	**Source**	**Date**
Green Stormwater Infrastructure Plan	Delaware Valley Regional Planning Commission (DVRPC)	Authored June 2017
DELCORA Consent Decree	Delaware County Regional Water Quality Control Authority (DELCORA)	Dated June 2015
Vision 2020 Climate Adaptation Planning Elements Report	Chester Hazards and Climate Project Team	Authored June 2014
CSO Tributary Boundary GIS Layer	DELCORA/Greeley and Hansen	Received June 2017
CSO Modeling Data for Typical Year	DELCORA	Dated March 2016
Chester Impervious Coverage GIS Layers	AKRF	Received May 2017
CSO Network GIS Layers	DELCORA	Received April 2017
Chester Parcel GIS Layer	Delaware County Board of Assessments	Received April 2017
Chester City Planning GIS Layers: • Libraries, Post Offices, Schools, County and Municipal Boundaries, Cemeteries, Electrical Lines • Transportation Centers, Abandoned Rail Lines, Road Centerlines • Protected and Developed Lands • Rivers, Lakes, Ponds, Streams, Wetlands, Floodplains FEMA (2015), Open Spaces and Recreation	Delaware County Planning Department	Received May 2017
Other Public GIS Layers: • LiDAR Imagery • Contours • Watersheds • Land Use • Historical Markers • NCSS Soil Data	Online – public domain	Downloaded April 2017

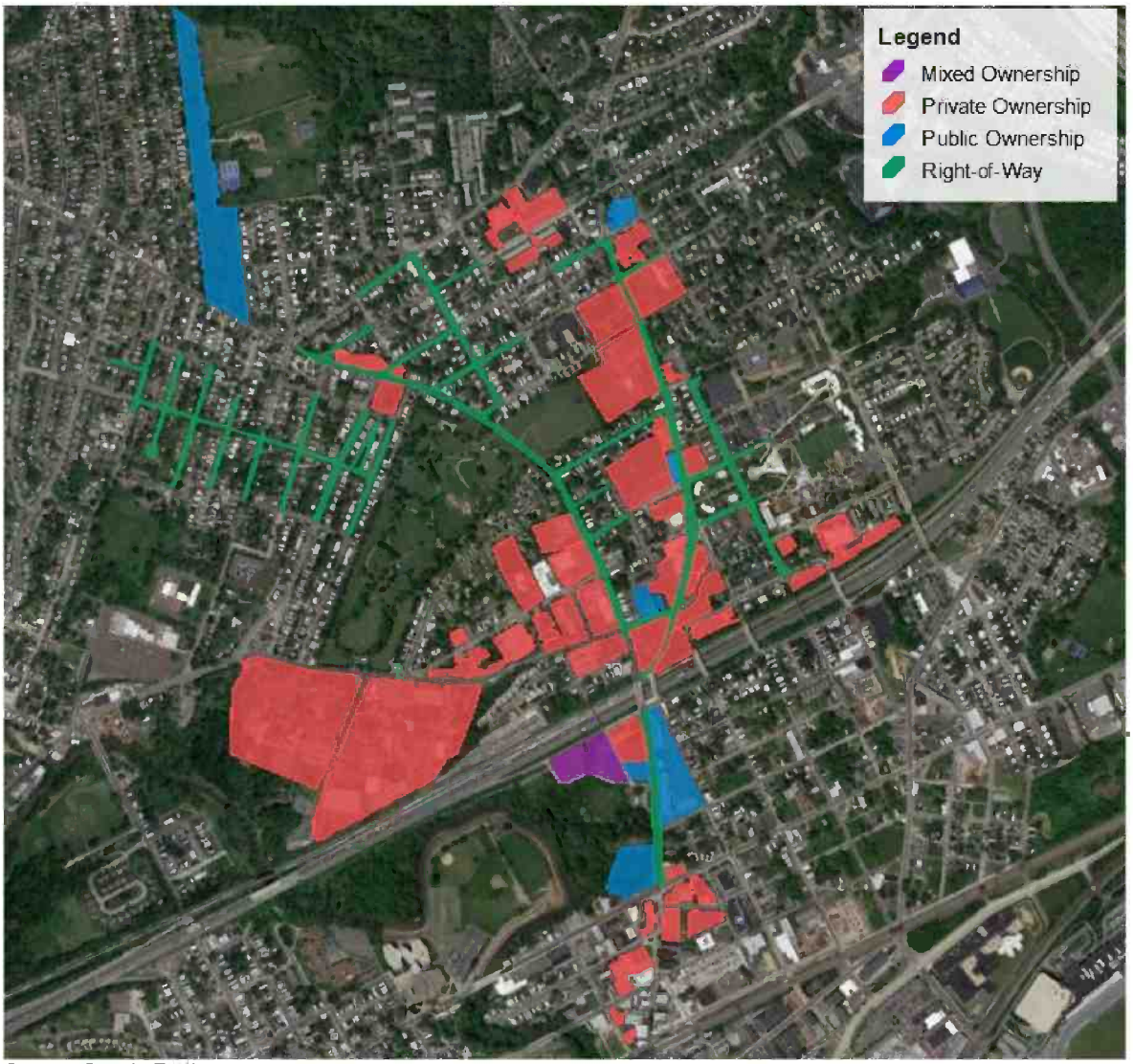
3.0 Site Identification

Using the above information, the first evaluation step involved reviewing parcel data to identify large impervious surfaces and open spaces within the project limits which generate significant runoff to the combined sewer. These sites include:

- Large vacant lots
- Right-of-way corridors greater than 40' wide
- Large publicly-owned parcels or groups of parcels
- Parks and open spaces

- Large private parcels with significant impervious surfaces.

This evaluation step resulted in 61 sites with significant tributary areas that could be managed by GSI practices. These sites are mapped below in Figure 2. This map is color-coded based on ownership type: right-of-way (green), private (red), public (blue), mixed public and private (purple).



Source: Google Earth

Figure 2: Sites with Potential for GSI

4.0 Site Screening

For the screening phase, the 61 sites identified in the previous step were reviewed to determine which sites generated the largest volume of stormwater runoff. These sites have the greatest potential for reducing the volume of water entering the combined sewer system.

During heavy rainfall, all surface types generate runoff which drain to the combined systems and can contribute to CSO events. While impervious surfaces generate a higher rate of runoff, large areas of pervious surfaces can also generate significant runoff volumes. For this reason, the

evaluation specifically targets impervious surfaces, but also considers large pervious areas such as parks and playing fields.

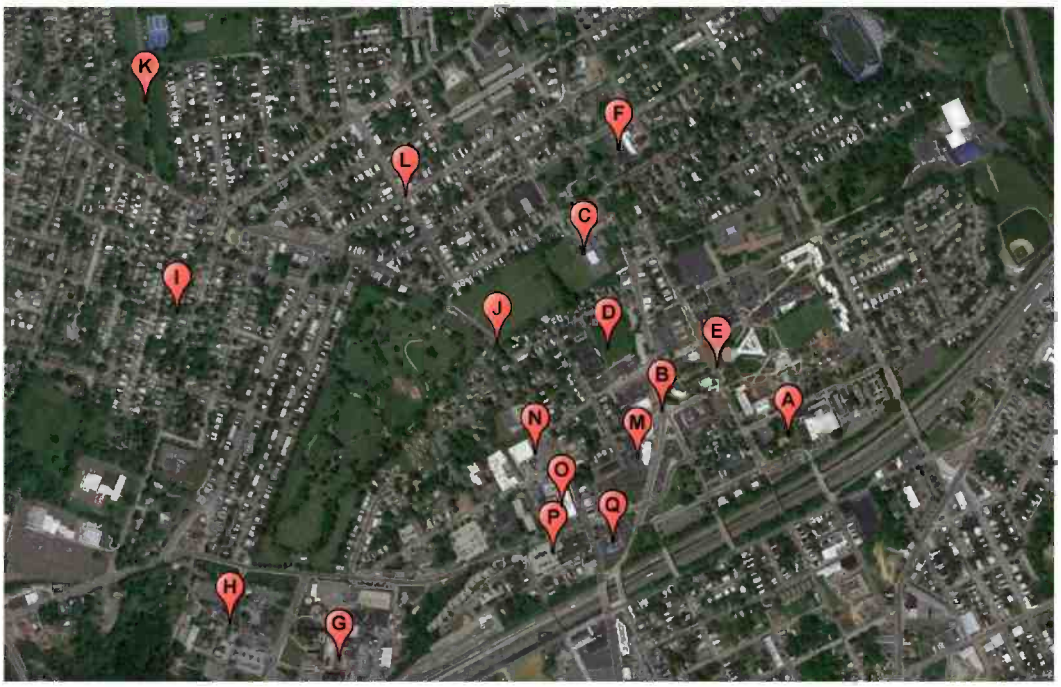
An equivalent acre value was used to calculate a site's total runoff volume. The equivalent acreage of a site was found by adding one quarter of the pervious tributary area to the impervious tributary area. The 0.25 coefficient is a conservative multiplier based on Natural Resources Conservation Service (NRCS) runoff curve numbers for open spaces and lawns with an additional factor of safety to maintain the emphasis on impervious surfaces.

The top sites, based on this screening and organized by CSO outfall tributary area, are listed in Table 2 and mapped in Figure 3. The following locations were also identified in CSO 22, but were subsequently removed from consideration, as noted in Section 1.

- Madison Street Parking Lot,
- Edgmont Avenue South, and
- E12th/Crosby Triangle.

Table 2: High-Potential GSI Sites based on Screening

CSO 18
A. Widener University B. Providence Avenue C. Drexel Neumann Academy D. Smedley Allied Health High School E. Walnut Street F. UHS Keystone Health Center
CSO 19
G. Crozer-Chester Medical Center H. Crozer Seminary I. Crozer Street J. Edgmont Avenue K. Chester Park Vacant Lots L. Madison Street M. Best Western N. Family Dollar O. Widener Partnership School P. 1350 Edgmont Office Building Q. Days Inn



Source: Google Earth

Figure 3: Locations of High-Potential GSI Sites

5.0 Opportunity Evaluation

To evaluate and rank the top sites identified above, a spreadsheet tool was created for scoring various criteria from four primary categories: CSO Volume Reduction, Project Feasibility, Site Suitability, and Community Benefits. Each category consists of defining criteria and is weighted to emphasize important priorities, as detailed in Table 3.

Table 3: Project Evaluation Categories and Criteria

Weight: 50%	**CSO Volume Reduction**
• CSO Effective Tributary Area Managed	
Weight: 25%	**Project Feasibility**
• Design Complexity • Constructability • Utility Conflicts / Constraints (Visual Assessment) • Environmental Remediation (Proximity to Environmental Risk Sites) • Operations and Maintenance Implementation	
Weight: 15%	**Site Suitability**
• Available Land for GSI Practices • Public Safety	
Weight: 10%	**Community Benefits**
• Revitalize Depressed Areas (Social Justice) • Catalyst for New Business and Commerce • Provide Recreation & Education • Environmental Improvement (Greening)	

The ratings for each criterion were based on quantifiable metrics when possible in order to normalize and compare the scoring across all projects. Other ratings such as "Design Complexity" and "Constructability" were based on experience implementing similar GSI practices in other urban areas nationwide. Because the most important categories have heavier weighting, the scores for these criteria had greater consequence for the overall total.

The following data and documents guided the scoring in this evaluation:

- CSO Tributary Maps from DELCORA/Greeley and Hansen to confirm location within the priority CSO tributaries.
- Demographic maps from *Vision 2020 Climate Adaptation Planning Elements* report to determine impact to impoverished areas, location of high-population densities, and proximity to environmental risk zones.
- Google Earth to perform desktop analysis and measure tributary and impervious areas.

For the purpose of this evaluation, it was assumed that the following types of GSI practices would likely be considered for each project during next steps and, specifically, concept development:

- **Bioretention** – vegetated practices within a public or private parcel
- **Tree trenches** – linear tree pits with integrated subsurface storage for runoff
- **Green streets** – combination of right-of-way bioretention or tree trenches, green curb extensions or medians, permeable pavement, and bike paths (where feasible)
- **Permeable pavement** – concrete, brick, or asphalt surfaces that allow runoff to infiltrate to subsurface storage media
- **Green roofs** – vegetated detention layers on flat roof surfaces
- **Subsurface storage** – underground facilities that typically manage stormwater diverted from subsurface drainage structures such as downspouts or separate stormwater pipes. These practices can be designed to infiltrate the stored stormwater or slow-release it back to the system.

6.0 Evaluation Results

Using the information detailed previously, a rating was given for each of the above criteria and entered into the spreadsheet evaluation tool. The spreadsheet then aggregated the scores and applied the weighting factors to each category to derive the total score out of a maximum of 100.

The results for each of the top sites are listed in Table 4 from highest total score to lowest. The table also includes each category score out of the weighted total.

Table 4: Evaluation Results

	Category Scores				
	CSO Volume Reduction	Project Feasibility	Site Suitability	Community Benefits	Total
Project	**50.0**	**25.0**	**15.0**	**10.0**	**100.0**
Providence Avenue	50.0	21.5	11.3	5.1	**88.0**
Crozer Street	50.0	18.0	13.5	4.5	**86.0**
Widener University	50.0	18.5	10.5	6.5	**85.5**
Edgmont Avenue	50.0	14.5	13.5	7.3	**85.3**
Crozer Seminary	50.0	18.0	10.5	3.5	**82.0**
Crozer-Chester Medical Center	50.0	13.5	9.0	4.8	**77.3**
Chester Park	35.0	20.0	11.3	7.5	**73.8**
Madison Street Parking Lot	31.0	19.5	11.5	4.0	**70.0**
Drexel Neumann Academy	25.0	19.5	10.5	6.8	**61.8**
Walnut Street	23.0	17.0	13.5	5.8	**59.3**
Smedley Allied Health High School	23.0	19.5	9.0	7.5	**59.0**
UHS Keystone Center	18.0	19.5	10.5	4.3	**52.3**
Widener Partnership School	16.0	18.0	10.5	7.5	**52.0**
Best Western	17.0	19.5	9.8	4.8	**51.0**
1350 Edgmont Office Building	16.0	19.5	10.5	4.8	**50.8**
Family Dollar	16.0	18.0	10.5	4.8	**49.3**
Days Inn	14.0	19.5	10.5	4.8	**48.8**

For each category column, the highest scores are green, the middle scores are yellow, and the lowest scores are red. The maximum score for each category is listed below the category header. Total scores are out of a maximum of 100.

After initial scoring and during the project meeting held on September 15, 2017, DELCORA advised that Crozer Seminary and Crozer-Chester Medical Center should be assumed to be separately sewered. As a result, these sites were subsequently removed from consideration for this evaluation. DELCORA also requested that Walnut Street be combined with the Widener University concept.

After reviewing the results, DELCORA agreed to proceed with site investigations for the top sites as scored:

- Providence Avenue
- Crozer Street
- Widener University / Walnut Street
- Edgmont Avenue

7.0 Site Investigation Overview

Following the identification of the top four scored opportunities, site investigations were completed to gather further information on each site to inform concept development. The investigations focused on completing the below activities:

- Taking representative site photographs
- Locating surface drainage features such as catch basins, drains, manholes, ditches, and channels
- Recording high and low points, site contours, and other features that may affect surface flow
- Delineating tributary area boundaries within each opportunity area

- Identifying site constraints that may affect GSI construction, functionality, and maintenance such as limited accessibility, site usage and constraints, and existing trees and vegetation.

The information gathered during the site investigations contributed to the development of the proposed GSI concepts presented in Section 8.

8.0 GSI Concept Overviews

8.1 Approach

The approach to developing the proposed GSI concepts is a high-level adaptation of techniques used for GSI planning nationwide. The step-by-step process is detailed below.

The first step was to delineate the tributary for each opportunity area. The **total tributary area** is defined as all the surface area that contributes stormwater runoff to a termination point such as a drain, low point, or waterbody. Tributary areas should be delineated to account for all site runoff from both impervious and pervious surfaces.

After delineating the tributaries, the **total runoff volumes** were determined based on a design storm depth of 1.5 inches. This depth is consistent with design guidance for publicly-funded GSI projects as part of CSO control programs in other cities in the region. The total runoff volume was then calculated by multiplying the design storm depth by the effective tributary area (impervious tributary area plus 25% of the pervious tributary area).

Using the site investigation information, the most suitable GSI types were selected for each area. The preferred option is to utilize vegetated solutions such as **bioretention**. Vegetated solutions offer many co-benefits such as beautification, shading and temperature reduction, environmental enhancement, and relative ease of maintenance.

Where vegetated practices are not feasible due to accessibility issues, traffic and pedestrian usage, or line-of-site constraints, **permeable pavement** was recommended. Permeable pavement practices offer fewer co-benefits, but can be installed in places where vegetated features are not feasible.

Green stormwater infrastructure practices in the right-of-way were considered **green streets**. These practices consist of a combination of bioretention, permeable pavement, and other amenities such as pedestrian crossings and bike lanes. The exact configuration of these components should be finalized during the detailed design stage.

Subsurface storage was the last option considered. These practices manage stormwater in underground chambers and are not visible on the surface; therefore they offer few additional co-benefits. However, in cases of drainage diversions or disconnections, subsurface storage can be used to efficiently manage large volumes of runoff from a regional system by infiltrating the water into the surrounding soil or discharging it back to the combined sewer at a lower peak rate of runoff.

GSI **footprint areas** within each concept were then estimated based on the available space observed during the site investigations. In the right-of-way, GSI practices were assumed to have an average width of five feet, situated within the parking lanes or road

shoulders. Onsite, the GSI footprint areas were sized to maximize the storage volume, up to the total runoff volume, based on site constraints such as available space and mature trees. Estimation of GSI footprint areas for this evaluation did not consider survey or subsurface conditions that may limit siting or sizing of GSI, as this data would be collected as part of design activities.

Based on industry best practices, the ratio of tributary area to footprint area was limited to a maximum of 5:1 for permeable pavements and 20:1 for bioretention where feasible. Higher ratios may require additional pretreatment features or increased maintenance frequencies.

GSI **storage volumes** were estimated using the footprint areas, typical cross-sections, and design components for the respective GSI type. Note that due to site limitations, storage volumes were not always sufficient to manage the total runoff volume.

From the estimated footprint sizes, conceptual cost estimates were established based on typical costs per square foot for construction and maintenance. See Section 8.2 for cost estimation assumptions.

8.2 Assumptions

The concepts presented in Section 8.3 are based solely on the information detailed in this report, information gathered during the site investigation, and direction given by DELCORA.

The tributary and GSI footprint areas are approximate and only based on the available information and observations during the site investigations. At this stage, it is assumed that all open space identified during site investigations will be available to install GSI practices. For this report, only static storage volumes were estimated and infiltration was not taken into account.

During design, the tributary areas and GSI locations will need to be fully investigated and amended as necessary. This may include adding, removing, and modifying GSI practices based on geotechnical investigations, topographic survey, utility coordination, and cost/benefit analyses.

Conceptual cost estimates summarized in Section 8.3 are based on estimated construction and maintenance costs per square foot of GSI footprint. These rates are summarized below (all costs are in current dollars):

- $90-$105 per square foot to construct GSI practices (bioretention or permeable pavement, respectively) within the right-of-way.
- $30-$35 per square foot to construct GSI practices (bioretention or permeable pavement, respectively) within public and private parcels.
- $0.75-$1.25 per square foot **annually** to maintain GSI practices (permeable pavement or bioretention, respectively).
- Subsurface storage cost estimates were based on footprint size, volume of excavation required, and assumed level-of-effort for annual maintenance.

The differences in costs are due to increased expenses when working in the right-of-way and the variability of costs per GSI type. These figures do not include additional costs

such as mobilization, traffic control, utility relocations, or surface amenities. These estimates are based on recent trends in urban GSI development and are considered reasonable for the purposes of preliminary budgeting. The costs shall be confirmed during the detailed design of individual projects.

8.3 Concept Summaries for Top-Scoring Sites

Concepts for the four highest-scoring GSI opportunity areas are summarized in Table 5 below. The cost estimates for construction and operations and maintenance (O&M) included below are conceptual-level only as described in Section 8.2.

Table 5: Summary of GSI Concepts

1 Providence Avenue Regional Management

Proposed GSI: Subsurface Storage

Total Tributary Area: 33.2 acres
- Impervious Area: 30.1 acres
- Pervious Area: 3.1 acres

Total Runoff Volume: 168,215 CF

GSI Footprint Area: 5,500 SF
GSI Storage Volume: 31,350 CF

Construction Cost Estimate: $600,000
Annual O&M Cost Estimate: $15,000

Summary:
DELCORA survey records show the separate stormwater system in this area collects runoff from a tributary area of 33.2 acres and flows south down Providence Avenue. The separate system discharges to the CSO 18 combined sewer system just north of the proposed site in the grassed triangle.

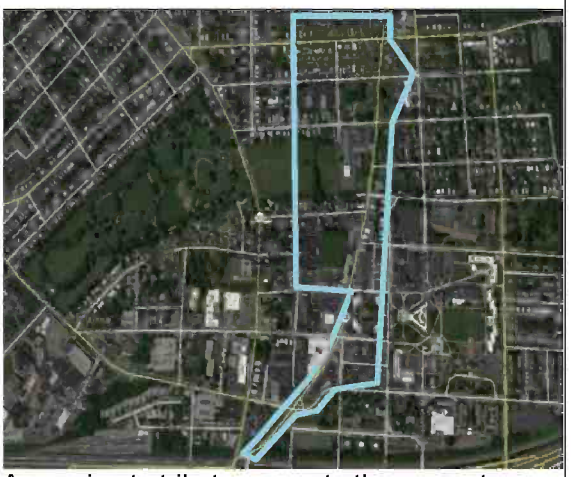
This concept would divert the separate stormwater flow to a regional storage facility installed underground in the grassed triangle area east of Providence Ave, before it enters the CSO 18 combined sewer system. Due to mature trees, the available footprint area for the subsurface storage is approximately 5,500 square feet, which is not sufficient to manage the total runoff volume.

Records from the City of Chester show that this triangle area is owned by Widener University, so a procurement or easement would need to be coordinated with the University. The location and inverts of the existing separate sewer connection and soil infiltration rates will affect the design and need to be confirmed in a subsequent phase.

Overall, this site may be able to manage a large volume of runoff in a relatively small area. While the GSI practices would be underground, surface features or amenities could be added during design and construction to provide community benefits such as benches and other passive recreation. However, due to the small and remote site, co-benefit potential may be minimal.

Secondary options include expanding the subsurface storage to the adjacent parking lot or to the grassed area to the north to increase storage capacity.

Proposed site of regional subsurface storage in grassed traingle


Approximate tributary area to the separate stormwater system in Providence Ave

Grassed triangle viewed from the north

2 Crozer Street Green Street

Proposed GSI: Green Streets

Total Tributary Area: 42.4 acres
- Impervious Area: 25.3 acres
- Pervious Area: 17.1 acres

Total Runoff Volume: 161,276 CF

GSI Footprint Area: 18,100 SF
- Bioretention: 3,000 SF
- Permeable Pavement 15,100 SF

GSI Storage Volume: 33,405 CF
- Bioretention 6,225 CF
- Permeable Pavement 27,180 CF

Construction Cost Estimate: $1.9M
Annual O&M Cost Estimate: $15,000

Summary:
Crozer Street runs east and west through a residential zone in the CSO 19 tributary area. Available data shows that this street is at a low point, receiving stormwater runoff from adjacent streets and properties.

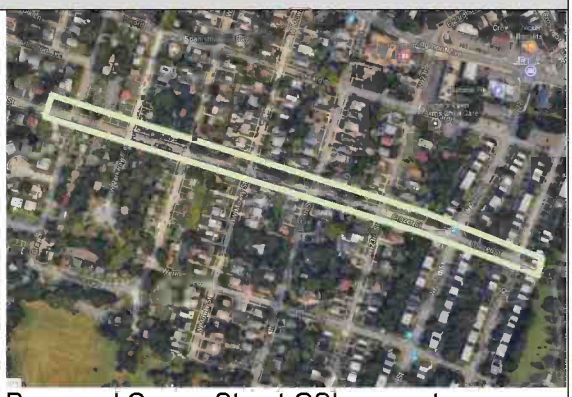
Right-of-way bioretention practices are proposed at the intersections in Crozer Street and its cross-streets. These will be bumped out into the roadway just upstream of the existing catch basins.

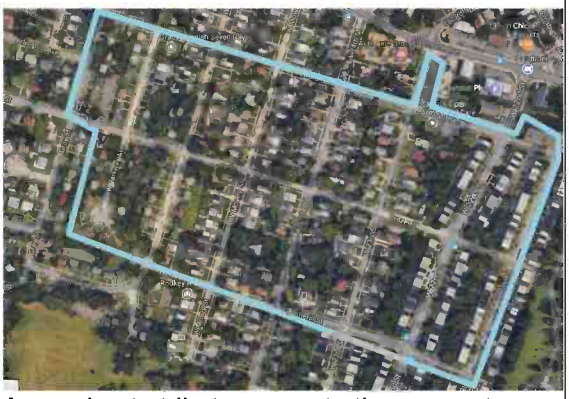
Due to the large tributary area, permeable pavement is also proposed in the shoulders of Crozer Street to increase the storage capacity.

This concept is favorable because it lies entirely within publicly-owned property in low-density, residential areas. The lower relative elevation of Crozer Street also allows the GSI practices to collect runoff from a large area.

This site can also provide community co-benefits such as traffic calming, pedestrian safety, street-level landscaping, and neighborhood beautification.

Crozer Street is narrow in some portions and lined with mature trees, so exact sizes and locations of GSI practices will need to be confirmed after topographic survey during the design phase.


Proposed Crozer Street GSI concept area


Approximate tributary area to the concept

Typical intersection on Crozer Street

3	Widener University / Walnut Street

Proposed GSI: Permeable Pavement

Total Tributary Area: 14.1 acres
- Impervious Area: 11.2 acres
- Pervious Area: 2.9 acres

Total Runoff Volume: 64,978 CF

GSI Footprint Area: 65,306 SF
GSI Storage Volume: 60,544 CF

Construction Cost Estimate: $3.6M
Annual O&M Cost Estimate: $50,000

Summary:
Widener University campus offers many opportunities to collect and manage runoff from impervious areas in the CSO 18 tributary area.

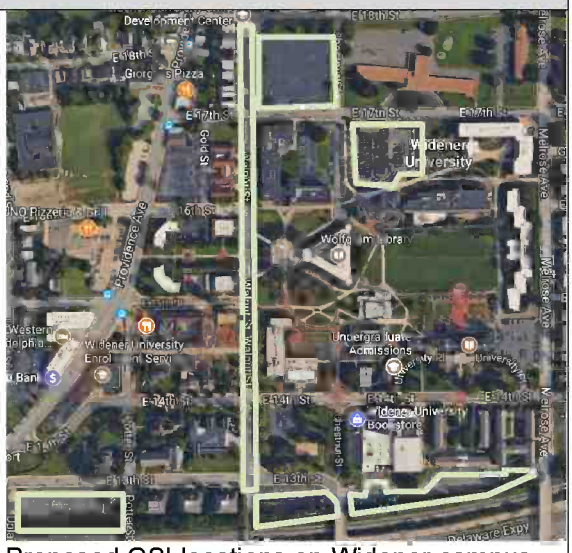
During site visits, several potential locations with large impervious areas were identified. The proposed locations include five parking lots and the right-of-way of Walnut Street, which runs north and south through the campus.

Due to vehicular and pedestrian traffic, parking constraints, and site limitations, the proposed GSI practices are permeable pavements. Both in the parking lots and within the right-of-way, permeable pavement can be installed within existing parking spaces. Brick pavers are recommended in order to be consistent with the campus aesthetics.

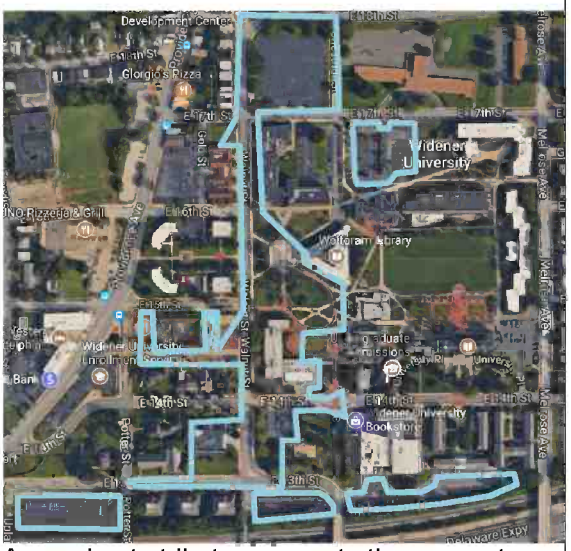
There may be opportunities for bioretention within the wider sections of Walnut Street, around the perimeter of the parking lots, or within the grassed plazas on campus. These opportunities will need to be identified after topographic survey during the design phase. Any designs on private property or affecting campus parking would need to be coordinated with Widener University.

The CSO 18 tributary area boundaries will also need to be confirmed prior to design to ensure that these areas are not separately sewered.

In general, there are several GSI opportunities across the Widener University campus. Widener University could also make an excellent community partner as DELCORA moves forward with their CSO LTCP program.



Proposed GSI locations on Widener campus



Approximate tributary areas to the concepts

On Walnut St. looking north to E 16th St.

4 Edgmont Avenue Green Street

Proposed GSI: Green Streets

Total Tributary Area: 20.8 acres
- Impervious Area: 13.3 acres
- Pervious Area: 7.5 acres

Total Runoff Volume: 82,864 CF

GSI Footprint Area: 36,875 SF
- Bioretention: 2,425 SF
- Permeable Pavement 34,450 SF

GSI Storage Volume: 67,042 CF
- Bioretention 5,032 CF
- Permeable Pavement 62,010 CF

Construction Cost Estimate: $3.9M
Annual O&M Cost Estimate: $30,000

Summary:
Edgmont Avenue runs north and south through Chester and bisects much of the CSO 19 tributary area and is also a main route from the residential areas to the central business district.

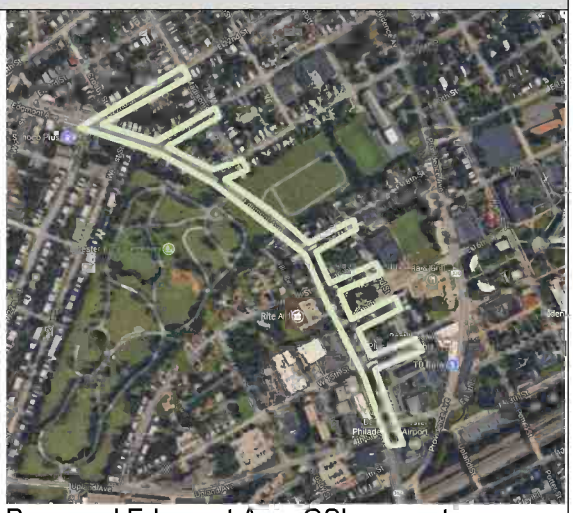
The stormwater runoff in this area is generated by the impervious right-of-way and the adjacent commercial and residential properties.

Due to the narrow streets, parking limitations, and space constraints, permeable pavement is proposed for most of this concept along the shoulders of Edgmont Avenue and its side streets.

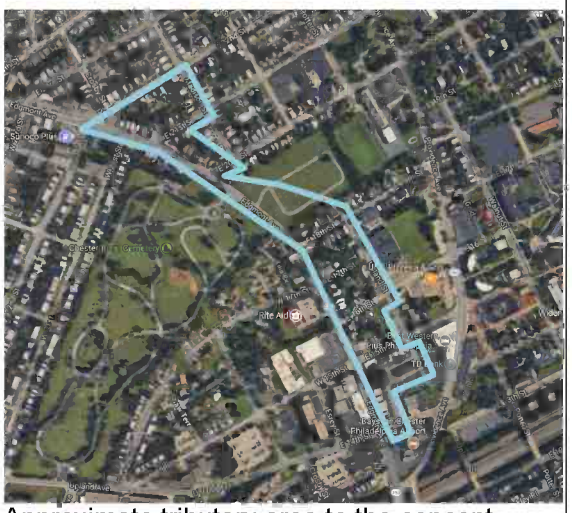
Bioretention practices are proposed in the wider roadway section adjacent to the cemetery and at the larger intersections.

Due to connectivity potential, other amenities such as bike paths may be considered during design, but may not be feasible due to narrow streets.

Actual location and sizes of features would be finalized during design and subject to City of Chester requirements.



Proposed Edgmont Ave. GSI concept area



Approximate tributary area to the concept

Looking north at wider sections of Edgmont Avenue near the cemetery

APPENDIX O

DELCORA Alternatives Analysis Contingency Breakdown

- DELCORA Alternatives Analysis Opinion of Probable Cost Methodology Memorandum dated June 21, 2018

GREELEY AND HANSEN

MEMO

Date: June 21, 2018

To: DELCORA Project File

C: -

From: Brian R. Olson, P.E., CFM, CPESC

Subject: DELCORA Alternatives Analysis Opinion of Probable Cost Methodology

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The purpose of this memorandum is to provide background about the methodology used to estimate costs for the CSO Control Technologies utilized in the DELCORA Alternatives Analysis.

The opinions of probable construction cost are considered Level 5 estimates, as designated by The Association for the Advancement of Cost Engineering (AACE) Recommended Practice No. 18R-97. The accuracy range for Class 5 estimates is generally within a range of fifty percent less (50%) to one-hundred percent more (100%) than the actual cost. To develop the present worth values of Alternatives, the primary components of the Alternative opinion of probable construction cost methodology is:

- Identify appropriate Alternative cost line items;
- Generate operation and maintenance costs along with contingency and other cost factor percentages; and
- Generate capital and life-cycle cost curves;

Capital Cost Sources and Cost Factors

The sources to develop capital costs include the following:

- Greeley and Hansen project data
- RS Means
- Manufacturer's cost data
- EPA project cost data and cost curves
- South Bend, Indiana CSO Long Term Control Plan Optimization Final Report (South Bend)
- Alexandria, Virginia CSS Long Term Control Plan Update Alternatives – Alternatives Evaluation: Sewer Separation
- Washington Sanitary Sewer Commission: Bladensburg Trunk Sewer Preliminary Design Report
- Anderson, Indiana CSO Long Term Control Plan: Basis for Cost Estimate (Anderson, Indiana)
- Capital Region City Beautiful Water Program Plan: Basis of Cost Opinions (Capital Region)
- District of Columbia Water and Sewer Authority Combined Sewer System Long Term Control Plan Final Report
- Passaic Valley Sewerage Commission Long Term Control Plan Technical Guidance Manual (PVSC TGM)
- The Sewer Authority of the City of Scranton Combined Sewer Overflow Long Term Control Plan (Scranton LTCP)
- Combined Sewer Overflow Long Term Control Plan Update – Basis for Cost Estimates, City of Elkhart, Indiana (Elkhart, Indiana)
- DELCORA Green Stormwater Infrastructure Evaluation – Corvias
- Cost Estimates for Regulator Modification – Waterware

- Long-Term CSO Control Plan – Weston Solutions

All cost items are adjusted to January 2018 dollars accounting for inflationary, escalation, and interest costs using the Engineering News Record Construction Cost Index (ENR-CCI). This index tracks the United States cost of labor and common construction materials on a monthly basis.

The following Table 1 lists capital improvement cost factors that are applied to the capital cost to obtain, in addition to the operation and maintenance present value, the full cost to implement the Alternative.

Table 1: Capital Improvement Cost Factors

Capital Improvement Cost Factor	**Escalation Factor**
Overhead and Profit	15% of Capital Cost
Bonds and Insurance	3% of Capital Cost
Mobilization/Demobilization	5% of Capital Cost
Engineering	10% of Construction Cost
Permitting	3% of Construction Cost
Contingency Factors	**Percent of Capital Cost**
Pipe Installation – Heavy Utilities	45%
Pipe Installation – Light Utilities	30%
Tank/Storage Conduit – Heavy Utilities	50%
Tank/Storage Conduit – Light Utilities	30%
Green Infrastructure – Heavy Utilities	40%
Green Infrastructure – Light Utilities	25%
Regulator/Real Time Control – Difficult Modification	25%
Regulator/Real Time Control – Simple Modification	15%
Pump Station – Difficult Installation	45%
Pump Station – Simple Installation	30%
WWTP Upgrade – Difficult Modification	50%
WWTP Upgrade – Simple Modification	30%
Sewer Separation – Heavy Utilities	45%
Sewer Separation – Light Utilities	30%
Disinfection – Difficult Installation	40%
Disinfection – Simple Installation	25%
Settling/Separation – Difficult Installation	40%
Settling/Separation – Simple Installation	25%

Quantity take offs have not been performed as part of the cost breakdown, such as for clearing and grading, filling, excavation, and restoration. These line items are considered to be part of the contingency factor.

Capital and Life-Cycle Cost Estimates

Control Technology costs can be highly variable due to site constraints, location, and overall feasibility and ease of construction. As previously stated, the cost curves and equations developed are for AACE Level 5 planning purposes only. As further details for the implementation of the Control Technologies present themselves, a more detailed cost breakdown can be completed.

Cost Escalation Factor

In the subsequent capital cost estimate analyses, all costs are escalated to January 2018 using the Engineering News Record Construction Cost Index (ENR-CCI) for Philadelphia. The ENR-CCI value used for January 2018, Philadelphia is 12979.40. In the event base costs are given as a national ENR-CCI escalated value, the following equation is utilized to convert costs to January 2018, Philadelphia.

January 2018, Philadelphia = Original cost * (12979.40/Original National ENR-CCI)

In the event base costs are given as a local Philadelphia cost, the following equation is utilized to convert costs to January 2018, Philadelphia.

January 2018, Philadelphia = Original cost * (12979.40/Original Philadelphia ENR-CCI)

Operation and Maintenance Costs

Operation and maintenance (O&M) costs were estimated by first using the following methodology:

- Operation
  - Labor costs and requirements for the various CSO Control Technologies were based on the average cost of maintaining a single operating post manned by one operator on a 24-hour, year round basis. Local operations labor is approximately $53.60/hour, including fringe benefits. Assuming an eight hour workday, with three shifts per day, for 365 days per year, the average cost for a Continuous Operating Post (COP) would be $470,000. The number of COPs needed for operations purposes can be seen in Table 2 below.
- Maintenance
  - Costs taken as a percentage of the construction cost, as seen in Table X below.

Table 2: O&M Cost Basis

Item	Unit	Cost Basis (per year)
Operation		
Green Infrastructure	-	Included in maintenance cost, see below.
High Rate Clarification	COP	2.0
Pump Station Up to 100 MGD Over 100 MGD	 COP COP	 0.5 2.0
Storage	COP	0.5
Tunnels	COP	1.0
Conveyance Pipelines/Sewer Separation	-	Included in maintenance cost, see below.
Maintenance		
Green Infrastructure Permeable Pavement Bioretention	 SQ-FT SQ-FT	 $0.75 $1.25
High Rate Clarification	% of construction cost	3.0%
Pump Station	% of construction cost	3.0%
Storage	% of construction cost	3.0%
Tunnels	% of construction cost	1.0%
Conveyance Pipelines/Sewer Separation	% of construction cost	0.25%

*Pump station operation for storage and tunnels included in storage and tunnel operation. Only add pump station operation costs if standalone pump station.

This initial method was used to calculate total life-cycle costs when utilizing the capital cost curves. However, per the Consent Decree, it is required to formulate life-cycle cost curves. To do this, operation costs have to be converted to a per-unit basis instead of being calculated on an annual basis. This was calculated by first iterating the percentage of operations cost per unit and then melding that into an overall life-cycle cost per unit. Once the life-cycle cost curve was formulated, the same capital cost curve x-axis units were used to come up with a corresponding total life-cycle cost. Final capital and life-cycle costs were near exact to each other or within a small percentage. This then provided the evidence that the percentage used for operations cost for the per-unit basis was correct.

Present-Worth Calculations

To combine O&M and construction costs for each Control Technology, present worth calculations have to be completed. For this, a discount rate of 2.75% is used (taken from the Rate for Federal Water Projects, NRCS Economics, Department of the Interior) with a life span of 20 years. The following equation is then utilized to calculate the present worth factor to convert from annual O&M costs to present worth.

(P/A, i%, n) = ((1+i)^n -1)/((i(1+i)^n)

This is then multiplied by the annual O&M costs and then added to the construction costs to obtain the total life cycle cost. Salvage value is considered to be $0, as it is assumed no resale value will result from the Control Technologies utilized.

Cost Curve Construction

Once cost curves have been formulated for both capital and life-cycle costs, they are utilized to calculate the full cost of implementation from a life-cycle perspective. Sewer separation is calculated on a per CSO area basis by utilizing the appropriate cost curve. By applying the area of each of the combined sewer areas into the cost curve, the total cost to separate each CSO is summed together to come up with a final life-cycle cost. Sewer separation is presumed to only occur to eliminate all overflows from the combined sewer system.

Both storage tanks and tunnel storage are sized for the required Consent Decree overflow amounts of 0, 2, 4, 6, 8, and 12 overflow events per Typical Year by using results from H&H modeling which includes Pump Station 6 (PS6) is inserted into the associated model. CSO areas are subsequently grouped together to formulate feasible pairings so storage can be lumped together. The locations of storage tanks and tunnels was determined for overall feasibility of installation and size depending on the characteristics of the surrounding area (width of road, location next to buildings, etc.). The locations of utilities (electrical, gas, etc.) is not known, however it is presumed utilities are a large factor considering the combined sewer area is set in an urban location. This is taken into consideration within the contingency added into the overall life-cycle cost. Overall storage volume for each overflow event is determined, with the appropriate cost curve utilized to calculate the associated life-cycle cost. To get flow to the storage tanks and tunnels, transmission mains have to be installed. To calculate the size of the transmission mains, the peak discharges from each regulator was determined. For each group, the max discharge from each regulator was then determined. Using Mannings equation, the diameter was solved for to come up with the correct pipe size based on full flow. A minimum slope was used by determining the shallowest slope along the proposed transmission main schematic, which allowed for a more conservative approach to calculate the diameter of the pipe flowing full. Once the installed pipe diameter was calculated, the appropriate cost curve was used to calculate the total life cycle cost to install the storage tank and tunnel

for each overflow event per Typical Year. Plant expansions also used new or improved conveyance lines, as well as improved pumping capacities to handle increased flow to the WRTP based on the EPA-SWMM modeling. For tunnels, drop shafts were considered in the cost. A drop shaft was assumed to be needed at the beginning and end of every tunnel, and at points where the direction of the pipe changed laterally. Green infrastructure costs were also implemented from the work completed by Corvias, and were added on to the total life-cycle cost calculated for the various Control Technologies.

The following, except for green infrastructure, are the capital and life-cycle cost curves utilized to come up with overall costs for the various Control Technologies.

Green Infrastructure

Opinions of probable construction cost have been developed for the project area by Corvias in a memorandum titled "Green Stormwater Infrastructure (GSI) Evaluation" dated November 2017. In the memorandum Corvias completed an opinion of probable construction cost for proposed green infrastructure Control Technologies in CSO areas 18 and 19. These Technologies consist of permeable pavement, subsurface storage, and green streets/bioretention. According to the memorandum,

"Conceptual cost estimates…are based on estimated construction and maintenance costs per square foot of GSI footprint. These rates are summarized below.

- *$90-105 per square foot to construct GSI practices (bioretention or permeable pavement, respectively) within the right-of-way.*
- *$30-35 per square foot to construct GSI practices (bioretention or permeable pavement, respectively) within public and private parcels.*
- *$0.75-1.25 per square foot annually to maintain GSI practices (permeable pavement or bioretention, respectively)*

The differences in costs are due to increased expenses when working in the right-of-way and the variability of costs per GSI type."

These costs above are in November 2017 dollars, local to Philadelphia, and do not include items such as mobilization, traffic control, utility relocations, or surface amenities.

The overall analysis consists of utilizing the sited green infrastructure Control Technologies proposed by Corvias and does not implement further practices on a systemwide basis. The Consent Decree requirements do not dictate using green infrastructure on a global basis, but rather that they be incorporated in some fashion within the analysis. Given the above costs, and escalated to January 2018 dollar values (Philadelphia) with maintenance included, the following Table 3 gives green infrastructure costs on a per square foot basis.

Table 3: Green Infrastructure Opinion of Probable Construction Cost

Green Infrastructure Practice	**Cost Per Square Foot**
Bioretention – within right-of-way	$91.30
Bioretention – within public and private parcels	$31.30
Permeable pavement – within right-of-way	$105.80
Permeable pavement – within public and private parcels	$35.80

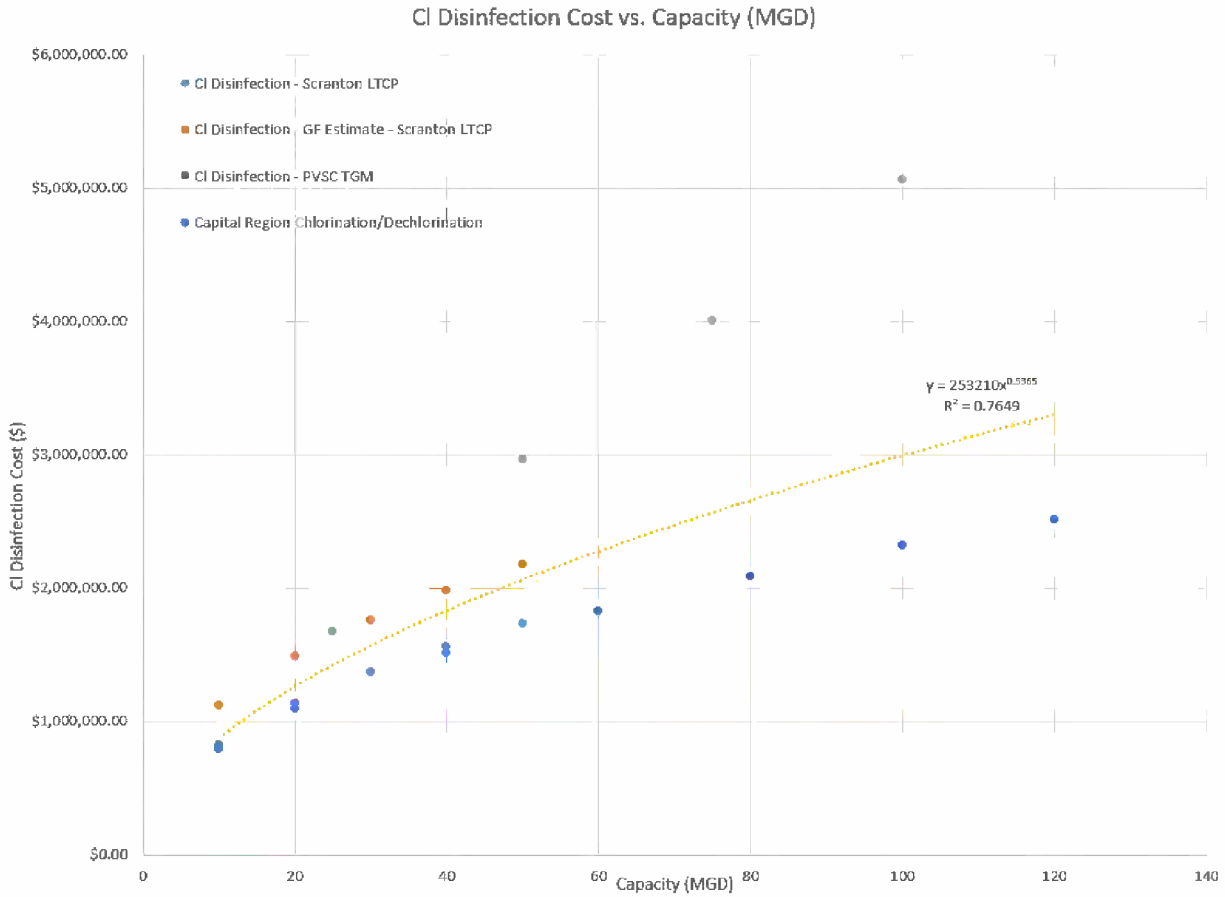
Chlorine Disinfection

The use of chlorine disinfection is recommended for use at satellite high-rate treatment facilities. Data sources include cost curve information from Capital Region, Scranton LTCP, and PVSC TGM. All include the use of chlorine in some form to disinfect stored combined sewer overflow after being treated at a satellite treatment facility. In addition, all sources cross reference equipment costs as obtained from equipment manufacturers. The resulting capital cost curve for chlorine disinfection is the following:

Y = 253,210*x^.5365

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD. This trendline equation can be seen in Figure 1 below, and shows a medium to high R^2 correlation value.

Figure 1: Chlorine Disinfection Capital Cost vs. Capacity (MGD)

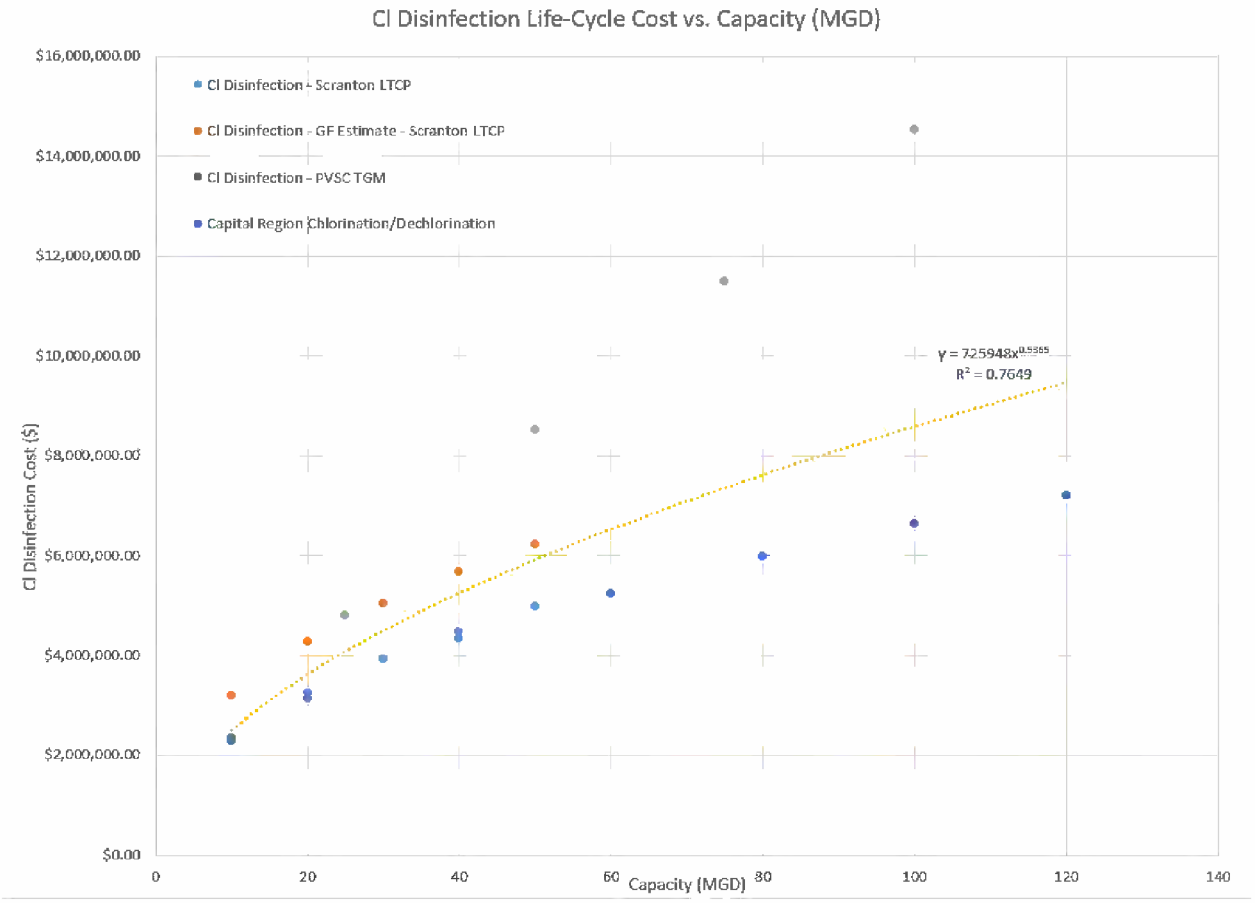


The resulting life-cycle cost curve for chlorine disinfection is the following:

Y = 725,948*x^.5365

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD. This trendline equation can be seen in Figure 2 below, and shows a medium to high R^2 correlation value.

Figure 2: Chlorine Disinfection Life-Cycle Cost vs. Capacity (MGD)



Settling/Separation

Vortex separation is the method utilized for developing cost curves for settling/separation. More specifically cost data is taken from various data sources listed in Section 11.4.2.1 for Storm King, Hydroves, and Sansep separators. The basic premise of a vortex separator is that it produces a self-induced swirling action that encourages the settling of solids at the bottom of the unit, which are then sent to a wastewater treatment plant for treatment. The reason why these separators are so attractive to install is due to its low overall footprint, ease of maintenance, and it overall being a simple process from an operating standpoint. In the development of the cost curve, all sources cross reference equipment manufacturers to ensure accuracy. The resulting capital cost curve for the Storm King unit is the following:

Y=95,305*x+750,265

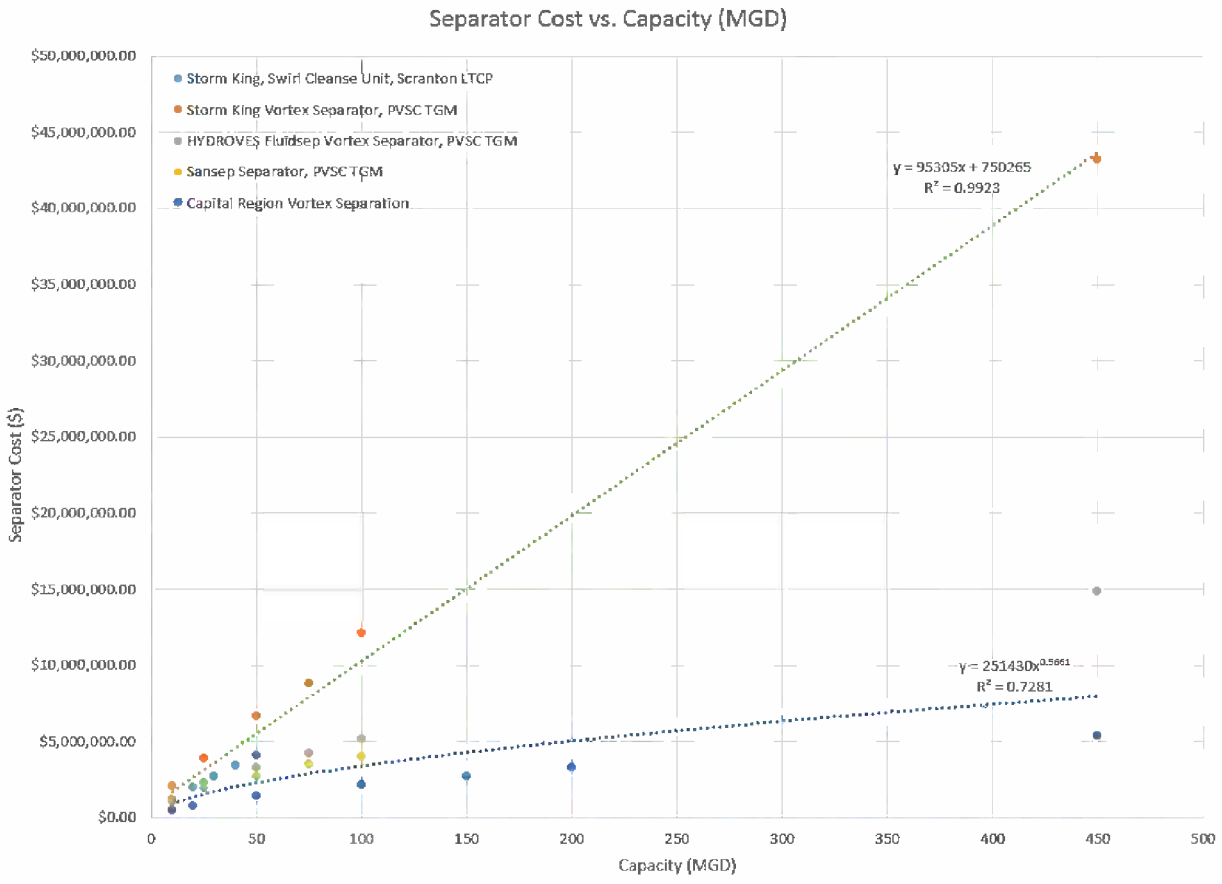
Where Y equals the total cost in million dollars and x equals treatment capacity in MGD.

The resulting capital cost curve for remaining types of settling/separation units, such as the Hydroves and Sansep Separators, is the following:
Y=251,430*X^0.5661

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD.

These trendline equations can be seen in Figure 3 below, with both showing a medium to high R^2 correlation value.

Figure 3: Separator Capital Cost vs. Capacity (MGD)



The resulting life-cycle cost curve for the Storm King unit is the following:

Y=273,236*x+2*10^6

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD.

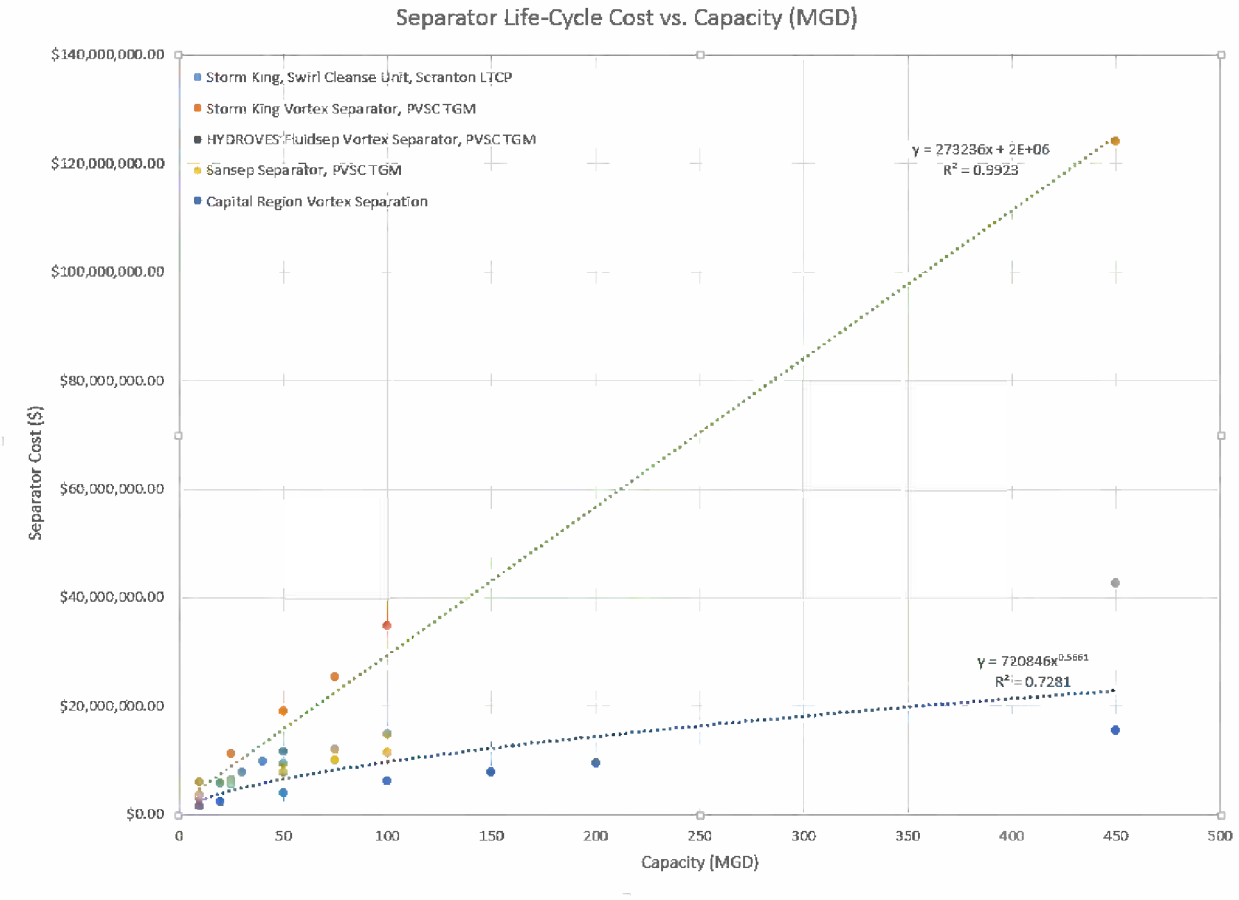
The resulting life-cycle cost curve for remaining types of settling/separation units, such as the Hydroves and Sansep Separators, is the following:

Y=720,846*X^0.5661

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD.

These trendline equations can be seen in Figure 4 below, with both showing a medium to high R^2 correlation value.

Figure 4: Separator Life-Cycle Cost vs Capacity (MGD)



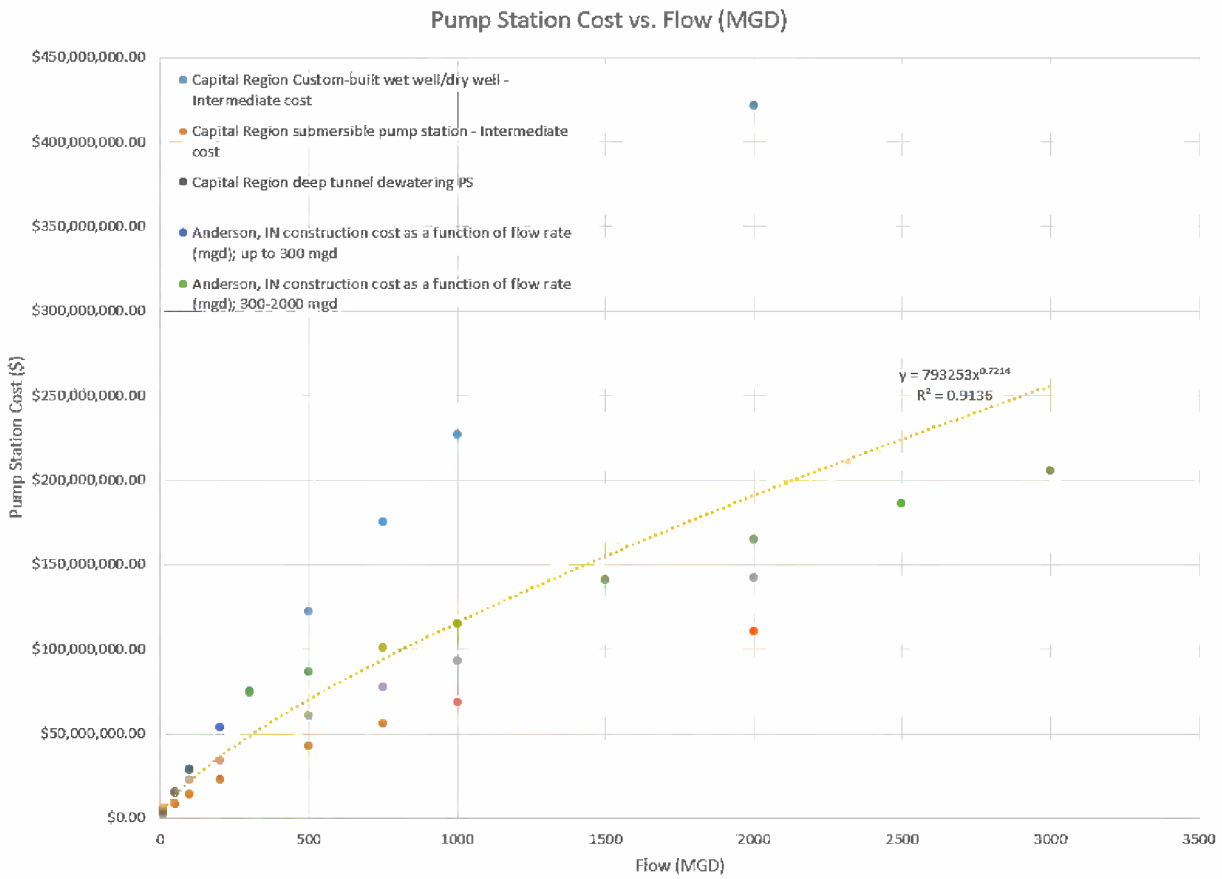
Pump Station

All pump stations in the cost analysis are assumed to be constructed as stand-alone structures and not part of a larger treatment or storage facility and are necessary in order to convey flow from satellite treatment facilities or storage locations. Data sources include cost curve information from Capital Region and Anderson, Indiana. Both sources of data include cost data from actual facilities and EPA cost curves. The Capital Region costs classifies the pump stations as either built wet-well/dry-well facilities or submersible facilities along with giving a range of low, intermediate, and high cost curves to cover the wide variety of pump station installation applications. For the purposes of this exercise the intermediate cost curves were utilized. The resulting capital cost curve for pump stations is the following:

Y=793,253*X^0.7214

Where Y equals the total pump station cost and x equals flow capacity in MGD. The trendline equation can be seen in Figure 5 below, showing a relatively high R^2 correlation value.

Figure 5: Pump Station Capital Cost vs. Flow (MGD)

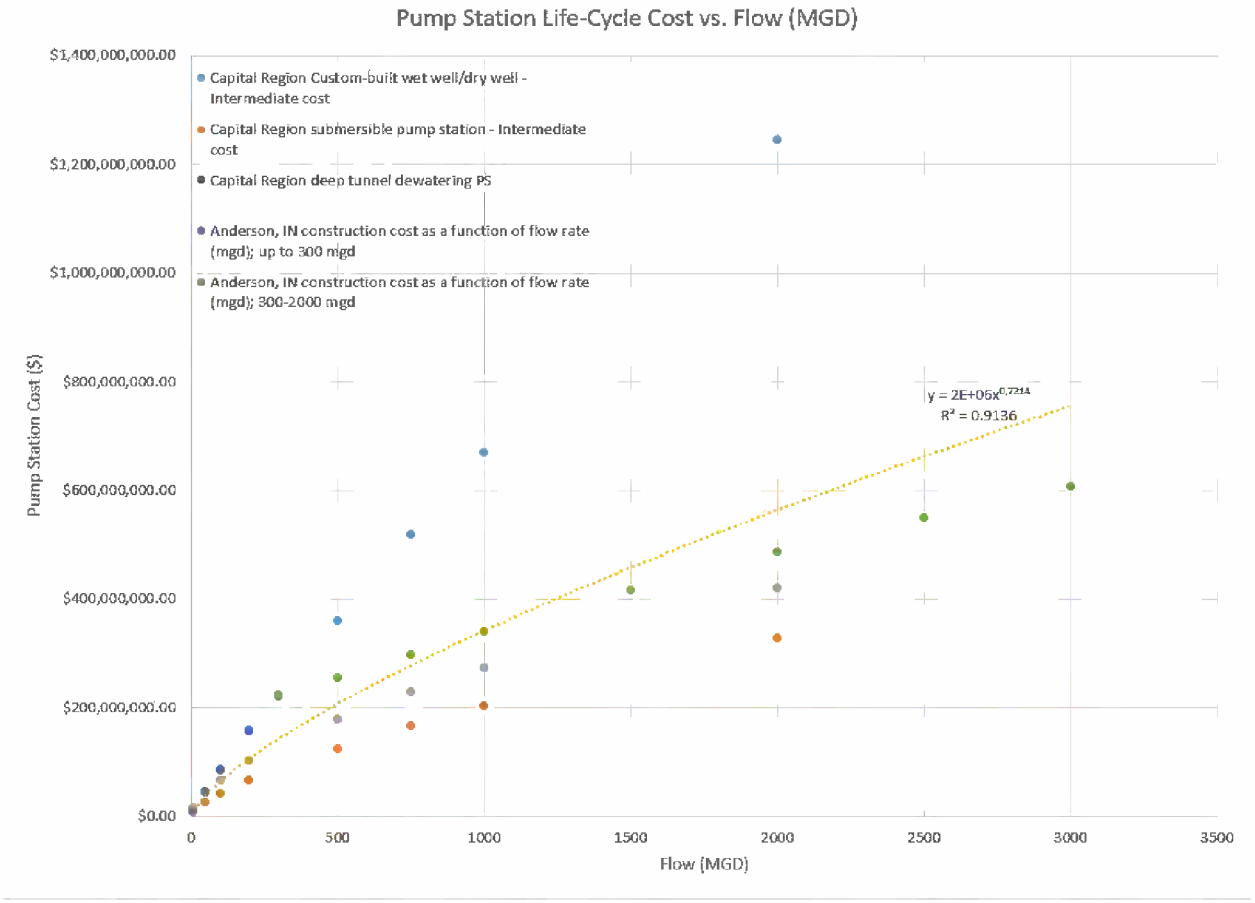


The resulting life-cycle cost curve for pump stations is the following:

Y=2*10^6*X^0.7214

Where Y equals the total pump station cost and x equals flow capacity in MGD. The trendline equation can be seen in Figure 6 below, showing a relatively high R^2 correlation value.

Figure 6: Pump Station Life-Cycle Cost vs. Flow (MGD)



Installed Offline Storage – 15-ft and 22-ft Side-Wall Depth

The purpose of offline storage as a Control Technology in this project is to store flow during peak discharges when interceptors can no longer handle additional flow. Offline storage tanks are located so as to not be on the typical dry weather flow path and only be utilized when needed during wet weather. When free to accept additional flow, the interceptors can slowly accept this additional offline storage and allow it to re-enter the conveyance system. It is assumed that these offline storage volumes would both be fed and discharge via gravity, thus making it a cheaper alternative as pump stations are not needed. However, detailed design is needed to figure out whether this is in fact the case (not needing pump stations).

Cost data is taken from the PVSC TGM. Additional data was mined from Capital Region and Scranton LTCP, however this data did not match up well with the PVSC TGM data. Based on engineering judgment, it was decided to proceed with using cost data from the PVSC TGM. The data utilized for this estimate is for concrete tanks that is inclusive of all ancillary facilities for an offline storage tank. The resulting capital cost curve for installed offline storage – 15-ft side-wall depth is the following:

Y=3E+06*x + 2E+06

Where Y equals the total in million dollars and x equals the tank capacity in MG.

The resulting capital cost curve for installed offline storage – 20-ft side-wall depth is the following:

Y=2E+06*x + 4E+06

Where Y equals the total in million dollars and x equals the tank capacity in MG.

These trendline equations can be seen in Figure 7 and 8 below, with both showing high R^2 correlation.

Figure 7: Installed Offline Storage Capital Cost – 15-ft Side-Wall Depth

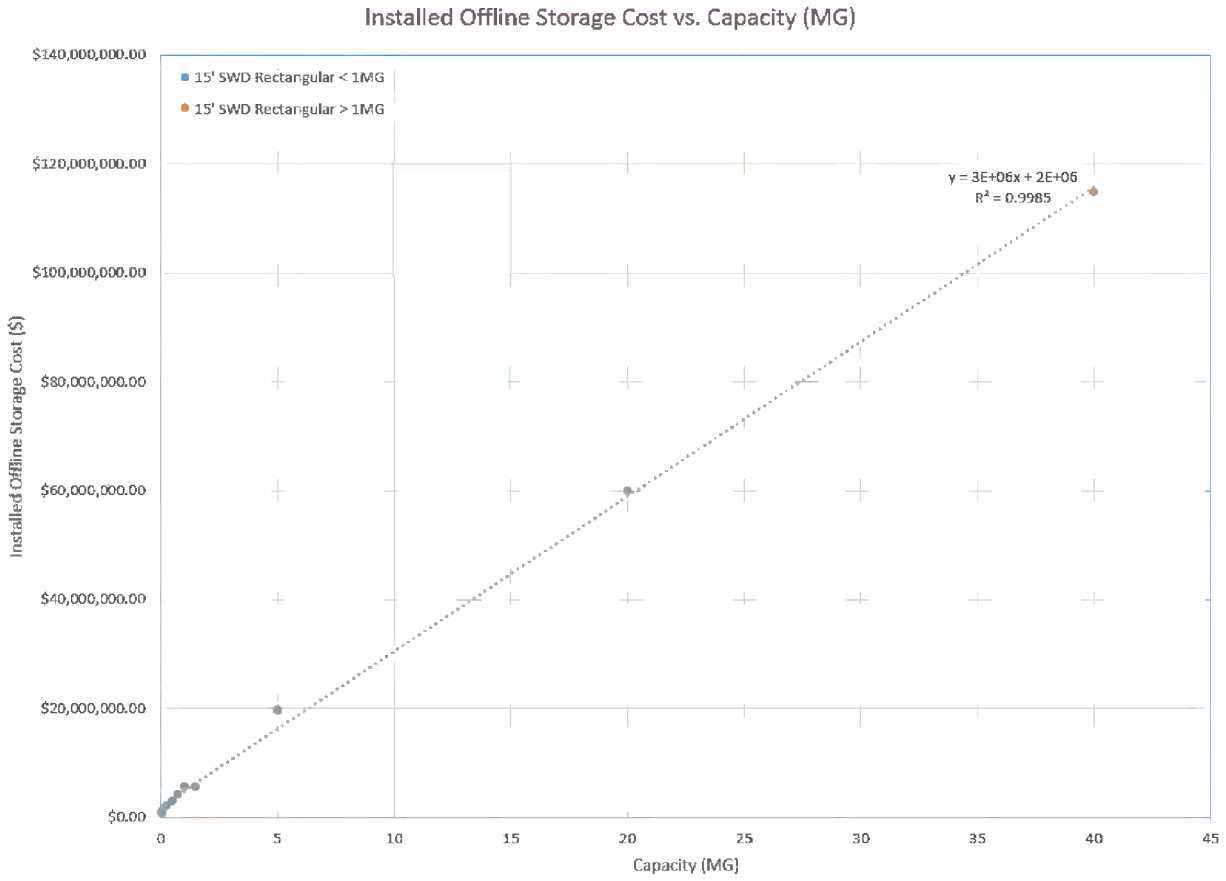
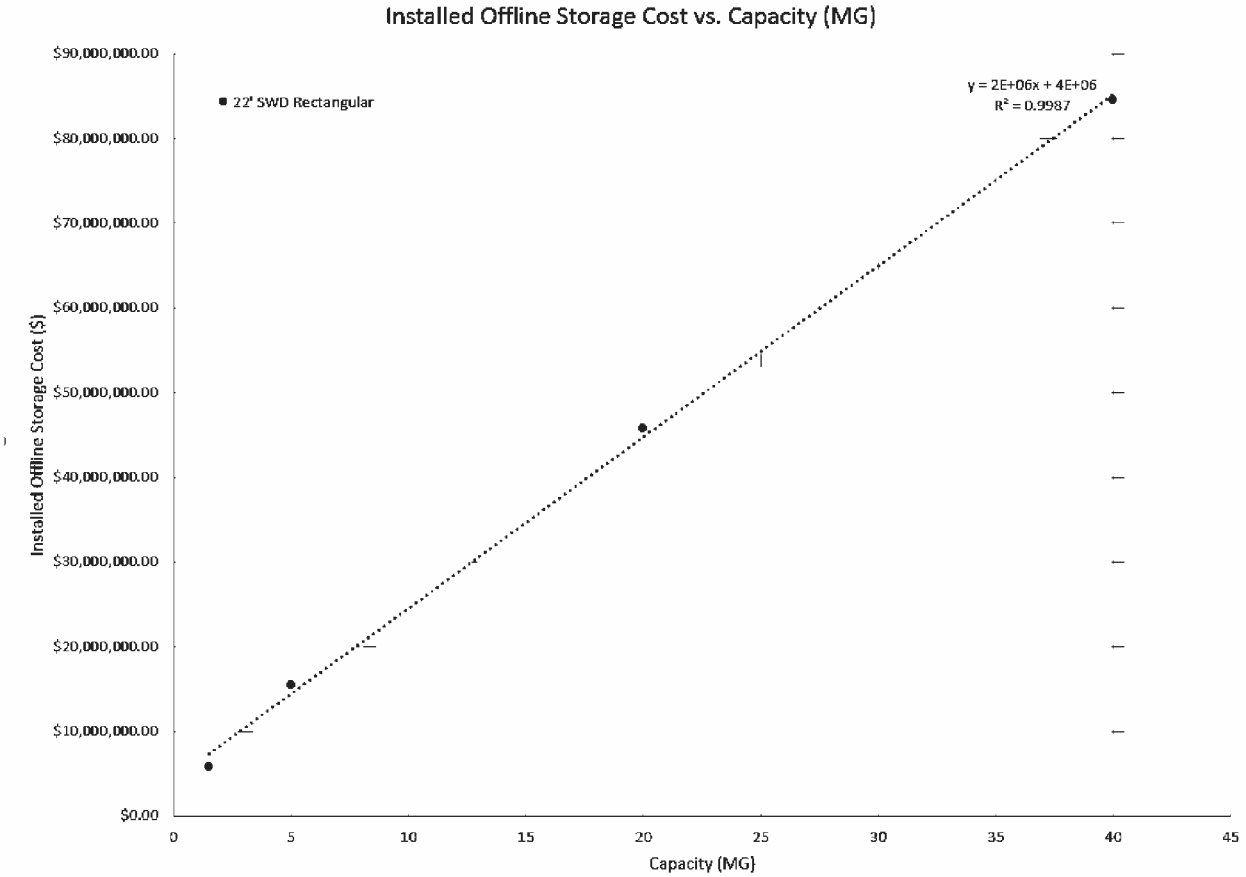


Figure 8: Installed Offline Storage Capital Cost – 22-ft Side-Wall Depth



The resulting life-cycle cost curve for installed offline storage – 15-ft side-wall depth is the following:

Y=8E+06*x +6E+06

Where Y equals the total in million dollars and x equals the tank capacity in MG.

The resulting capital cost curve for installed offline storage – 22-ft side-wall depth is the following:

Y=6E+06*x + 1E+07

Where Y equals the total in million dollars and x equals the tank capacity in MG.

These trendline equations can be seen in Figure 9 and 10 below, with both showing high R^2 correlation.

Figure 9: Installed Offline Storage 15' SWD Life-Cycle Cost vs Capacity (MG)

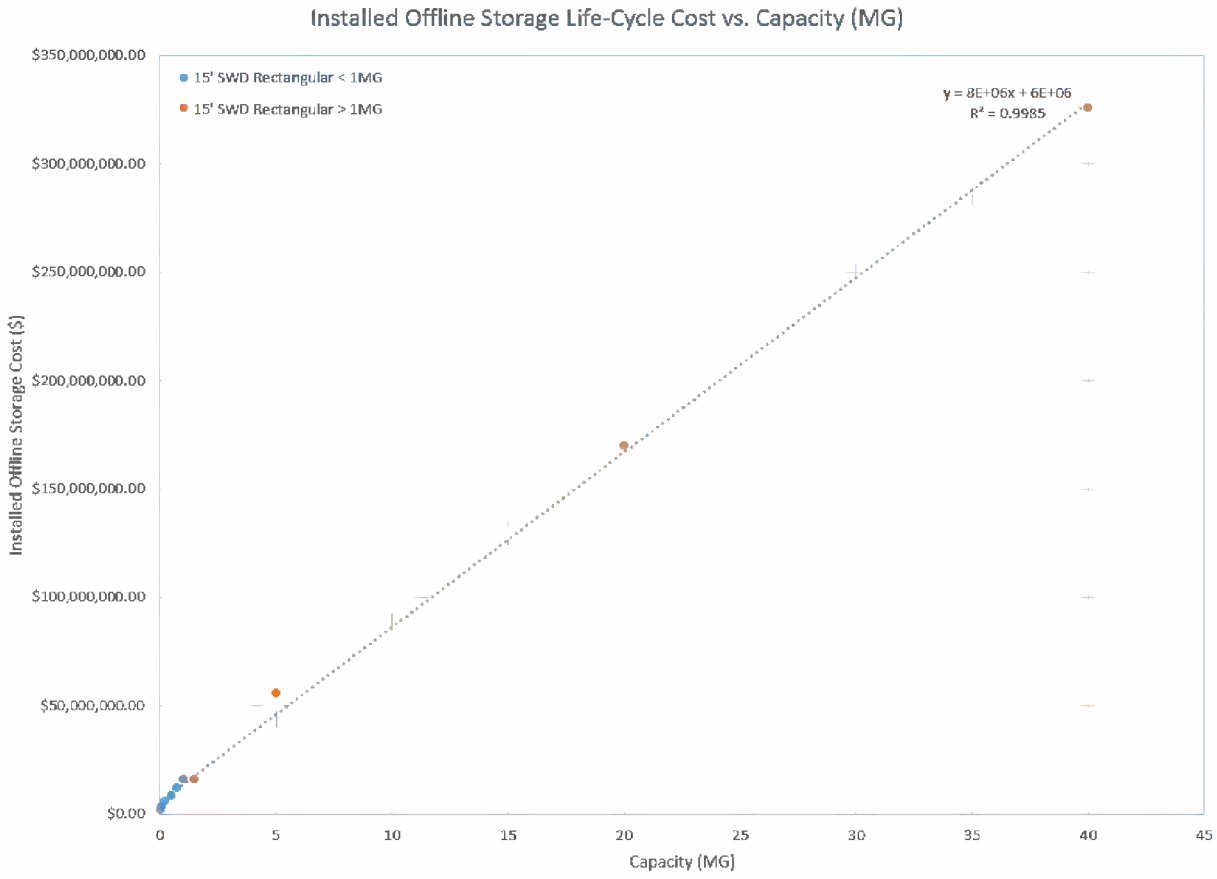
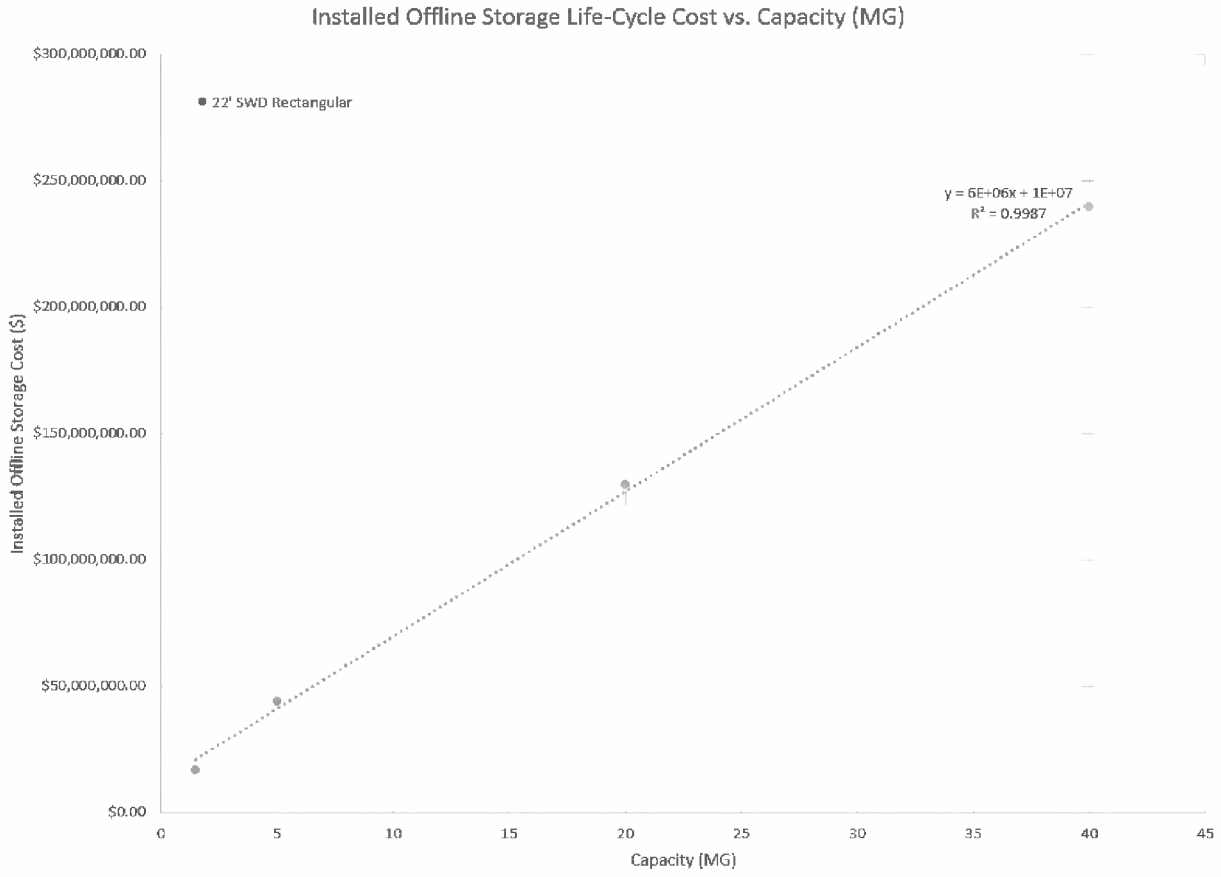


Figure 10: Installed Offline Storage 22' SWD Life-Cycle Cost vs Capacity (MG)



Deep Tunnel Storage

Deep tunnel storage is one of the global Consent Decree requirements that has to be investigated as part of the Alternatives Analysis. Due to the overall complexity of drilling deep tunnels for storage use, this alternative has multiple cost curves to take into account different scenarios. Specific examples include soft ground both below and above groundwater and tunneling within rock for tunnels less than 10,000-ft in length. Similar in use to offline storage, the capture and storage of CSO discharges takes place so as to limit volume within the combined sewer system during wet weather events. Data sources include cost curve information from PVSC TGM and Anderson, Indiana with cost information taken from previously completed projects. It should be noted that drop shafts are not included as part of the per linear foot cost of deep tunneling. The resulting capital cost curve equation for tunneling less than 10,000-ft in soft ground below groundwater is:

Y=263.25*x + 1,652.9

Where Y equals pipe cost per linear foot and x is the size of tunnel in feet.

The resulting capital cost curve equation for tunneling less than 10,000-ft in soft ground above groundwater is:

Y=1,359.1*e^0.0645*x

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The resulting capital cost curve equation for tunneling less than 10,000-ft in rock is:

Y=203.43*x + 1,273.7

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The resulting capital cost curve equation for tunneling greater than 10,000-ft is:

Y=187.93*x + 148.3

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The trendline equations for the above show medium to very high R^2 correlation values.

Figure 11: Deep Tunnel < 10,000-ft Pipe Cost Per Linear Foot vs. Size (feet)

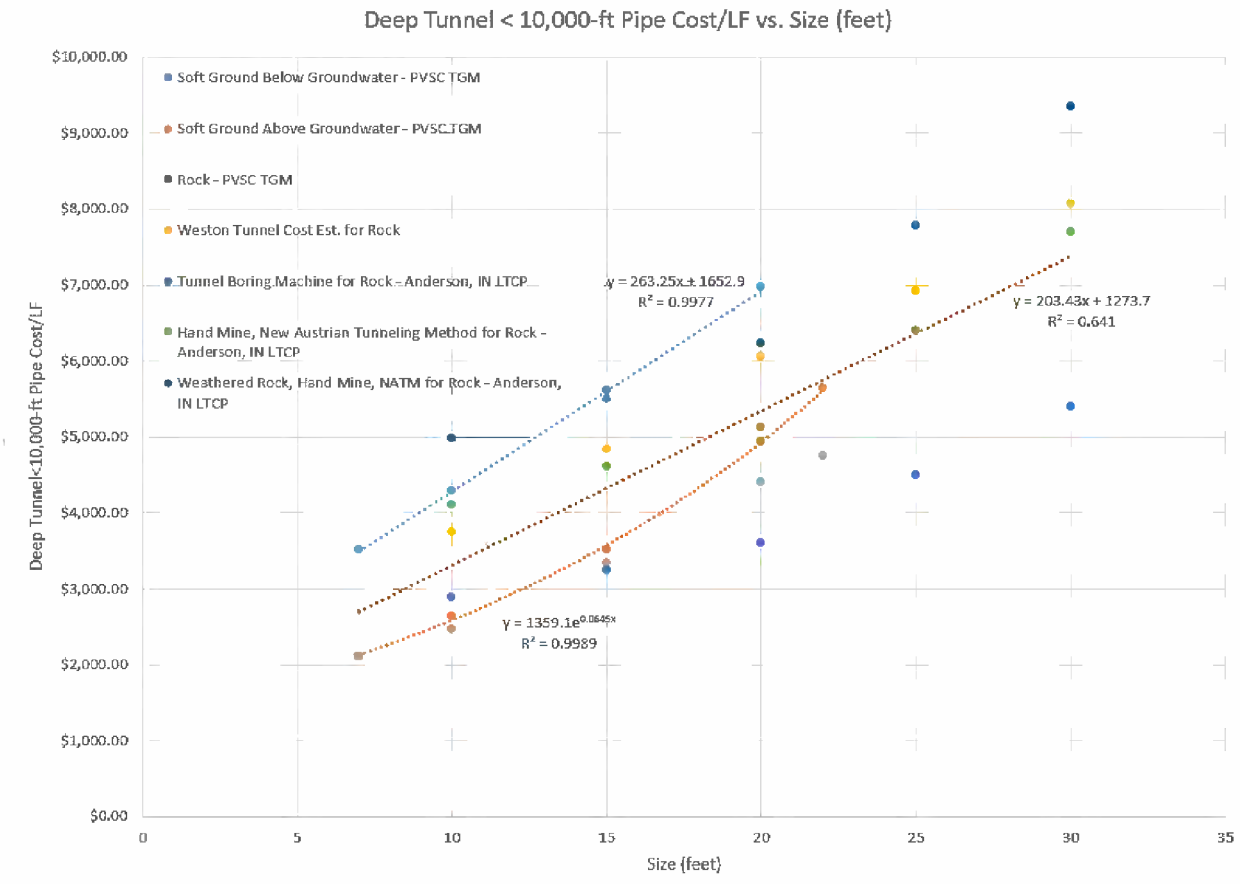
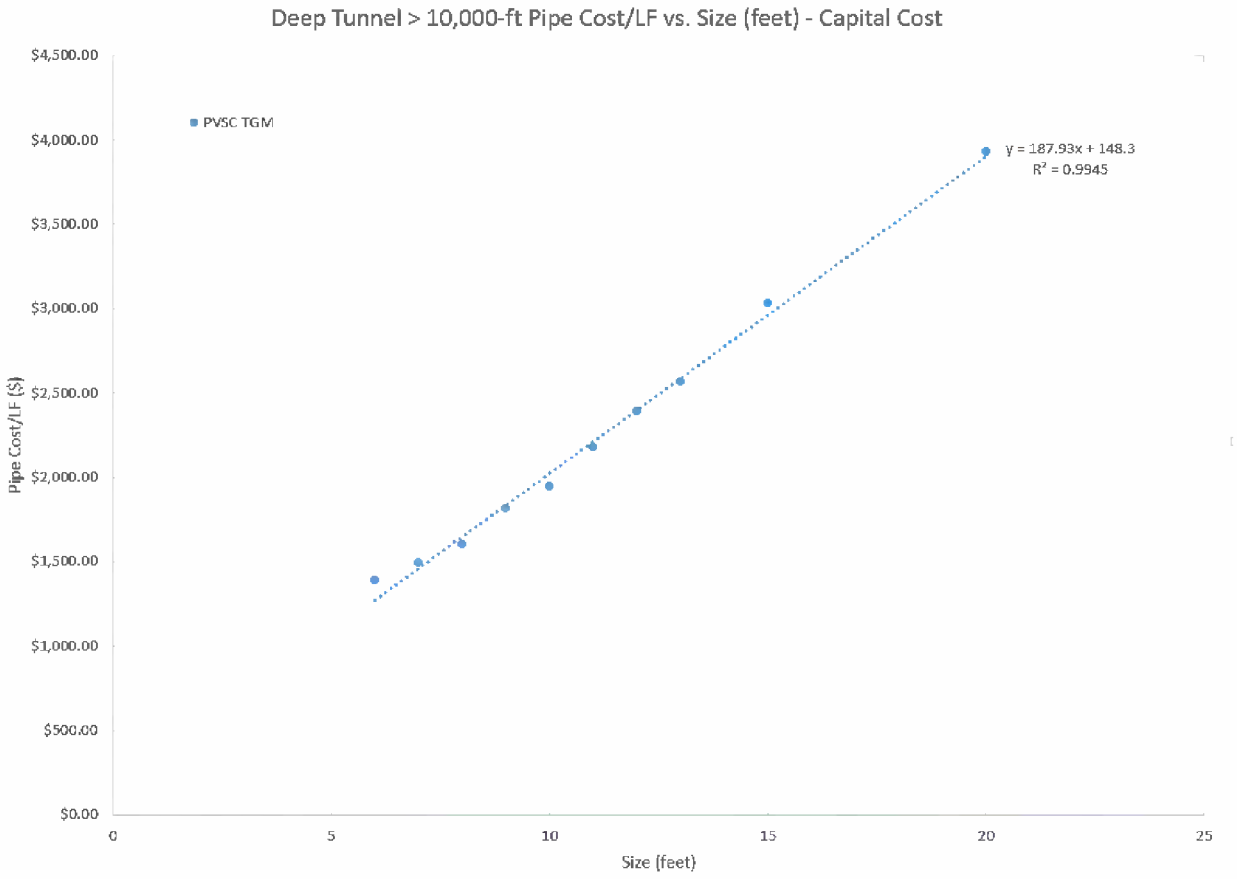


Figure 12: Deep Tunnel > 10,000-ft Pipe Cost Per Linear Foot vs. Size (feet)



The resulting life-cycle cost curve equation for tunneling less than 10,000-ft in soft ground below groundwater is:

Y=623.16*x + 3,912.6

Where Y equals pipe cost per linear foot and x is the size of tunnel in feet.

The resulting life-cycle cost curve equation for tunneling less than 10,000-ft in soft ground above groundwater is:

Y=3,217.3*e^0.0645*x

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The resulting capital cost curve equation for tunneling less than 10,000-ft in rock is:

Y=481.55*x + 3,015.2

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The resulting life-cycle cost curve equation for tunneling greater than 10,000-ft is:

Y=444.85*x + 351.04

Where Y equals pipe cost per linear foot and x is the size of the tunnel in feet.

The trendline equations for the above show medium to very high R^2 correlation values.

Figure 13: Deep Tunnel<10,000-ft Pipe Life-Cycle Cost/LF vs. Size (feet)

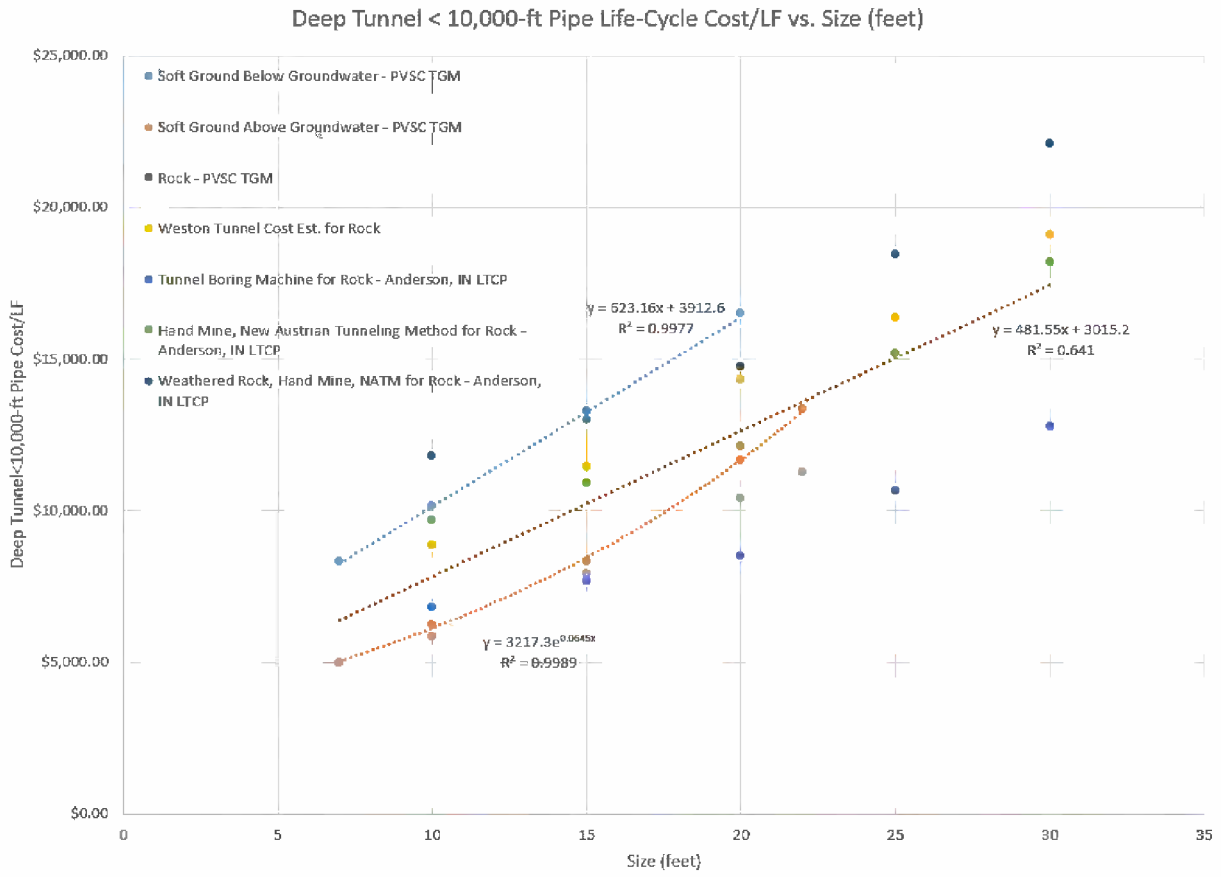
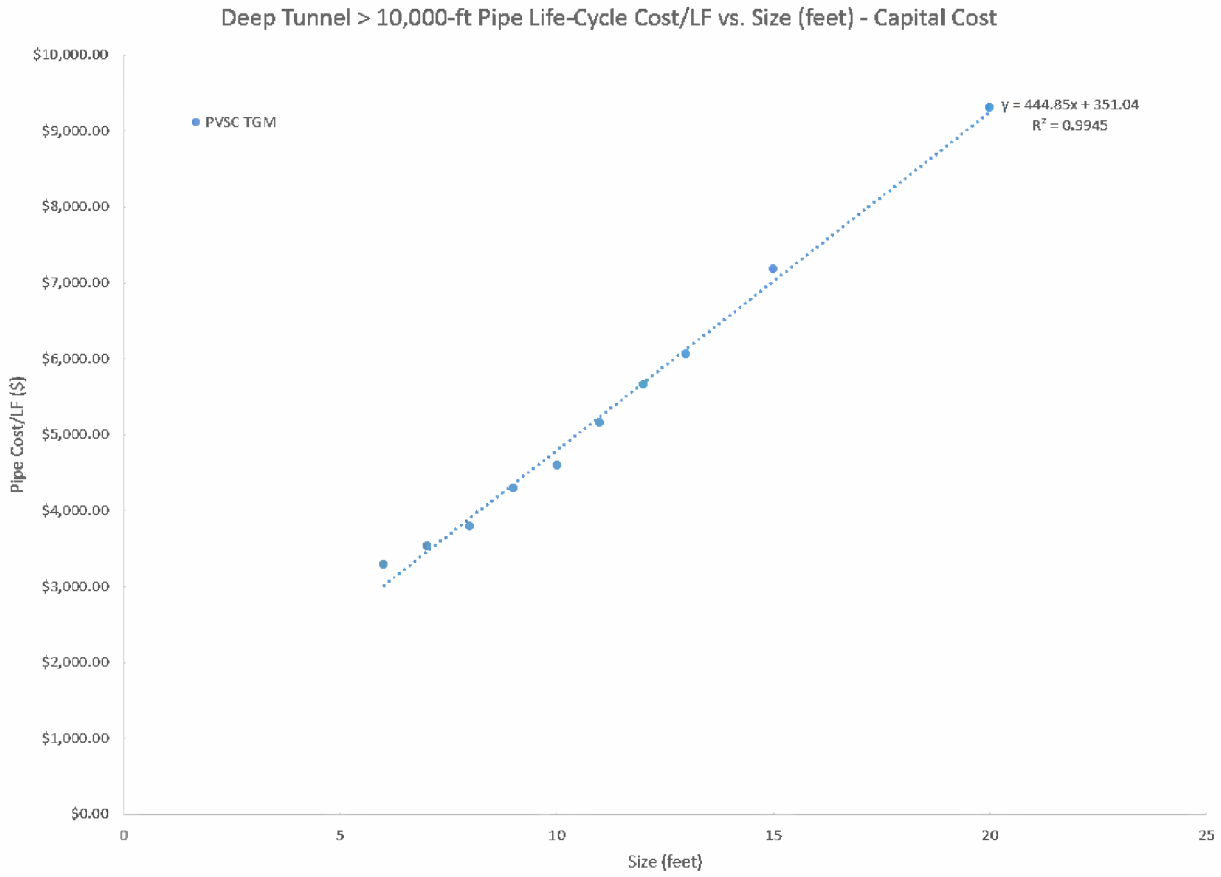


Figure 14: Deep Tunnel>10,000-ft Pipe Life-Cycle Cost/LF vs. Size (feet)



In addition, the use of tunnel drop shafts is needed to convey flow from the ground elevation down to tunnel level. Drop shafts vary in depth depending on the application and typically include tangential inlets, the drop shaft itself, and a deaeration chamber. Cost curves were developed for drop shafts as well, which include cost for tangential inlets and the deaeration chamber in addition to the drop shaft. Data sources for the drop shaft cost curves are PVSC TGM and Anderson, Indiana LTCP. It should be noted that two cost curves exist as the data sources were for different depths of drop shafts from which the data was collected. PVSC TGM assumes no greater than 30-ft depth, whereas Anderson, Indiana assumes a 50-ft depth. The capital cost curve for PVSC TGM – no greater than 30-ft depth is the following:

$Y=1,305.2*\ln(x) - 130.89$

Where Y equals cost per vertical foot of drop shaft and x equals flow capacity of the drop shaft in MGD.

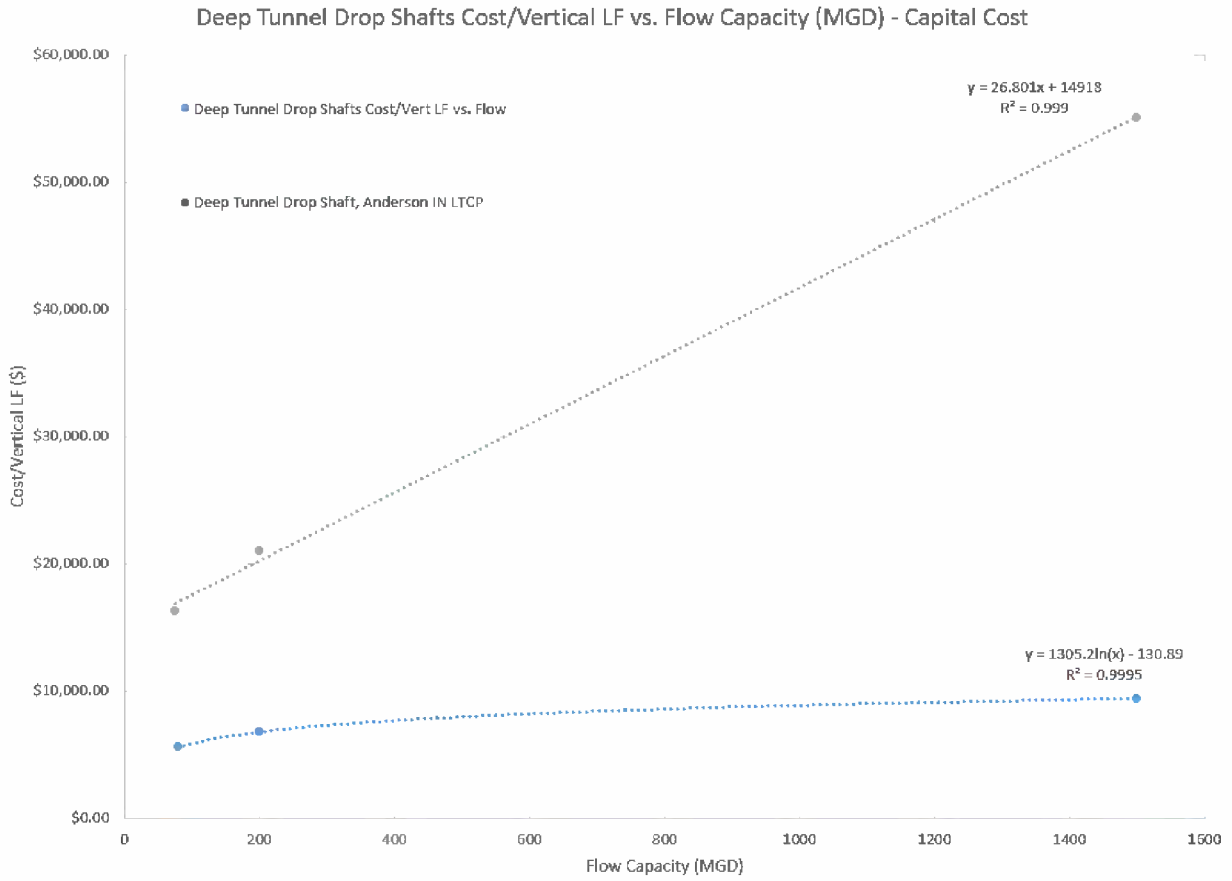
The capital cost curve for Anderson, Indiana – 50-ft depth is the following:

$Y=26.801*x + 14,918$

Where Y equals cost per vertical foot of drop shaft and x equals flow capacity of the drop shaft in MGD.

The trendline equations for the above slow very high R^2 correlation values.

Figure 15: Deep Tunnel Drop Shafts Cost/Vertical Foot vs Flow Capacity (MGD)



The cost curve for PVSC TGM – no greater than 30-ft depth is the following:

Y=3,089.6*ln(x) – 309.84

Where Y equals cost per vertical foot of drop shaft and x equals flow capacity of the drop shaft in MGD.

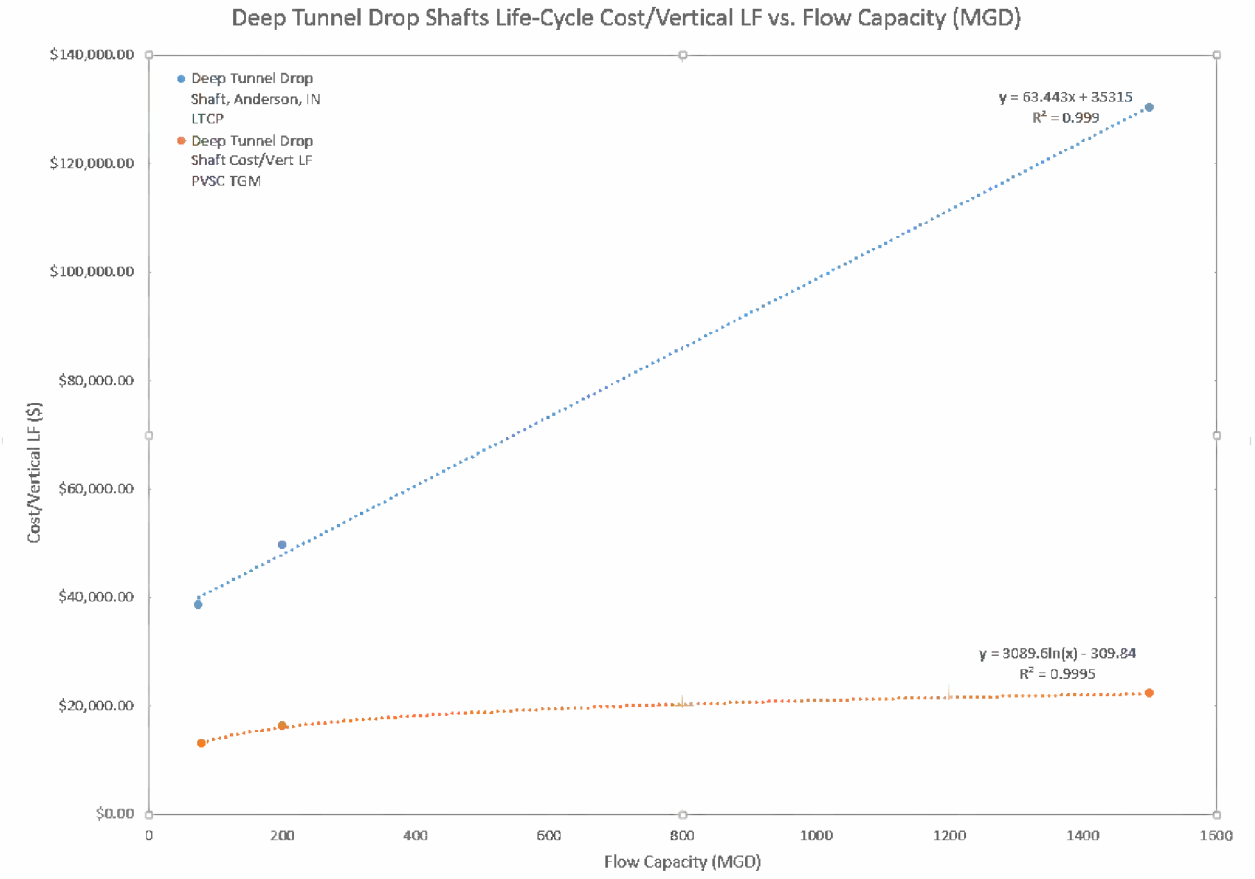
The cost curve for Anderson, Indiana – 50-ft depth is the following:

Y=63.443*x + 35,315

Where Y equals cost per vertical foot of drop shaft and x equals flow capacity of the drop shaft in MGD.

The trendline equations for the above slow very high R^2 correlation values.

Figure 16: Deep Tunnel Drop Shafts Life-Cycle Cost/Vertical LF vs. Flow Capacity (MGD)



Installed Pipe

Pipe installation consists of the means of transmitting CSO discharges to storage areas along with placing parallel interceptor piping to add conveyance where needed. This method of pipe installation does not consist of pipeline storage as deep tunnel storage does. To divert excess flow into a parallel interceptor a diversion structure would be needed, which is not accounted for in these cost curves. In addition, the cost curve takes into account the cost to install the pipe, but does not take into account restoration of the pipe installation. Data sources include cost curve information from PVSC TGM, Anderson, Indiana and Scranton LTCP. Due to pipe needing to be installed at various depths because of utilities and existing connections to pipes, cost curves for various depths of pipes are given at 10-, 15-, 20-, and 25-ft depths. The resulting capital cost curve for installed pipe at 10-ft depth is the following:

Y=10.696*x + 12.935

Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 15-ft depth is the following:

Y=297.84*e^0.0182*x

Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 20-ft depth is the following:

443.63*e^0.0167*x

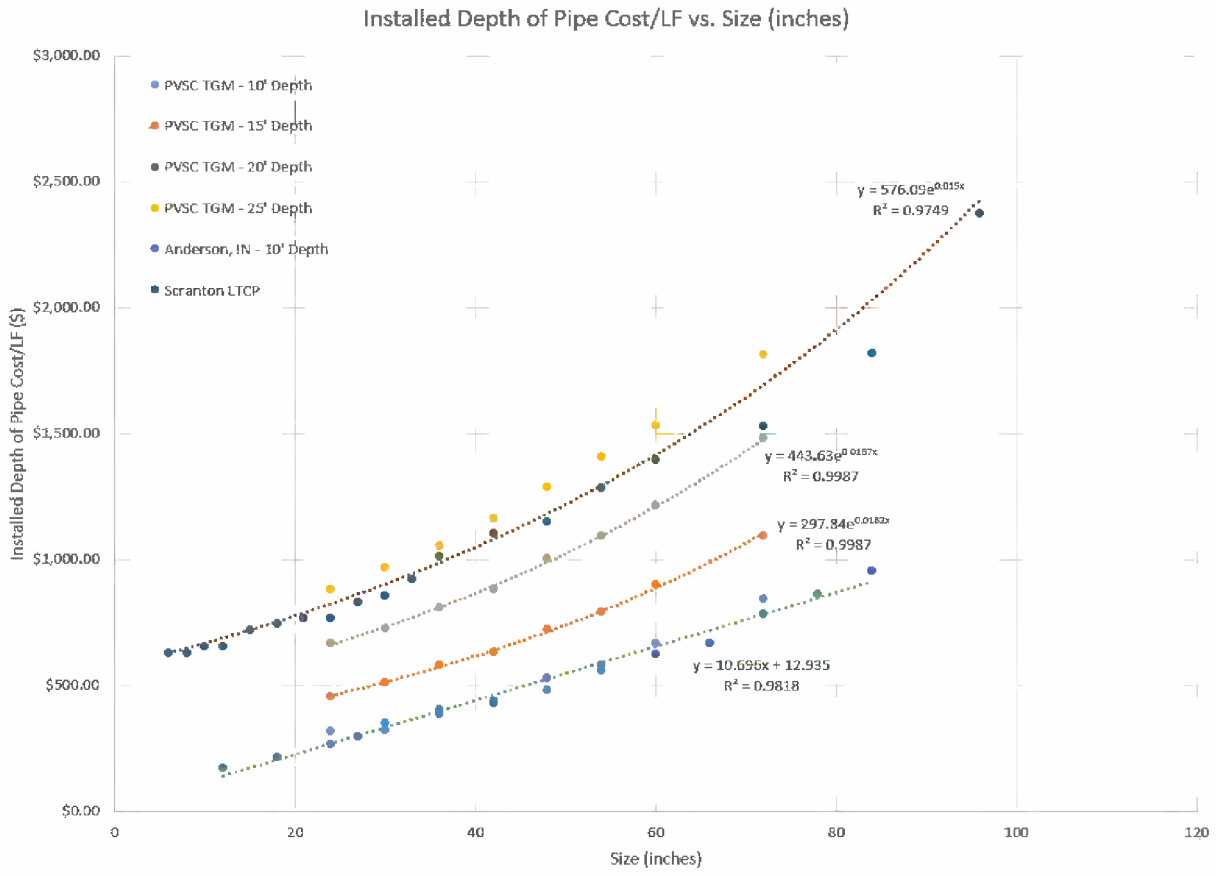
Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 25-ft depth is the following:

Y=576.09*e^0.015*x

The trendline equations for the above show very high R^2 correlation values.

Figure 17: Installed Depth of Pipe Capital Cost/Linear Foot vs. Size (inches)



The resulting capital cost curve for installed pipe at 10-ft depth is the following:

Y=20.882*x + 13.166

Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 15-ft depth is the following:

Y=584.47*e^0.0182*x

Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 20-ft depth is the following:

Y=870.55*e^0.0167*x

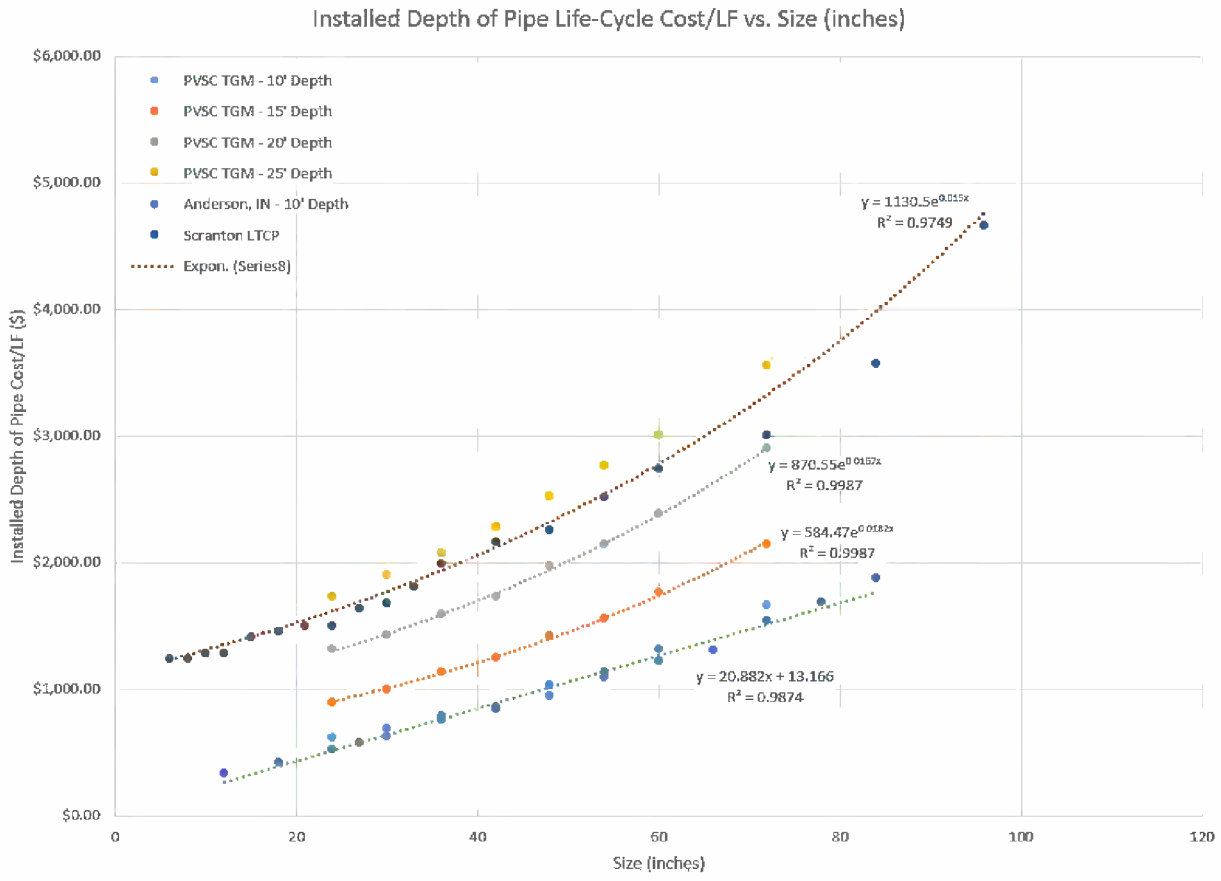
Where Y equals pipe cost per linear foot and x equals the size of pipe in inches.

The resulting capital cost curve for installed pipe at 25-ft depth is the following:

Y=1130.5*e^0.015*x

The trendline equations for the above show very high R^2 correlation values.

Figure 18: Installed Depth of Pipe Life-Cycle Cost/Linear Foot vs. Size (inches)



Wet Weather Blending

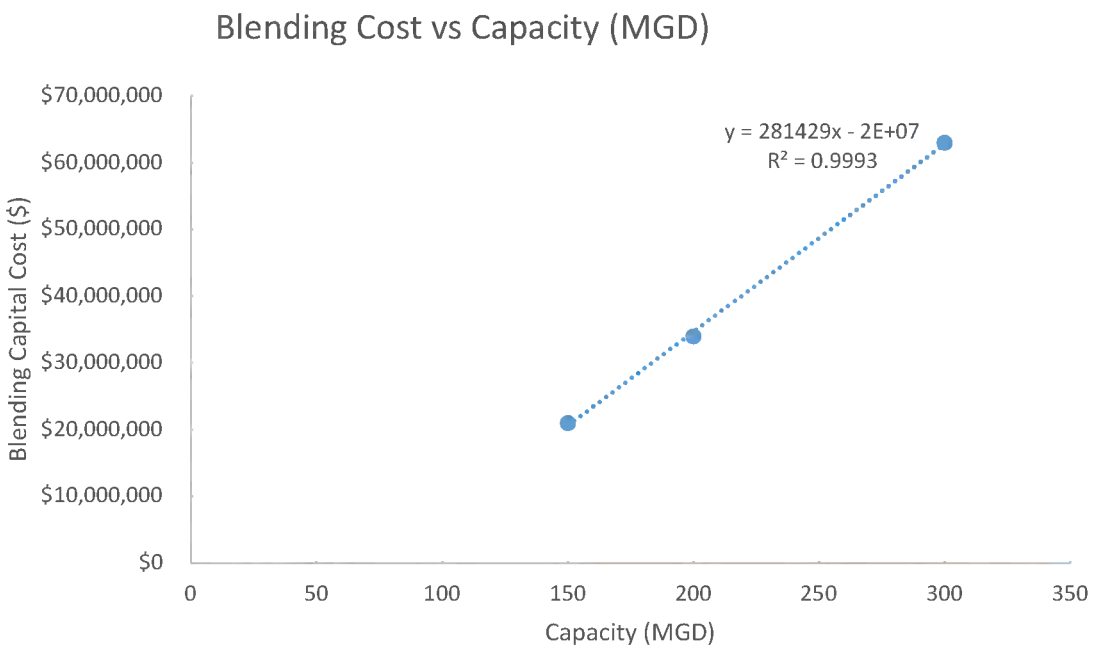
In the wet weather blending option, the additional wet weather flow undergoes the preliminary and primary treatment and then is directly conveyed to the disinfection process. The blended additional wet weather flow with the fully treated and disinfected flow is then discharged. The Wet Weather Blending option alone may not be able to meet the effluent quality standards and will achieve 78% TSS and 56% CBOD removal.

For estimation of the probable costs, 3 flow scenarios of 150, 200 and 300 MGD were considered for expansion of the plant's wet weather treatment capacity. Data sources for the budgetary capital cost estimate of 200 and 300 MGD scenarios include DELCORA Long-Term CSO Control Plan – Weston Solutions. The same costs have been adjusted for the 150 MGD flow scenario. The total capital cost used for cost curve construction does not include the chemical cost for chemically enhanced primary treatment, CEPT. The resulting capital cost curve for blending is the following:

Y = 281429x – 2E+07

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD. This trendline equation can be seen in Figure 19 below, and shows a high R^2 correlation value.

Figure 19. Blending Capital Cost vs Capacity



BIOACTIFLO

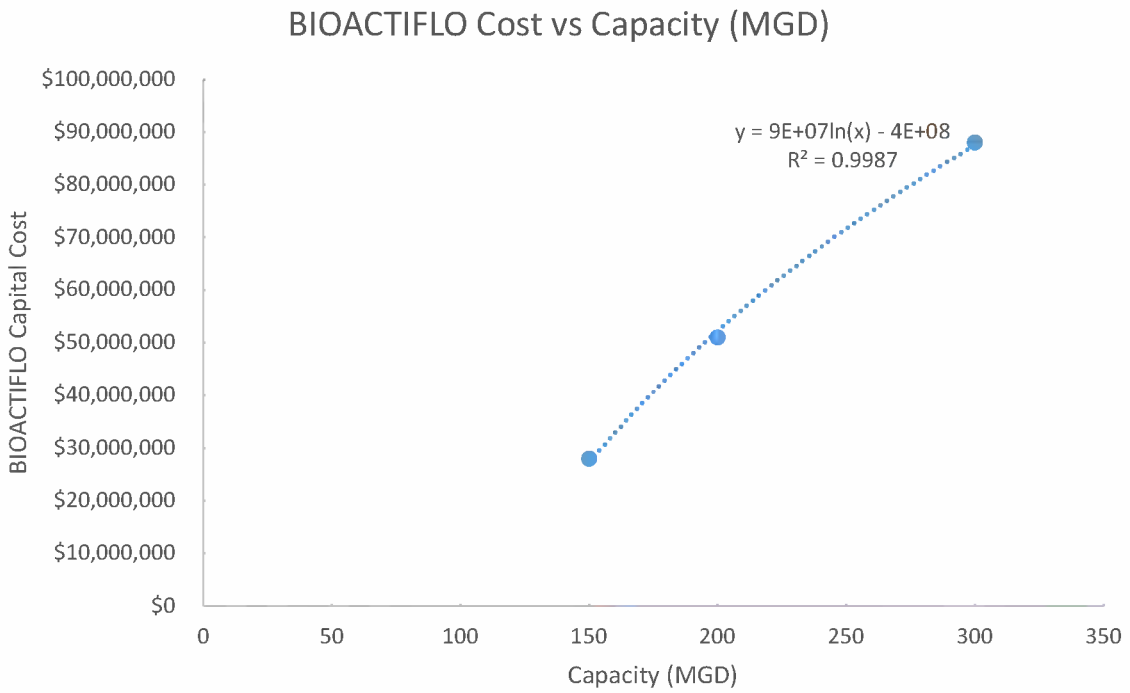
The BIOACTIFLO is a modified version of blending and provides enhanced treatment of additional wet weather flow through the combination of high rate biological treatment as well as high rate ballasted settling to meet the regulatory effluent standards. The additional wet weather flow that does not receive biological treatment in the plant's activated sludge process is treated by temporarily routing return activate sludge to a small aeration tank that is a part of the BIOACTIFLO process to achieve high rate biological treatment. The estimated effluent CBOD and TSS concentrations for BIOACTIFLO option are ≤ 25 mg/L and ≤ 30 mg/L respectively

Again, for the estimation of the probable costs, 3 flow scenarios of 150, 200 and 300 MGD were considered for expansion of the plant's wet weather treatment capacity to draw a comparison between the BIOACTIFLO and Blending option. Data sources for the budgetary capital cost estimate of 200 and 300 MGD flow scenarios include DELCORA Long-Term CSO Control Plan – Weston Solutions. The same costs have been adjusted to get the cost for 150 MGD scenario. The resulting capital cost curve for BIOACTIFLO is the following:

Y = 395714x – 3E+07

Where Y equals the total cost in million dollars and x equals treatment capacity in MGD. This trendline equation can be seen in Figure 20, and shows a high R^2 correlation value.

Figure 20: BIOACTIFLO Capital Cost vs Capacity



For any plant expansion costs, equivalent piping and pump additions or improvements to convey the proposed improvements must also be added for each alternative.

High Rate Clarification System (Actiflo)

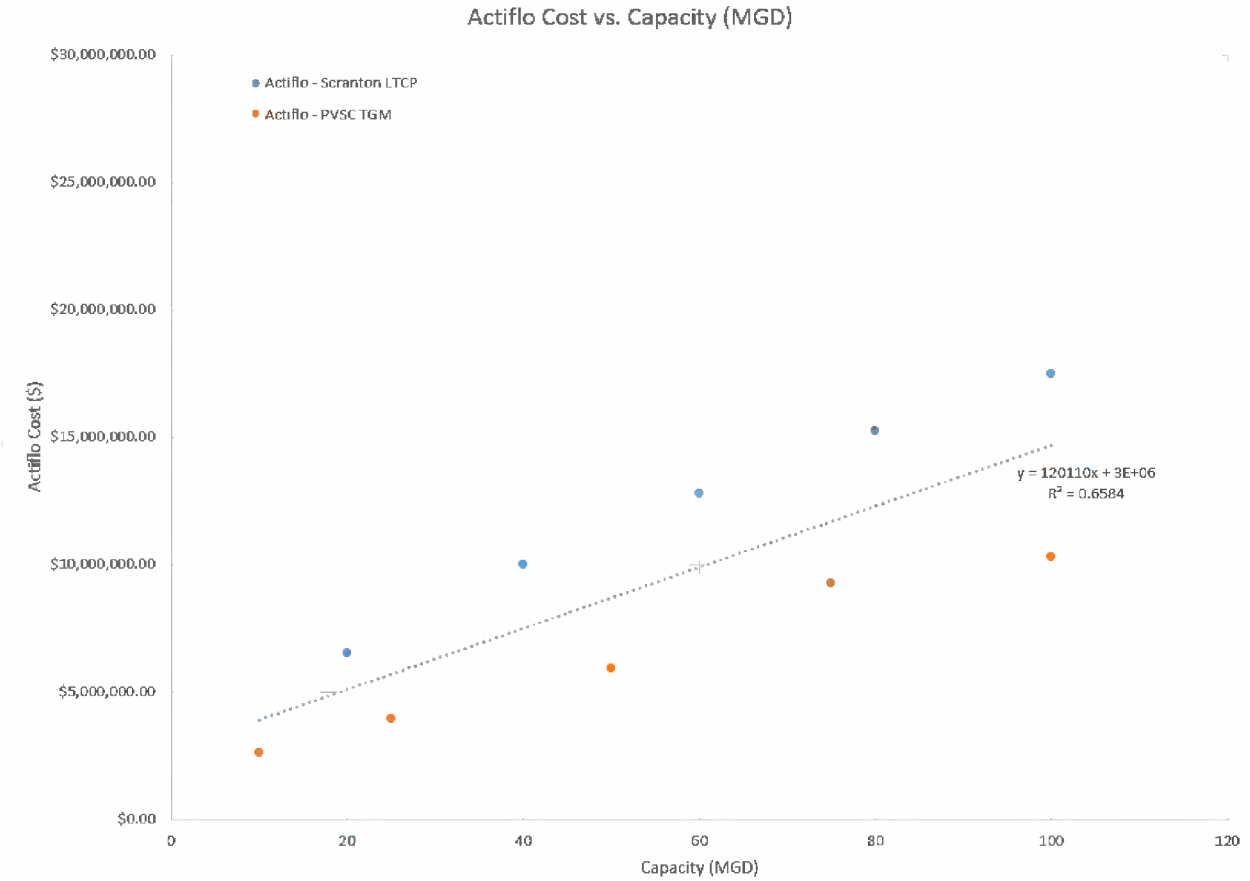
High rate clarification systems are to be used in the event primary treatment is needed at storage areas. These systems provide treatment at a quicker rate than conventional treatment systems along with having a decreased footprint. More specifically, a ballasted flocculation system increases the settling velocity of solids with the use of fine sands, polymer and coagulants. Actiflo® is a manufacturer of ballasted flocculation systems in particular. Data sources include cost curve information from PVSC TGM and Scranton LTCP with information from previous projects and actual installed costs being part of this data compilation. The resulting capital cost curve equation for high rate clarification systems is:

Y=120,110*x + 3E+06

Where Y equals the total Actiflo cost and x equals capacity in MGD.

The trendline equation for the above shows medium R^2 correlation.

Figure 21: Actiflo Capital Cost vs. Capacity (MGD)



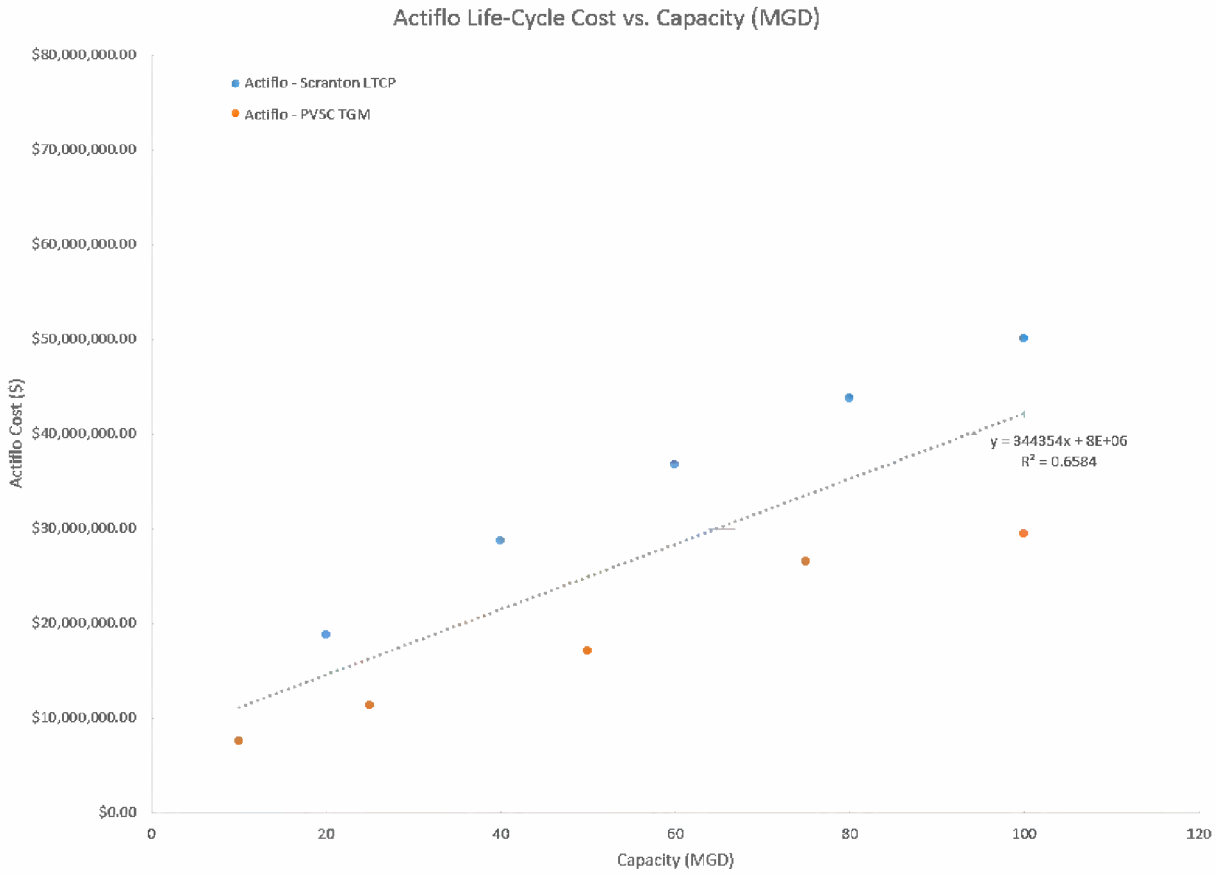
The resulting life-cycle cost curve equation for high rate clarification systems is:

Y=344,354*x + 8E+06

Where Y equals the total Actiflo cost and x equals capacity in MGD.

The trendline equation for the above shows medium R^2 correlation.

Figure 22: Actiflo Life-Cycle Cost vs. Capacity (MGD)


Actiflo Life-Cycle Cost vs. Capacity (MGD)
Actiflo - Scranton LTCP
Actiflo - PVSC TGM
y = 344354x + 8E+06
R² = 0.6584
Actiflo Cost ($)
$80,000,000.00
$70,000,000.00
$60,000,000.00
$50,000,000.00
$40,000,000.00
$30,000,000.00
$20,000,000.00
$10,000,000.00
$0.00
0
20
40
60
80
100
120
Capacity (MGD)

Regulator Modification

Regulator modification is a lower-cost option for existing regulators to passively reduce CSO overflow and maximize flow to the existing interceptors. Each CSO regulator is modified in different ways to achieve this goal, but the different modifications used in this report are increasing overflow weir height, increasing the regulator gate opening, increasing the orifice plate opening, and increasing the outflow pipe diameter to the connecting interceptor. The weir height increase allows the regulator to utilize the existing upstream pipe as temporary storage, while also utilizing the connecting interceptor's flow capacity better during storm events. Waterware is currently replacing or modifying the existing regulators for DELCORA, and was contacted for cost estimates on the regulator modifications listed above. The modifications focused on improving the regulator itself, and excluded external items which could vary greatly depending on each structure, including outflow pipe replacement, permitting, traffic control, asphalt paving, access cover replacement, and labor associated with these items. Since the greatest cost involves the regulator gate modification, three inclusive costs were given based on the size of standard gate sizes:

12" x 12" = $175,000
15" x 15" = $180,000
18" x 18" = $215,000

Waterware gave a high-end cost for access covers at $2,000, and labor costs for a general purpose laborer with a Superintendent supervising the work is $4,750 per week. Assuming each regulator takes a week or work to modify, the cost is rounded up to $10,000 to account for traffic control, asphalt paving, and scaffolding for the access covers, all of which can vary depending on the location and depth of each CSO and decrease with scale. Installed pipe costs were used to estimate the outflow pipe replacement.

The increase in flow to the receiving interceptors will increase flow to the WRTP, and so wet weather treatment costs may also be incorporated into the regulator modification costs for each alternative as needed. The actual need for plant expansion may be mitigated by additional CSO control technologies, however, and a study during post-construction monitoring should be conducted to determine the actual needs of the WRTP.

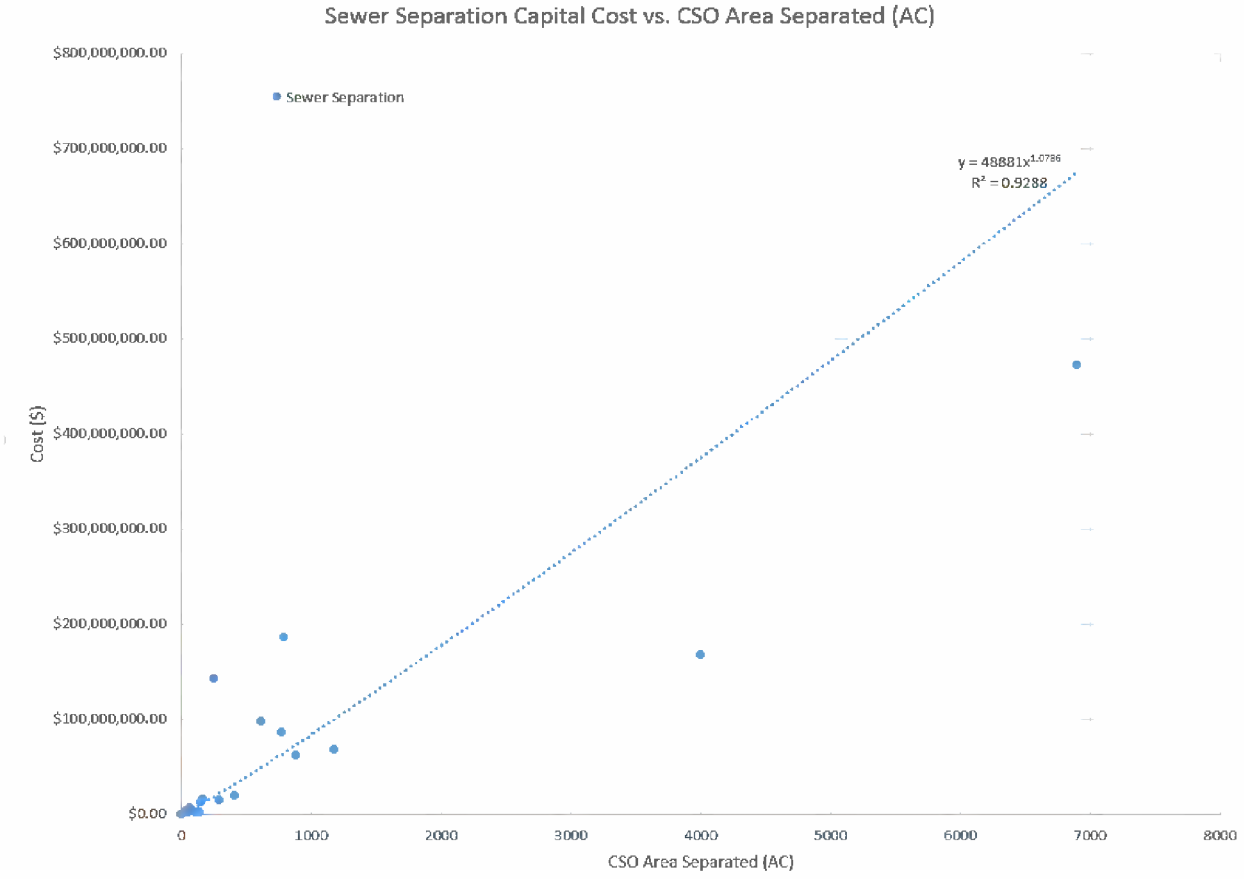
Sewer Separation

Sewer separation is utilized in combined sewer systems to ultimately reduce the amount of flow reaching the WRTP by eliminating stormwater from discharging into the system. This is usually done by installing new storm sewer pipe instead of sanitary pipe as sanitary pipe is usually deeper than storm sewer, thus causing it to cost more. In this specific analysis, the sewer separation cost curve is utilized for the Consent Decree analysis. A previous cost estimate was prepared to separate CSO 5, however this just involved installing a storm sewer along a strategic location to intercept stormwater flow as opposed to separating an entire area. The sewer separation cost curve uses construction cost estimates and bids from Elkhart, Indiana. The resulting capital cost curve for sewer separation is the following:

Y=48,881*x^1.0786

Where Y equals sewer separation cost and x equals the total area being separated. The trendline equation can be seen in Figure X below, showing a high R^2 correlation value.
Figure 23: Sewer Separation Capital Cost vs CSO Area Separated (AC)

Figure 23: Sewer Separation Capital Cost vs. CSO Area Separated (AC)

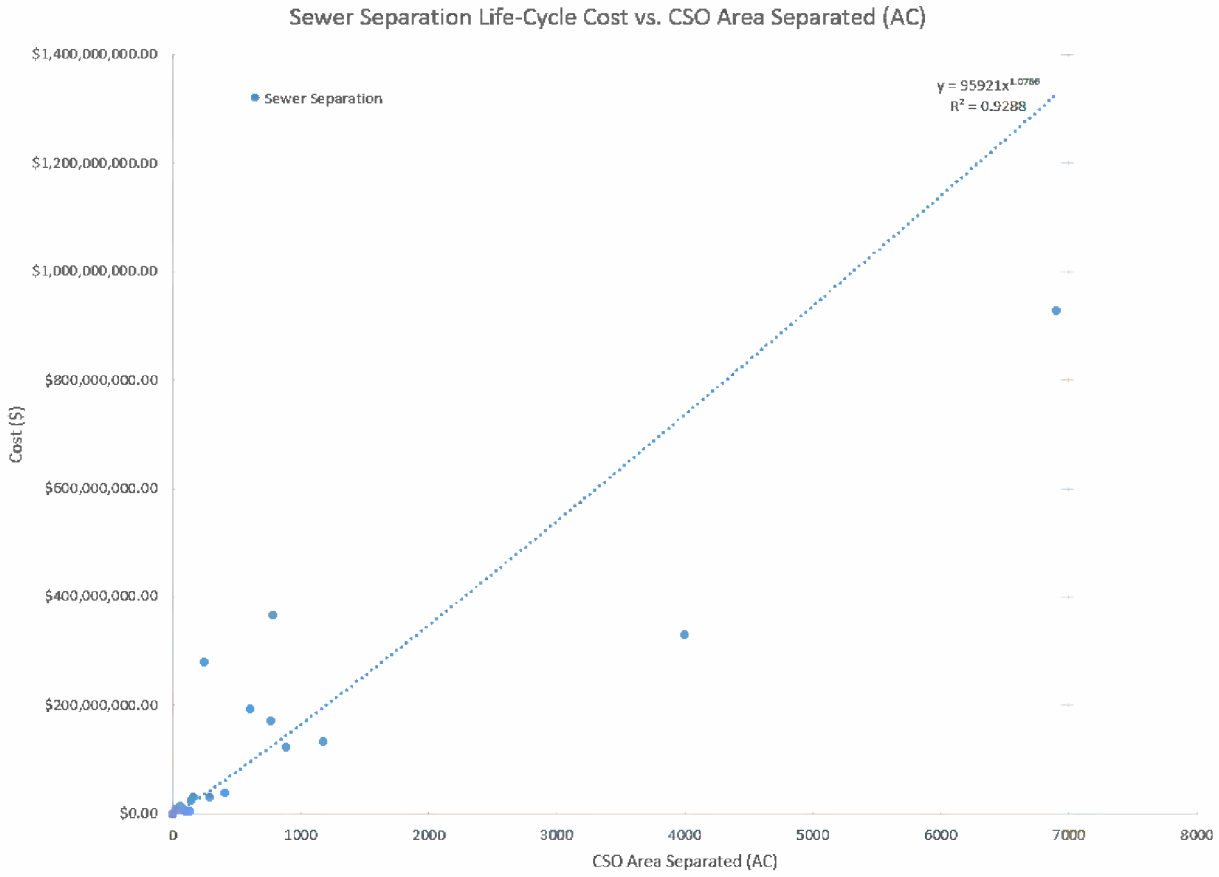


The resulting life-cycle cost curve for sewer separation is the following:

Y=95,921*x^1.0786

Where Y equals sewer separation cost and x equals the total area being separated in acres. The trendline equation can be seen in Figure X below, showing a high R^2 correlation value.

Figure 24: Sewer Separation Life-Cycle Cost vs CSO Area Separated (AC)



For the partial sewer separation in the regulator 5 CSS, Remington & Vernick provided two preliminary project estimates. We utilized the higher estimate, and added bonding and insurance, mobilization, and permitting costs to reach $4,400,000 for the project.

APPENDIX P

WRTP Process and Hydraulic Evaluation

- DELCORA Western Regional Treatment Plant Process and Hydraulic Evaluation dated April 2011 prepared by Weston Solutions, Inc.

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

WESTERN REGIONAL TREATMENT PLANT

PROCESS AND HYDRAULIC EVALUATION

APRIL 2011

Prepared by:

Weston Solutions, Inc.
1400 Weston Way
P. O. Box 2653
West Chester, PA 19380

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1. INTRODUCTION

This report presents an evaluation of the Delaware County Regional Water Quality Control Authority (DELCORA) Western Regional Treatment Plant (WRTP). DELCORA has requested that WESTON prepare an evaluation of the treatment process and hydraulic capacity of the WRTP.

1.1 BACKGROUND

In February 2000, DELCORA completed a Process Improvement Project (PIP) evaluation for its Western Regional Treatment Plant (WRTP) (WESTON 2000). The PIP evaluated the forward flow processes at the WRTP to identify process and operational efficiencies, determine the limiting hydraulic capacity of the plant, and evaluate the treatment capabilities of each unit process.

The results of the PIP evaluation showed the maximum hydraulic capacity of the WRTP was limited by the Aeration Basins, at a peak flow of at 137.4 MGD, with all basins in operation. If one basin is out of service, the hydraulic capacity is reduced to 102.1 MGD. The PIP also concluded that the biological treatment capacity of the WRTP was limited by the secondary clarifiers at 44.1 MGD (average flow) and the aeration basins at 45.5 MGD. The secondary clarifier limitation identified in the PIP was based on exceeding certain Pennsylvania Department of Environmental Protection (PADEP) design guidelines at peak flow, corresponding to average or rated flows above 44.1 MGD.

Since the completion of the PIP report, improvements to the aeration system have been implemented, resulting in increased treatment capacity to 50 MGD for the activated sludge components at the previously projected loadings.

In February 2003, WESTON prepared a report titled "Western Regional Treatment Plant Re-Rate to 50 MGD, Report on PADEP Guidelines" (WESTON, 2003). This report demonstrated that the performance of the aeration basins and clarifiers was not adversely impacted even while certain PADEP guidelines were not met, and that alternative loading factors may be more appropriate for design and operation of the system. This justification was further supported by

actual tested performance of the clarifiers under peak loading conditions. As a result of this study, PADEP has approved the re-rate of the WRTP to 50 MGD.

1.2 SCOPE OF EVALUATION

DELCORA is now pursuing additional flow for the WRTP through both strategic planning in the existing Western Region Service Area and potentially increasing the WRTP service area. Therefore, DELCORA desires to further evaluate the forward flow and solids handling processes at the WRTP for the purpose of identifying treatment capacity limitations. This evaluation will assume a target average daily flow of 60 MGD and utilize the most current loading data.

This report evaluates each unit process in the WRTP in order to estimate each unit's ultimate treatment capacity and its ability to accommodate the target 60 MGD (average flow). The end result of this evaluation is an assessment of whether the plant can accommodate 60 MGD and, if not, what upgrades are needed to meet that target. The assessment has been conducted utilizing recent influent loading data and, where appropriate, assumed loading values for the additional future flows. While the previous PIP evaluated forward flow processes, this evaluation includes thickening and dewatering processes as well. An evaluation of the incinerator system has not been included in this scope.

As compared to the PIP, and as discussed in the sections that follow, there are three main factors that may affect the capacity of the existing WRTP component.

1. The intended increase in average flow to 60 MGD.
2. An increase in wastewater strength since the time the PIP was completed. For example the PIP was based on a raw wastewater BOD_5 of approximately 127 mg/L at the then-rated capacity of 44 MGD. By comparison, data for the years 2006-2009, summarized in Section 2.1, shows an average influent BOD_5 of 199 mg/L. Allowing for future contributions (discussed in Section 2.1) this study is based on a projected influent BOD_5 of 208 mg/L.
3. An anticipated requirement for future nitrification, as discussed in Section 2.2. Nitrification requires lower loadings on the aeration basin and secondary clarifiers and therefore the capacity of these units at lower required loading is reduced.

A fourth factor that has an effect on these calculations is that the short-term peak factors were higher than were used in the PIP.

1.3 CURRENT FACILITIES

1.3.1 Description

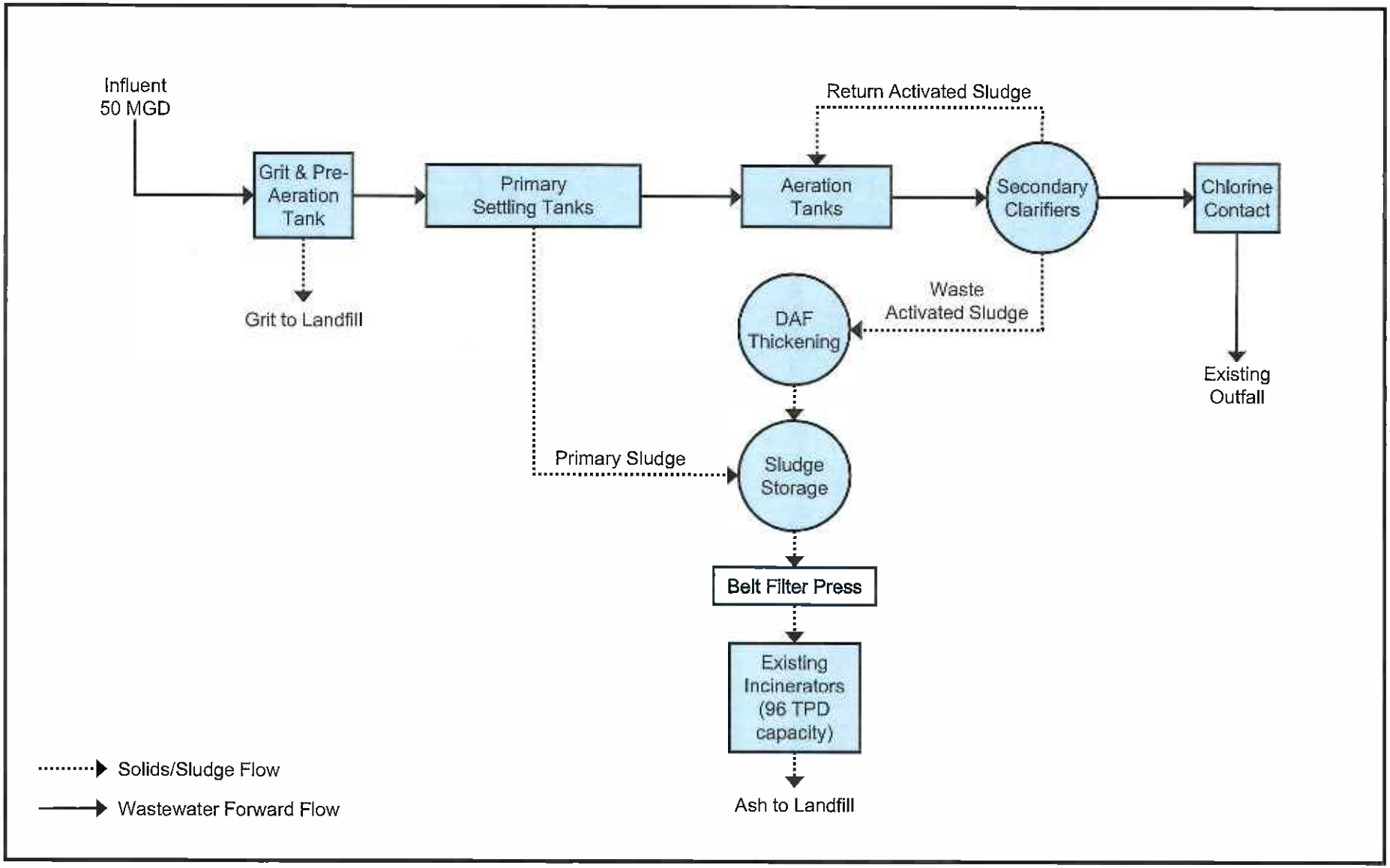
The DELCORA Western Regional Treatment Plant (WRTP) has a permitted treatment capacity of 50 million gallons per day (MGD). The treatment process is commonly described as "Activated Sludge Treatment." The overall process includes pre-treatment, primary treatment, secondary treatment, and final treatment steps (Figure 1-1).

Municipal and industrial wastewater enters the WRTP and proceeds to the pre-treatment step. Pre-treatment consists of aerated grit removal and pre-aeration tanks. During pre-treatment inorganic solids (sand, gravel, etc.) are removed from the wastewater for disposal and air is introduced to the wastewater to aid in the biologic treatment of the waste.

During the primary treatment step, the wastewater passes through eight parallel primary settling tanks where organic and inorganic settleable solids (sludge) are removed and disposed. Oil, grease, and other floatables are skimmed off of the tanks and also removed for disposal.

Effluent from the primary settling tanks is directed to the four aeration tanks in the secondary treatment step. Here air is introduced to the wastewater to add oxygen and provide mixing to maintain bacteria and organic material in suspension (mixed liquor). As a result, dissolved and suspended organic material is synthesized into new biomass (activated sludge). The mixed liquor is then conveyed to the five secondary clarifiers. Settled activated sludge is continuously removed from the secondary clarifiers and returned to the aeration tanks to support the treatment process or, if not needed, it is "wasted" and sent to sludge holding tanks for subsequent treatment and disposal.

The final treatment step is composed of chlorination tanks where the water is disinfected prior to discharge to the Delaware River.



WRTP Process and Hydraulic Evaluation

Delaware County Regional Water Quality Control Authority

Restoring Resource Efficiency

FIGURE 1-1

WRTP EXISTING BLOCK FLOW DIAGRAM

Figures 2.ppt

1.3.2 Performance

Table 1-1 summarizes WRTP performance during the period January 2007 – November 2009.

Table 1-1
WRTP Performance
January 2007 - November 2009
Average Flow Conditions

Parameter	Influent	Final Effluent	Removal Efficiency, %
Flow, MGD	36.65	36.35	NA
BOD_5, mg/L	199	5.85	97
TSS, mg/L	252	7.07	97
TKN, mg/L	19.7	2.8	86
Ammonia Nitrogen, mg/L	10.7	1.2	89

NA – Not Applicable

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2. BASIS OF EVALUATION

2.1 INFLUENT CHARACTERISTICS

An understanding of current performance data (influent and effluent characteristics) and operating conditions (i.e., MLSS/MLVSS, aeration rates, RAS/WAS data and similar) is needed to evaluate the performance of the existing WRTP systems relative to conventional benchmarks and to help assess the potential effects of additional loads on that performance. In addition, the influent flow and wastewater characteristics for the evaluation must be estimated to calculate unit process capacities. The WRTP receives a mixture of domestic and industrial/commercial wastewaters (Figure 2-1). The peak flow factors and characteristics of the wastewater in the future will be affected by whether the incremental future flow is primarily domestic or industrial.

To accomplish this task, WESTON reviewed operating data for the period January 2007 through November 2009 to understand current flow conditions at the WRTP. For the incremental flow up to the target values, WESTON reviewed with DELCORA the possible sources of the flow and developed estimates of waste characteristics from those sources. The following contributions were projected.

- DELCORA's current flow from its existing service area is, on average, 36.65 MGD.
- The Southwest Delaware County Municipal Authority (SWDCMA) may close its wastewater treatment plant with DELCORA assuming its flow. The SWDCMA plant is rated at 6 MGD average flow, and it is assumed that all flow would be routed to the WRTP.
- The remaining flow up to the target 60 MGD (17.35 MGD) is assumed to come from additional but as yet not defined sources and is assumed to consist of typical medium strength domestic sanitary wastewater.

A combination of DELCORA data, limited data from SWDCMA and literature characteristics for sanitary wastewater was used to develop a weighted average characteristic for this evaluation. The calculations are summarized in Appendix A. Table 2-1 summarizes the results of this estimate.

Table 2-1
Estimated Wastewater Characteristics
for Capacity Evaluation

Parameter	Influent Characteristics
Flow, MGD	60
BOD_5, mg/L	208
COD, mg/L	484
TSS, mg/L	250
Total Nitrogen, mg/L	28
Ammonia Nitrogen, mg/L	16
Oil and Grease, mg/L	48
Alkalinity, as CaCO3, mg/L	100

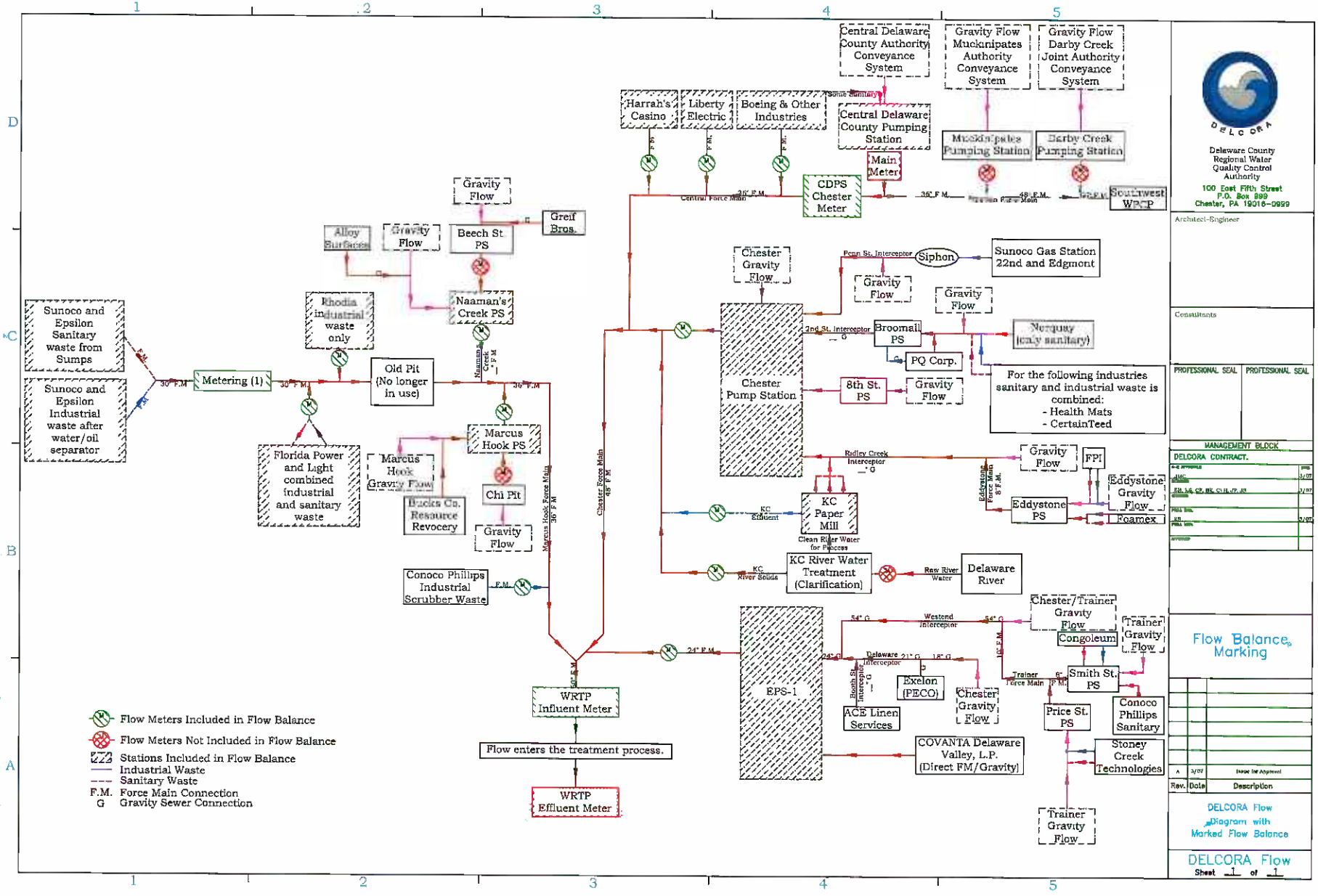
Table 2-2 summarizes daily peak factors based on DELCORA's current data.

Table 2-2
Estimated Daily Peak Load Factors
Based on DELCORA Influent Data, 2007-2009
(All Factors are the Ratio of the
Indicated Value to the Average Value)

Parameter	Flow	BOD_5 Load	TSS Load	Total Nitrogen Load
Maximum	2.35	3.05	3.15	1.89
99^{th} Percentile	1.74	2.05	2.28	1.88
95^{th} Percentile	1.33	1.53	1.61	1.35

Based on these data, this evaluation assumes a maximum daily flow of 104.5 MGD corresponding to the upper 99^{th} percentile daily peak flow. Process calculations are also based on the upper 99^{th} percentile BOD_5, TSS and Nitrogen loadings where appropriate. This is considered to provide a conservative basis for estimating capacity without overdesign for extreme events.

An analysis of hourly flow data (which affects hydraulic sizing of certain process units) for the period of January 2007 to November 2009 would suggest an hourly peak factor of approximately 2.4 (based on an upper 99th percentile hourly flow of 88.5 MGD and the long term average flow of 36.65 MGD.) Extending this peak factor to the target flow of 60 MGD would indicate a peak



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Architect-Engineer

Consultants

PROFESSIONAL SEAL | PROFESSIONAL SEAL

MANAGEMENT BLOCK
DELCORA CONTRACT.

Rev.	Date	Description
A	3/07	Issue for Approval

Flow Balance Marking

DELCORA Flow Diagram with Marked Flow Balance

DELCORA Flow
Sheet 1 of 1

CADFILE: Flow Diagram with Marked Flow Balance.dwg

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currently limited by influent pumping capacity to approximately 110 MGD, based on historically observed flow values. This would imply a mechanically limited peak factor at 60 MGD of approximately 1.84. However, since the mechanical limitation could be resolved in the future, DELCORA has directed that this limit not be used as the estimate for peak flow. Therefore, this evaluation assumes the 1.74 (upper 99th percentile) daily flow peak factor (Table 2-2) applies to daily flow up to 60 MGD and an hourly peak flow of 144 MGD (2.4 peaking factor based on upper 99th percentile value.)

PADEP design guidelines also use maximum monthly flow for some parameters. An estimate of maximum monthly average flow was calculated from 30 day averages of the daily flow data as provided by DELCORA. This estimated maximum monthly average flow for the period January 2007- November 2009 was 48.4 MGD. This corresponds to a maximum month to average peak factor of 1.33 and a maximum monthly flow of 80 MGD at the target 60 MGD average flow.

These peak values are considered to be relatively conservative. In general, pecking factors tend to decline at higher flow and it is possible that the peaking factors at the target for of 60 MGD may be somewhat lower than at the current average flow. In addition the peaking factors used in this report are based on upper 99th percentile values of the historic data. Because of these factors, the capacities estimated in this report are generally considered to be somewhat conservative.

2.2 EFFLUENT LIMITATIONS

Projected effluent limitations were evaluated to establish the performance standard the WRTP must meet under future conditions. In principle, this could be based on one of several assumed scenarios for the future, including:

- The continuation of existing mass based NPDES permit limits on BOD_5: This scenario would result in progressively lower concentration-based effluent limits as flows increase. (It should be noted however, that based on discussions between DELCORA and DRBC, DELCORA anticipates the current BOD_5 limit will be changed to a $CBOD_5$ limit during the next NPDES permit renewal.)
- The assumption that additional mass allocations can be obtained, such that the current concentration based limits would remain in effect.

- Nutrient (nitrogen and phosphorus) removal requirements. Nutrient limits have not historically applied on the main stem of the Delaware River. However at DELCORA's direction, WESTON has previously evaluated these options for DELCORA with respect to expanding the WRTP, constructing a new WWTP for Eastern Delaware County, and for certain potential satellite plants that could be constructed on smaller streams within the County, for which nutrient limitations may be applied in the near future.

- The potential for toxic Water Quality Based Effluent Limits (WQBELs) in the future could be considered. DELCORA does not at present have such limits imposed in the NPDES permit. If they were likely to be imposed in the future, several options may need to be considered including

    - Revision of local limits to more specifically control industrial inputs

    - Possible additional (tertiary) treatment, or,

    - Since many WQBELs allow for a mixing zone in the river as part of a compliance strategy, outfall modifications is a way to provide necessary dilution.

    It should be noted that DELCORA is currently designing an outfall extension into the Delaware River to address effluent mixing requirements based upon discussions with the DRBC, The new outfall will provide increase mixing and may affect the likelihood of WQBELS in the future.

Based on discussion with DELCORA the following determinations were made with respect to these options:

- With respect to BOD_5 limitation, WESTON, at DELCORA's direction, contacted the Delaware River Basin commission to determine whether an additional allocation would be obtained when DELCORA took over the Southwest Delaware County treatment plant. A record of this conversation is provided as Appendix B. Based on that discussion, it is assumed for this study that no additional allocation would be provided. Applying the existing mass allocation to the future flow of 60 mg/L would require an effluent BOD_5 concentration of 14 mg/L

- DELCORA anticipates an ammonia limit in the futures. For purposes of this evaluation an ammonia limit of 8 mg/L ammonia-nitrogen (NH_3-N) was adopted. DELCORA does not at present see a corresponding limit on phosphorus as a nutrient in the future.

- WQBELS will not be considered in this evaluation, but now may be placed in the NPDES permit with the pending rerate to 50 MGD.

3. HYDRAULIC EVALUATION

Section 4 of this report identifies the limiting element(s) for each unit process involving the forward flow of the treatment process In addition the capacity of the return activated sludge (RAS) and waste activated sludge (WAS) piping has been estimated. Information regarding equipment type and size was taken from as-built drawings provided by DELCORA.

3.1 FORWARD FLOW

3.1.1 Approach

Forward flow through the pre-aeration, primary clarification, activated sludge secondary clarification and disinfection processes was estimated based on gravity flow from one unit process to the next, accounting for head losses in the system (i.e. piping losses). Figure 3-1 depicts the hydraulic profile of the forward flow processes with the main points of analysis annotated.

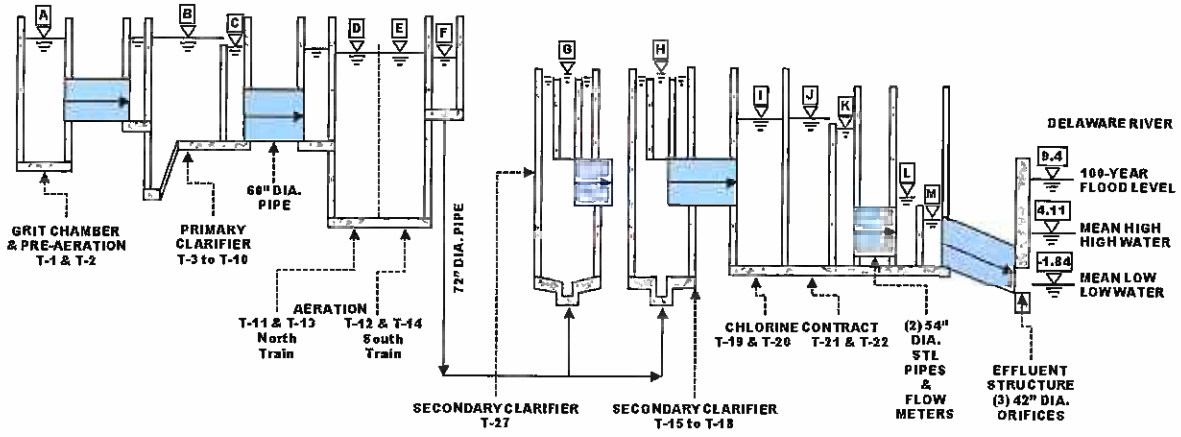


Figure 3-1 Hydraulic Profile of the Wastewater Processes

In general, the criterion adopted for this evaluation was to assume, at a minimum, free fall over weirs and outlet structures between unit process tanks. Piping losses are based on the data for piping and fittings as summarized in the PIP report and verified from record drawings.

3.1.2 Maximum Forward Flow Analysis (Individual Treatment Processes)

This analysis estimates the maximum forward flow for the pre-aeration, primary clarification, activated sludge secondary clarification and disinfection processes independently. Forward flow

through each process was increased until the effluent water elevation reached the top of its v-notch weirs (where applicable) or the influent water elevation reached 1 inch below the effluent weir of the preceding process. This analysis maintained the assumption of freefall over weirs and outlet structures as described in Section 3.1.1. Results of the individual process analysis are summarized in Table 3-2 and discussed further in the following four sections.

Maximum forward flow on an individual process basis is not limited by the capacity of downstream process flow capacities. Therefore the maximum forward flow through the entire treatment works differs from this analysis because it is controlled by the most flow limited process. Analysis of the treatment works as a whole is presented in Section 3.1.3.

Table 3-1
Maximum Forward Flow Analysis (Individual Treatment Processes)

PROCESS	MAXIMUM FORWARD FLOW, (MGD)	
Pre-aeration Tank and Primary Clarifier	169.3	
Aeration Basin	95.5[1]	108.6[2]
Secondary Clarifiers[3]	135.5[1]	118.2[2]
Chlorine Contact Tanks	131.1	

1. Maximum aeration basin effluent weir setting (EL. 20.30ft)
2. Minimum aeration basin effluent weir setting (EL. 19.32ft)
3. Maximum water surface elevation so backwater does not exceed 1" below aeration basin effluent weir setting.

3.1.2.1 Pre-aeration Tank and Primary Clarifier

The water level in the primary settling tanks (T-3 through T-10) is set by the 2.5 inch 90° v-notch weirs with a bottom elevation of 24.64 ft (point B). Maximum flow through the primary settling tanks is assumed to occur at the top of the v-notch weir (EL. 24.85 ft). At this elevation, each of the 5,288 notches flows at 22.23 gpm for a total maximum flow of 169.3 MGD. Head loss through the grit and pre-aeration tanks (T-1 & T-2) is estimated at 0.1 ft for 169.3 MGD forward flow. This results in a water surface elevation of 24.95 ft in the grit and pre-aeration tanks (point A). The calculations of maximum forward flow through individual unit processes are included in Appendix C.

Flow over the primary effluent weirs can be influenced by the water elevation in the primary effluent channel. Flow over the weir will be reduced if the water in the effluent channel

approaches the weir bottom; therefore it is assumed that the maximum water elevation in the primary effluent channel is 1 inch below the bottom of the v-notch weir or elevation 24.56 ft (point C).

3.1.2.2 Aeration Basin

The current configuration directs flow from the primary effluent channel through a 60 inch diameter steel influent pipe and into two parallel trains of aeration basins (T-11 to T-13 and T-12 to T14). The water levels in the aeration basins (points D and E) are set by eight 12 foot adjustable weirs with a maximum crest elevation of 20.30 ft and minimum elevation of 19.32 ft. Assuming a sludge recycle ratio of 0.53 and that the effluent weir is set at its maximum elevation, 95.5 MGD of forward flow will pass through the aeration basins without exceeding the maximum water elevation in the primary effluent channel of 24.56 ft (point C).

When the effluent weir is set at its minimum elevation, 108.6 MGD will pass through the aeration basins without exceeding the maximum water elevation in the primary effluent channel. The calculations of maximum forward flow through individual unit processes are included in Appendix C.

3.1.2.3 Secondary Clarifiers

The max flow through the secondary settling tanks is assumed to occur at the top of the 2.5 inch 90° v-notch weir. The maximum forward flow apportioned by weir capacity alone is 46.3 MGD for T-15 through T-18 and 44.5 MGD for T-27. This flow however is not proportional to the clarifier area as required for process optimization. Control valves are required to balance the flow by clarifier area to 31.2% for T-27 and 17.2% through each of the four remaining clarifiers.

Assuming a recycle ratio of 0.53 and that maximum flow occurs at the top of the v-notch weir, the maximum area apportioned forward flow is 142.6 MGD; however this exceeds the maximum water elevation (point F) of 1 inch below the aeration basin effluent weir at its maximum setting. A flow of 135.5 MGD can pass through the secondary clarifiers without exceeding the maximum crest elevation of the aeration basin effluent weir (EL. 20.30 ft) and a flow of 118.2 MGD can pass through the secondary clarifiers without exceeding the minimum weir setting (EL. 19.32 ft).

Depending on the position of the aeration basin effluent weir the aeration basins and secondary clarifiers are the hydraulically limiting segments and therefore control the maximum forward flow of the entire treatment works. The calculations of maximum forward flow through individual unit processes are included in Appendix C. The forward flow analysis of the entire treatment works is presented in Section 3.1.3. This analysis assumes that the aeration basin effluent weir is set at its highest position (EL. 20.30 ft).

3.1.2.4 Chlorine Contact Tanks

The maximum flow through the chlorine contact tanks was calculated based on three criteria: (1) the influent water elevation at the outfall structure was limited to 1 inch below the crest of the magnetic flowmeter weir (point M); (2) the water elevation in the chlorine contact tank effluent channel was limited to 1 inch below the crest of the chlorine contact tank effluent weirs (point K); and (3) the water elevation in the secondary clarifier effluent channel was limited to 1 inch below the secondary clarifier effluent weirs (points G_{out} and H_{out}). This analysis includes all piping losses and a high tide river elevation of 3.2 ft. To maximize contact time, the adjustable chlorine contact tank effluent weirs were assumed to be in the highest position (EL. 12.65 ft)

A flow of 131.1 MGD was found to meet all three criteria. Maximum flow was limited by the water elevation in the chlorine contact tank effluent channel due to the constriction of flow through the single 54 inch magnetic flowmeter. At this flow the influent water elevations in the secondary clarifier effluent channel and at the outfall structure were more than an inch below the maximum elevations. The calculations of maximum forward flow through individual unit processes are included in Appendix C.

3.1.3 Maximum Forward Flow Analysis (Entire Treatment Works)

This analysis estimates the maximum forward flow of the entire treatment works as a whole. When the aeration basin effluent weir is set at its highest position (EL. 20.30 ft), the aeration basins are the hydraulically limiting segment with a maximum forward flow of 95.5 MGD. When the aeration basin effluent weir is set at its lowest position (EL. 19.32 ft), the aeration basins are still the hydraulically limiting segment with a maximum forward flow of 108.6 MGD. These flows maintain the assumption of freefall over all weirs and outlet structures as described in Section 3.1.1. These results are discussed further in the following sections.

Figure 3-2 shows the water elevations in each treatment process at 95.5 MGD and 108.6 MGD as well as water elevations at the target flow of 60 MGD, the maximum monthly flow of 80 MGD, the maximum daily flow of 104 MGD and the maximum hourly flow of 144 MGD. The calculations of forward flow through the entire treatment works are included in Appendix C.

3.1.3.1 Pre-aeration Tank and Primary Clarifier

At a flow of 95.5 MGD, the water surface elevation within the primary clarifier is 24.81 ft which is below the top of the v-notch weir (point B). The water surface elevation in the grit and pre-aeration tanks is 25.23 ft (point A). At a flow of 108.6 MGD, the water surface elevation within the primary clarifier is 24.81 ft which is below the top of the v-notch weir (point B). The water surface elevation in the grit and pre-aeration tanks is 25.36 ft (point A).

3.1.3.2 Aeration Basin

At a flow of 95.5 MGD, the water elevation in the primary effluent channel is 24.56 ft (point C) which is at the maximum elevation of 24.56 ft. At a flow of 108.6 MGD, the water elevation in the primary effluent channel is 24.56 ft (point C) which is at the maximum elevation of 24.56 ft.

3.1.3.3 Secondary Clarifiers

At a flow of 95.5 MGD and a recycle ratio of 0.53, the water elevation in the aeration basin effluent channel (18.09 ft) is more than 1 inch below the bottom of the aeration basin effluent weir (point F). At a flow of 108.6 MGD and a recycle ratio of 0.53, the water elevation in the aeration basin effluent channel (18.72 ft) is more than 1 inch below the bottom of the aeration basin effluent weir (point F).

3.1.3.4 Chlorine Contact Tanks

At a flow of 95.5 MGD, the water elevation in the secondary clarifier effluent channels (14.42 ft and 14.29 ft), the contact tank effluent channel (10.59 ft), and the outfall structure (3.83 ft) are all more than 1 inch below the maximum water elevation (points G_{out}, H_{out}, K, and M). At a flow of 108.6 MGD, the water elevation in the secondary clarifier effluent channels (14.47 ft and 14.33 ft), the contact tank effluent channel (10.68 ft), and the outfall structure (3.85 ft) are all more than 1 inch below the maximum water elevation (points G_{out}, H_{out}, K, and M).

3.1.4 60, 80, 104 and 144MGD Forward Flow Analyses (Entire Treatment Works)

Maximum forward flow through the entire treatment works is limited to 95.5 MGD by the assumption of freefall over weirs and outlet structures. Therefore the freefall assumption also holds for the target flow of 60 MGD, the maximum monthly flow of 80 MGD, the maximum daily flow of 104 MGD, and the maximum hourly flow of 144 MGD.

At a maximum hourly flow of 144 MGD, however, water elevations would back up in the system and flood over the top of wall (EL. 27.0 ft) of the grit chamber and primary clarifiers. Similarly, the aeration basin effluent weirs (point F) would be flooded by almost 3 inches, the secondary clarifier effluent weirs (points G_{out} and H_{out}) would be flooded by 5 inches, and the chlorine contact tank effluent weirs (point K) would be flooded by over 9 inches.

The walls of the grit chamber and primary clarifiers would have to be raised by 31.6 inches to avoid flooding at 144 MGD. The highest forward flow that would not overflow the grit chamber and primary clarifiers is 119 MGD. Lowering the aeration basin effluent weirs to their minimum position would allow 128.5 MGD forward flow before overtopping these tanks. However the maximum forward flow in the secondary clarifiers under these conditions is 118.2 (Table 3-1) which makes the secondary clarifiers the hydraulically limiting segment.

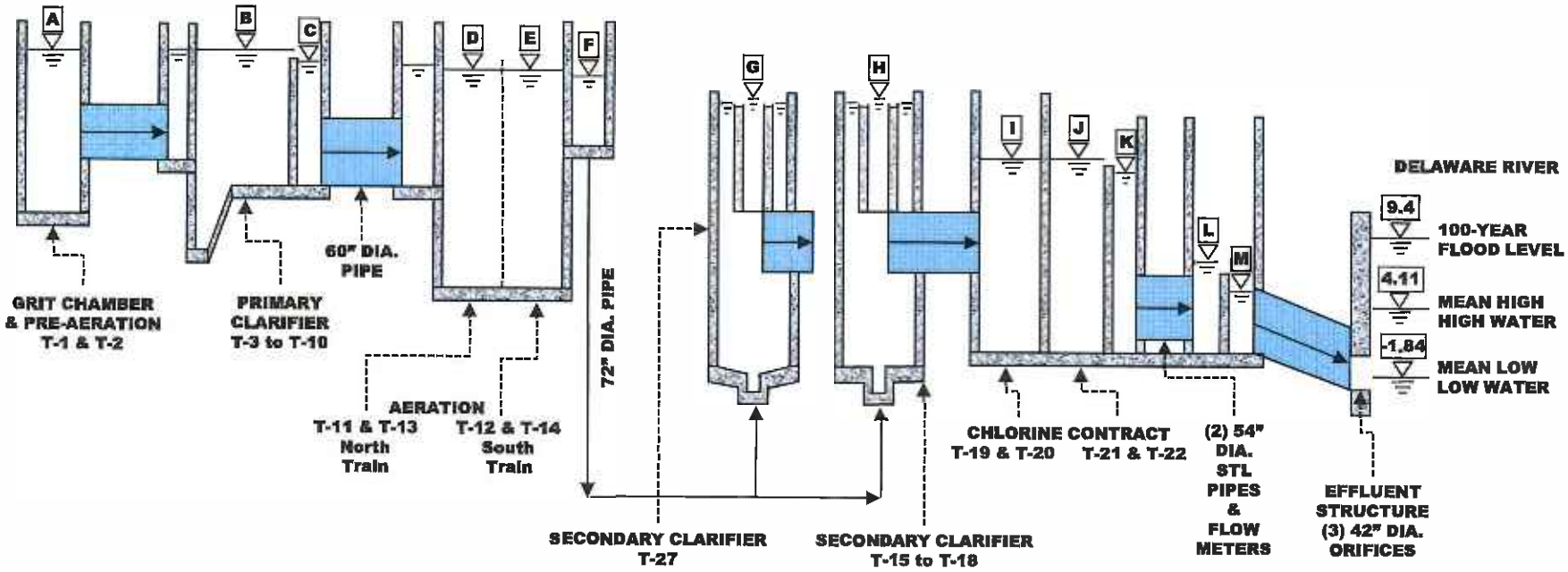
3.2 RETURN FLOWS

3.2.1 Approach

Return activated sludge (RAS) and waste activated sludge (WAS) are pumped to the aeration basins and the DAF system respectively. The capacity of the RAS and WAS systems was evaluated assuming a typical flow velocity of 5 feet per second (which generally represent reasonable head losses). Higher velocities, if needed, may be achievable at higher losses.

3.2.2 Return Activated Sludge

RAS is collected from secondary clarifiers T-15 to T-18 and pumped via RAS pumps P-11 and P-12 (in Pump Station PS-3) to aeration basins T-11 to T-14. RAS from secondary clarifier T-27 is pumped via RAS pump P-63 and P-64 (in PS-5) into the common RAS line with between PS-3 and aeration basins T-11 to T-14.



Condition	Flow	Water Level Elevation (ft)														
		Grit Chamber	Primary	Primary Effluent	North Basin	South Basin	Basin Effluent	Secondary Clarifiers				Chlorine Contact			Outfall Weir	
	MGD	T-1 & T-2	T-3 to T-10		T-11 & T-13	T-12 & T-14		T-27		T-15 to T-18		T-19 & T-20	T-21 & T-22	D/S Weir		
		A	B	C	D	E	F	G (in)	G (out)	H (in)	H (out)	I	J	K	L	M
Max. Free Fall EL.	--	--	24.85	24.56	--	--	20.22	15.71	15.42	15.55	15.42	--	--	12.57	--	6.92
Max. Aeration Basin Effluent Weir EL.	95.5	25.23	24.81	24.56	21.02	21.18	18.09	15.68	14.42	15.58	14.29	13.43	13.43	10.59	8.85	3.83
Min. Aeration Basin Effluent Weir EL.	108.6	25.36	24.81	24.56	20.08	20.31	18.72	15.69	14.47	15.59	14.33	13.44	13.44	10.68	8.87	3.85
Ave. Daily	60	24.94	24.78	22.49	20.95	20.83	16.44	15.65	13.63	15.60	13.57	13.22	13.22	9.04	8.35	3.45
Max Monthly Ave.	80	25.09	24.79	23.52	20.99	21.04	17.15	15.67	14.05	15.63	13.95	13.34	13.34	9.86	8.64	3.64
Max Daily	104	25.67	25.18	25.18	21.05	21.25	18.21	15.68	14.64	15.67	14.49	13.48	13.48	11.02	8.96	3.94
Max Hourly	144	29.55	28.64	28.64	21.16	21.54	20.47	15.71	15.83	15.71	15.57	13.68	13.68	13.39	9.43	4.62

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FIGURE 3-2

WRTP HYDRAULIC PROFILE

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Conventional design guidelines (PADEP, Ten States Standards) recommend a return activated sludge flow between 100% to 150% of the forward flow based on the type of treatment (Table 3-2). Assuming the target flow of 60 MGD and the maximum monthly flow of 80 MGD, this would indicate a return sludge capacity of up to 80 MGD to meet design guidelines for BOD_5 removal and 120 MGD for nitrification.

Table 3-2
Return Activated Sludge Guidelines

Parameter	Guideline		
	1 PADEP	2 Ten States	
	Conventional Biol. Treatment:	Conventional Biol. Treatment:	Single Stage Nitrification:
Recommended Return Activated Sludge Flow	100% Maximum Monthly Flow	100% Forward Flow	150% Forward Flow

Assuming a maximum RAS pipe flow velocity of 5 feet per second for long pipe runs, the single 36 inch diameter RAS line between PS-3 and the common RAS line limits the maximum total flow from secondary clarifiers T-15 through T-18 to 22.8 MGD. At a maximum velocity of 5 feet per second, the single 24 inch diameter RAS collection line under T-27 limits the maximum flow from secondary clarifier T-27 to 10.2 MGD. Similarly, the single 42 inch diameter common RAS line conveying flow from all secondary clarifiers limits maximum total flow to 31.1 MGD at 5 feet per second. Assuming a sludge recycle ratio of 0.53, the maximum forward flow through the plant is limited to 58.5 MGD by the single 42 inch common RAS line. Figure 3-3 shows flow velocities at several points in the RAS lines for flows of 60 MGD, 80 MGD, 104 MGD and 144 MGD. Evaluation of the PS-3 and PS-5 pump curves and the PAS system curves indicated that there is adequate pumping capacity up to the maximum daily forward flow of 104 MGD.

The analysis in the previous paragraph is based on the existing process configuration. As discussed in Section 4, additional aeration basins and an additional secondary clarifier will be required to meet the 60 MGD objective. In this case additional RAS lines would be needed.

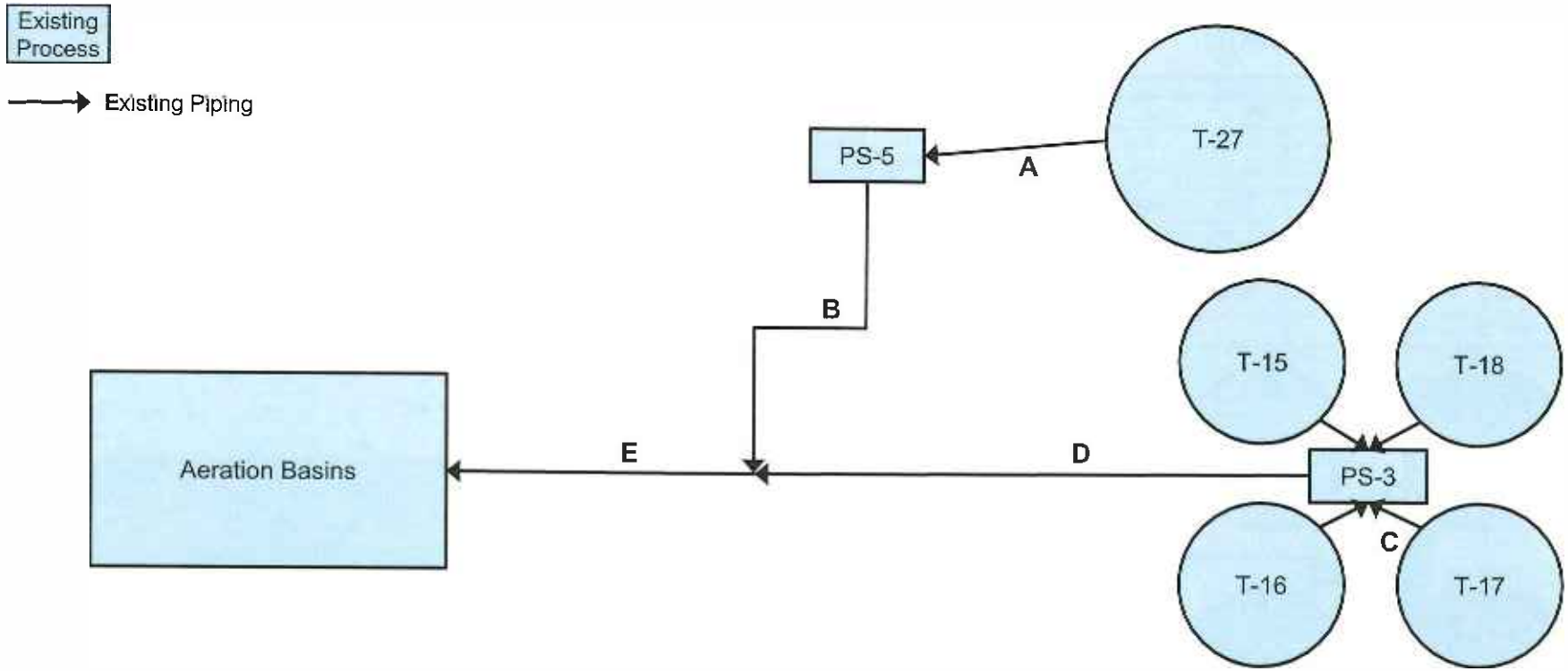
Addition of a new secondary clarifier (T-28) and new RAS lines from clarifiers T-27 and T-28 to a new aeration basin reduces the flow velocities in the RAS lines and increases the maximum

forward flow through the plant. Figure 3-4 shows flow velocities at several points in the existing and proposed RAS lines for flows of 60 MGD, 80 MGD, 104 MGD, and 144 MGD.

3.2.3 Waste Activated Sludge

Waste activated sludge is collected from secondary clarifiers T-15 to T-18 and pumped via WAS pumps in Pump Station PS-3 to dissolved air flotation DAF thickener tanks T-23 to T-26. WAS is collected from secondary clarifier T-27 and pumped via the pump in Pump Station PS-5 into the common WAS line with between PS-3 and the DAF thickener tanks.

Assuming a maximum pipe flow velocity of 5 feet per second for long pipe runs, the two 10 inch diameter WAS pump discharge lines in PS-3 have the smallest pipe diameters and therefore limit maximum total WAS flow from secondary clarifiers T-15 through T-18 to 3.5 MGD. At a maximum velocity of 5 feet per second, the single 12 inch diameter WAS line in PS-5 limits the maximum WAS flow from secondary clarifier T-27 to 2.5 MGD. Assuming a sludge waste rate of 0.017, the maximum forward flow through the plant is limited to 150 MGD by the single 12 inch common WAS line. Figure 3-5 shows flow velocities at several points in the WAS lines for flows of 60 MGD, 80 MGD, 104 MGD, and 144 MGD.



Forward Flow (MGD)	A		B		C		D		E	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	9.9	4.9	9.9	4.9	5.5	3.9	21.9	4.8	31.8	5.1
80	13.2	6.5	13.2	6.5	7.3	5.2	29.2	6.4	42.4	6.8
104	17.2	8.5	17.2	8.5	9.5	6.7	37.9	8.3	55.1	8.9
144	23.8	11.7	23.8	11.7	13.1	9.3	52.5	11.5	76.3	12.3

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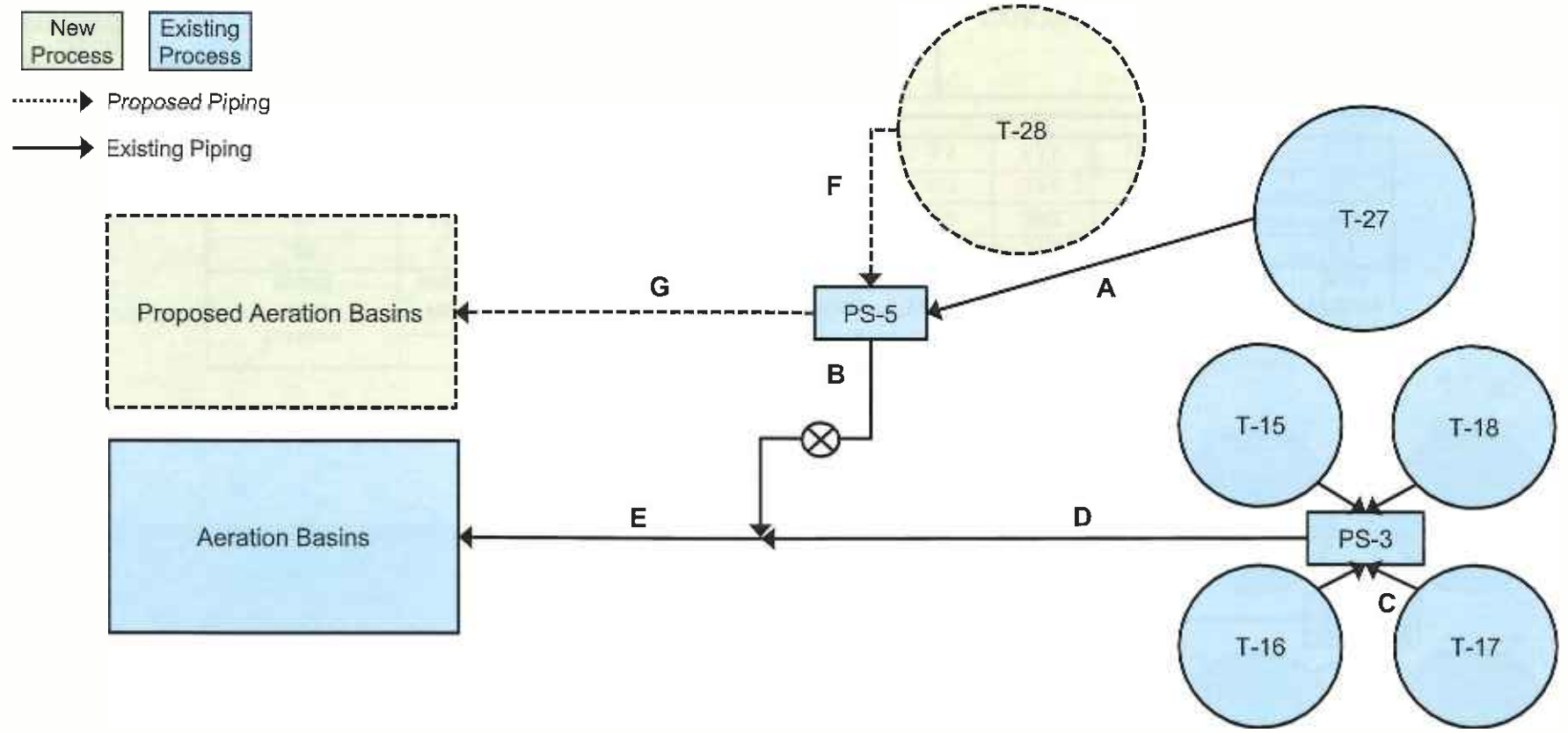
FIGURE 3-3

EXISTING RAS FLOW AND PIPE VELOCITIES (60MGD TO 144MGD)



Forward Flow (MGD)	A		B		C		D		E		F		G	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	7.0	3.5	0.0	0.0	3.9	2.8	15.6	3.4	15.6	2.5	9.2	3.6	16.2	2.6
80	9.4	4.6	0.0	0.0	5.2	3.7	20.7	4.5	20.7	3.3	12.3	4.8	21.7	3.5
104	12.2	6.0	0.0	0.0	6.7	4.8	27.0	5.9	27.0	4.3	16.0	6.2	28.2	4.5
144	16.9	8.3	0.0	0.0	9.3	6.6	37.3	8.2	37.3	6.0	22.1	8.6	39.0	6.3

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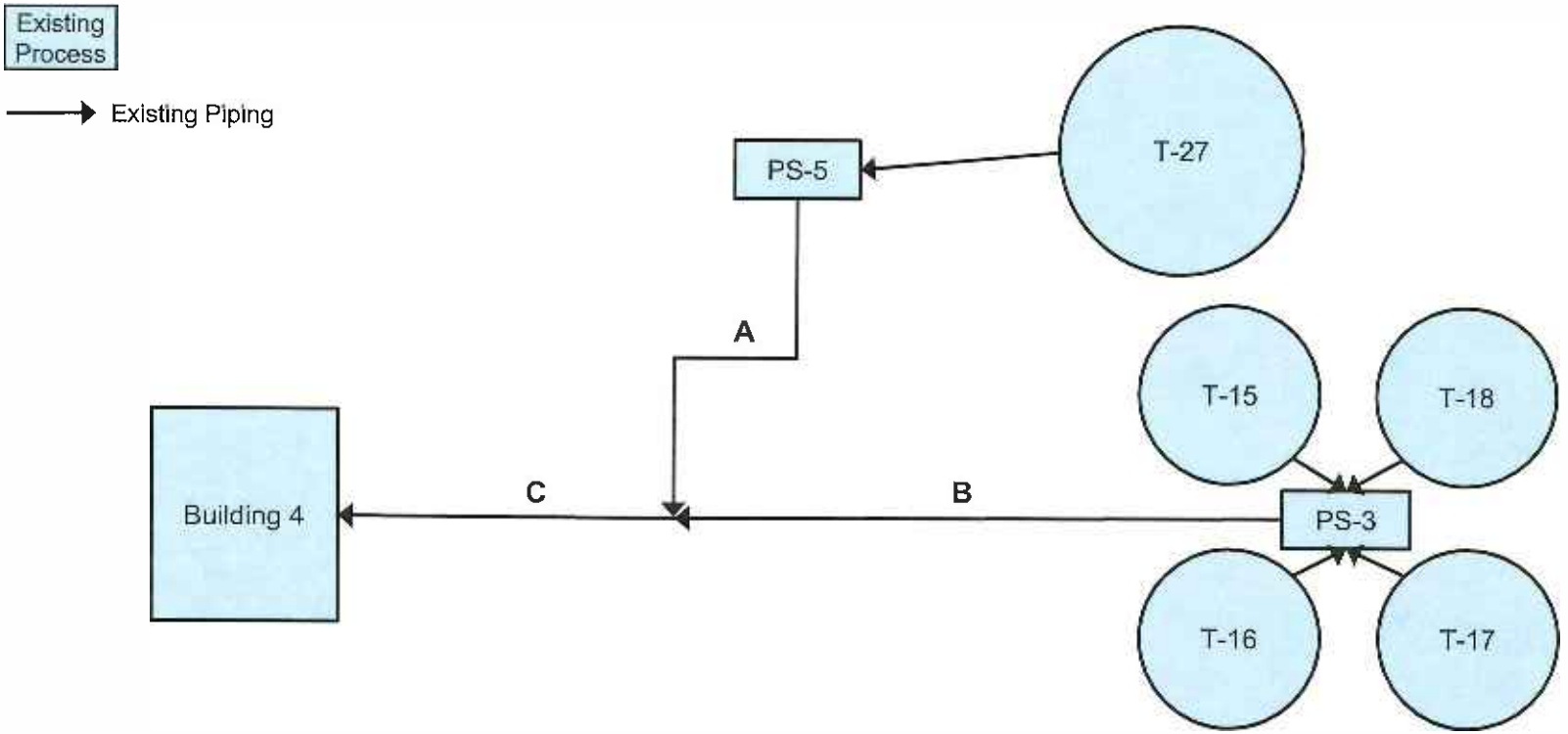
FIGURE 3-4

PROPOSED RAS FLOW AND PIPE VELOCITIES (60MGD to 144MGD)



Forward Flow (MGD)	A		B		C	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	0.3	0.6	0.7	1.4	1.0	2.0
80	0.4	0.8	0.9	1.8	1.4	2.7
104	0.6	1.1	1.2	2.4	1.8	3.5
144	0.8	1.5	1.7	3.3	2.4	4.8

WRTP Process and Hydraulic Evaluation

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FIGURE 3-5

EXISTING WAS FLOW AND PIPE VELOCITIES (60MGD TO 144MGD)

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4. PROCESS EVALUATION

4.1 APPROACH

WESTON used the data presented in Section 2 to support process calculations to estimate the capacity of individual unit processes and the WRTP as a whole. As a starting point, these calculations have been compared to existing conventional design criteria and guideline documents:

1. Pennsylvania Department of Environmental Protection (PADEP), Bureau of Water Quality Protection, *Domestic Wastewater Facilities Manual, a Guide for the Preparation of Applications, Reports and Plans*, PADEP 362-0300-001, 1997.

2. Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. *Recommended Standards for Wastewater Facilities*, 2004 Edition, ("Ten States")

3. Water Environment Federation (WEF) *Design of Municipal Wastewater Treatment Plants, Manual of Practice 8 (MOP-8)*, 1992

4. Metcalf and Eddy, *Wastewater Engineering, Treatment, Disposal, Reuse*, Fourth Edition 2003, ("M&E").

While the above sources provide baseline design criteria, it is also recognized that they are, for the most part, relatively conservative and that in some cases varying from those guidelines may be appropriate. For example, the WRTP's re-rate to 50 MGD is based in part upon a demonstration that the WRTP's clarifiers could operate successfully at flow values exceeding PADEP design guidelines.

WESTON evaluated the unit processes that could potentially limit the forward-flow processing rate at the WRTP. These processes include:

- Aerated Grit and Pre-aeration System
- Primary Clarifiers
- Aeration Tanks
- Secondary Clarifiers
- Disinfection System
  - Chlorine Contact Tanks
  - Chlorine Evaporators and Chlorinators

The following biosolids handling processes were considered:

- Sludge thickening by Dissolved Air Flotation (DAF)

- Sludge dewatering by Belt Filter Presses (BFP)

4.2 GRIT SYSTEM

4.2.1 Existing System Description

The WRTP has two aerated grit and pre-aeration tanks at the WRTP. These tanks are divided into a grit chamber (approximately one third of each tank) and a pre-aeration chamber (approximately two thirds of each tank). The grit chamber tanks are each 31.6 feet long and 30 feet wide, and have a side water depth of 15.75 feet.

4.2.2 Design Guidelines

Design criteria for grit chambers are typically based on hydraulic detention time (HRT).

4.2.3 Evaluation

Table 4-1 provides estimated values of design parameters for the WRTP grit chambers in comparison to design criteria.

Table 4-1
Grit System

Parameter	Guideline				WRTP at 60 MGD
	1 PADEP	2 Ten States	3 WEF MOP 8	4 M&E	
Peak Flow minimum HRT (minutes) [2]	Note 1	3-5	3 (typ.)	3 (typ.)	2.23

Notes:
1. To be based on particle size to be removed.
2. Peak hourly flow.

Based on these results the peak flow HRT in the grit system falls below most guidelines, although as noted PADEP allows for the tank to be sized based on the actual particle size distribution. HRT at average flow is 5.4 minutes. The effect of short retention time at peak flow would suggest some carryover of additional grit to the primary clarifiers particularly at peak flows. However, these calculations are based on that portion of the grit/pre-aeration tanks that are actually designed and equipped for grit separation (and which have a grit removal mechanism) (i.e. approximately 1/3 of the total grit/pre-aeration volume). It is likely that grit

would continue to separate in the remaining volume as well. This would likely reduce the grit carryover to the primary tanks. The principal concern with this is that, without grit removal equipment in these portions of the pre-aeration tanks, removal of the settled grit to maintain performance and provide for grit disposal would be more difficult.

Another option to reduce grit loading of the WRTP would be to improve grit removal at the pump stations serving the WRTP or at other remote locations.

4.3 PRIMARY CLARIFICATION

4.3.1 Existing System Description

There are eight primary clarifiers at the WRTP. Each primary clarifier tank is rectangular in shape, with a length of 155.5 feet, a width of 41.5 feet, and a side water depth averaging 9.50 feet. Each settling tank has a total weir length of 350 feet.

This evaluation assumes all eight primary clarifier tanks are operated in parallel, with influent flow split evenly among all tanks.

4.3.2 Current Performance

Primary clarifiers treating municipal wastewater can typically remove 50 to 70% of the suspended solids and 25 to 40% of the BOD_5 (M&E). The primary clarifier system performs very well at current flows (average 36.65 MGD) and loading conditions. Key performance parameters are summarized in Table 4-2.

Table 4-2
Summary of Primary Clarifier System Performance
January 2007 - November 2009
(Average Flow 36.65 MGD)

Parameter	Influent, mg/L	Effluent, mg/L	Removal Efficiency (%)
BOD_5	199	122	38
TSS	252	97	59

4.3.3 Design Guidelines

Design criteria for primary clarifiers are based on surface overflow rate, weir overflow rate and hydraulic retention time.

4.3.4 Evaluation

Table 4-3 provides estimated values of design parameters for the WRTP primary clarifiers in comparison to design criteria.

Table 4-3
Primary Clarifier System

Parameter		Guideline				WRTP at 60 MGD, 2.4 hourly peak factor
		1 PADEP	2 Ten States	3 WEF MOP 8[1]	4 M&E	
Surface Overflow Rate, gpd/sf	Average	1,000	1,000	NS[2]	800-1200 (1000 typical)	1,162
	Peak hourly	2,500	1,500-2,000	NS	2,000-3,000 (2,500 typical)	2,789
Weir Loading Rate, gpd/ft	Average	15,000[3]	NS	NS	10,000-40,000 (20,000 typical)	21,430 (average) 28,570 (max. monthly
	Peak hourly	NS	30,000	15,000 (typ.)	NS	51,430
Hydraulic Retention Time, hours	Average	NS	NS	NS	1.5-2.5 (2.0 typical)	1.47
	Peak hourly	NS	NS	NS	ND	0.61

Notes:
NS: Not specified.
1. In many cases MOP 8 does not provide criteria but refers to other literature values.
2. At maximum monthly flow rate.

The primary clarifier system is at the upper end of conventional design parameters at 60 MGD design average flow based on the surface overflow rates, and does not meet PADEP design criteria for WLR.

Among these design criteria the surface overflow rate is the more critical performance parameter. The surface overflow rate (SOR) is an upward flow velocity and particles having a settling velocity greater that the SOR will, in theory, be removed. Therefore maintaining SOR values within conventional ranges is the more critical factor in ensuring adequate removal of solids prior to the aeration basins.

By contrast weir overflow rate is related to the approach velocity of the water to the weirs; too high a velocity could tend to entrain some solids and carry them over the weir. However as noted in previous reports (WESTON 2003) weir overflow rate is generally considered of relatively minor importance in the performance of settling tanks and WEF MOP 8 notes that

"...weir rates have little effect on the performance of primary clarifiers especially with side wall depths in excess of 12 feet." (The WRTP clarifiers are 8.75 to 10.25 feet deep).

The primary clarifier system essentially meets typical criteria for HRT at 60 MGD average flow.

The Report on DEP Guidelines (WESTON 2003) summarized data from August 1999 when half of the clarifiers were out of service for maintenance and the remaining clarifiers consequently operated at high loadings (see Table 6, WESTON 2003). These results indicated that at maximum daily flows of almost 54 MGD and peak flow rates on the maximum day of 96 MGD the performance of the primary clarifier system was excellent at effective SOR values of 1,256 gpd/sf and WLRs as high as 23,164 gpd/ft. These values are slightly higher than the estimated values at the target flow of 60 MGD as noted in Table 4-3 and suggest that the primary clarifiers may operate at those conditions with little negative effect on performance.

At 60 MGD, however, the primary clarifier system will approach the upper range of typical practice and some decrease in efficiency may be expected. To provide a conservative basis for evaluation of the activated sludge system, it is assumed that at the target flow of 60 MGD the removal efficiency of the primary clarifier system is slightly lower than at the current flow, (50% for TSS and 30% for BOD_5).

DELCORA evaluated Chemically Enhanced Primary Treatment (CEPT) by addition of chemical coagulant to the primacy clarifier system, for two reasons:

1. As a possible means of addressing process upsets that interfere with primary settling. This might be done on either a short term (i.e. temporary) basis or by the installation of a permanent system.
2. Recent recommendations from an energy study by AECOM that DELCORA consider CEPT to increase primary BOD_5 removal and thus potentially reduce aeration power requirements.

While it is expected that CEPT could in fact increase BOD_5 and TSS removal in the primary system and assist with these goals, a preliminary evaluation of cost indicated that it would not be cost effective to do so on a continuous basis.

4.4 ACTIVATED SLUDGE SYSTEM

The activated sludge system includes the aeration basins and the aeration system blowers and diffusers.

4.4.1 Aeration Basins

4.4.1.1 Existing System Description

There are four aeration tanks at the WRTP. These tanks are square in shape, with a length of 136 feet, a width of 136 feet, and a side water depth of 18.1 feet. Various flow combinations are possible with the four tanks including a complete mix configuration. Typical operation uses two trains of two tanks each, providing essentially a complete mix activated sludge (CMAS) configuration.

Conventional design and operating criteria for aeration basins are based on hydraulic retention time, organic loading rate, food to microorganism ratio (F:M) and mixed liquor suspended solids MLSS levels. Current operating parameters for the system are summarized in Table 4-4.

Table 4-4
Summary of Aeration Basin Operating Parameters
January 2007 - November 2009
(Average Flow 36.65 MGD)

Parameter		Value
MLSS, mg/L		3,383
F:M, lb BOD_5/lb MLVSS		0.165
HRT, hours		6.6
SRT [(1)], days, MLVSS basis		10.5
Waste Activated Sludge (WAS)	Flow, MGD	0.263
	Concentration, mg/L	10,776
Return Activated Sludge (RAS)	Flow, MGD	19.27
	Concentration, mg/L	10,776
	Recycle Ratio, α	0.53

Notes:
1. Solids retention time.

A previous process model by Envitreat (Envitreat 2009) estimated a SRT of 15.4 days at 36.8 MGD average flow and an F:M value of 0.122 (VSS basis) using operating data from November 2006 to October 2008. According to the Envitreat report MLSS during the period averaged 3608 mg/L as compared to 3383 during the current evaluation.

A denitrification evaluation by Gannett Fleming (Gannett Fleming 2009) estimated a sludge age of 11 days at 38.21 MGD at an MLSS value of 3,565 mg/L, based on data from 2006-2008. The Gannet Fleming report indicated the SRT was based on MLSS rather than MLVSS. Assuming 80% VSS, the calculated 11 day SRT (MLSS basis) corresponds to approximately 8.8 days (MLVSS basis).The Gannet Fleming report did not include an estimated F:M value. However, based on data provided in Tables 4 and 5 and allowing for a VSS fraction of 0.8, an F:M value of 0.134 would be estimated.

This process evaluation considers the four aeration basins to be operating as a complete mix activated sludge system. The previous PIP evaluated multiple flow configurations for the activated sludge process, including so-called "reverse" flow wherein the influent would be directed to the second tank in each train (tanks T-12 and T-14 respectively) and back through the first tank in each train (tanks T-11 and T-13 respectively). This scenario is considered unlikely and therefore it will not be evaluated in this analysis.

While this section considers process capacity, it should be noted that the hydraulic capacity is between 95.5 MGD and 108.6 MGD depending on the effluent weir setting (see Table 3-1), the aeration basins cannot accommodate the estimated peak hourly flow of 144 MGD (60 MGD with a 2.4 peak factor.). This is relevant in that any option to increase process capacity in the existing tanks would still face this hydraulic limitation. This may effectively limit options for increasing activated sludge capacity to those which rely on new aeration basins.

4.4.1.2 Comparison to Standard Design Criteria

4.4.1.2.1 Design Guidelines

As noted above, conventional design and operating criteria for aeration basins are based on hydraulic retention time, organic loading rate, food to microorganism ratio (F:M) and mixed liquor suspended solids (MLSS) levels.

4.4.1.2.2 Evaluation under Conventional Design Guidelines

Table 4-5 provides estimated values of design parameters for the WRTP aeration system chambers in comparison to design criteria. Operation at 60 MGD will exceed all conventional criteria for nitrification and be at the upper limits of criteria for BOD_5 removal. Operation at 50

MGD average flow will continue to be above PADEP guidelines but is within other conventional design criteria for BOD5 removal. The Process Improvement Project Report (WESTON 2000) also concluded that treatment at 50 MGD would exceed certain PADEP guidelines. As noted below these guidelines are generally conservative. Typical criteria for nitrification would be exceeded at 50 MGD average flow.

Table 4-5
Existing Aeration Basin System

Parameter		Guideline				WRTP at 50 MGD	WRTP at 60 MGD
		1 PADEP	2 Ten States	3 WEF MOP 8	4 M&E		
Hydraulic Retention Time	BOD_5 Removal[1]	6[2]	NS	NS	3-5	3.62	3.02 [2]
	Nitrification [3]	12	NS	NS	6-15		
Solids Retention time, days	BOD_5 Removal[1]		NS	3-5	5-15	5.4	4.6
	Nitrification[3]		NS	5-15	8-20		
Maximum Organic Loading Rate lb/ BOD_5/1,000 cf/day	BOD_5 Removal[1]	40[4]	40	NS	50-120	93.1	112[5]
	Nitrification [3]	20[4]	15	NS	5-20		
F:M, lb BOD_5/lb MLVSS/day	BOD_5 Removal[1]	0.2- 0.5	0.2-0.5	0.2-0.4	0.2-0.6	0.55	0.66[5]
	Nitrification [3]	0.08-0.16	0.05-0.1	NS	0.1-0.25		
MLSS, mg/L	BOD_5 Removal[1]	1,000-3,000	1,000-3,000	1,500-3,000	1,500-4,000	~3,400[5]	~3,400[5]
	Nitrification [3]	2,000-5,000	3,000-5,000	NS	1,500-3,500		

Notes:
NS: Not specified
1. Complete mix activated sludge, using air for aeration (vs. pure oxygen).
2. At maximum monthly flow.
3. Combined carbon oxidation – nitrification.
4. Based on maximum daily BOD_5 load to the aeration tank.
5. At upper 99th permit daily BOD_5 peak, 30% primary BOD_5 removal, 3,400 mg/L MLSS and 0.8 volatile fraction.
6. Typical value under current operating conditions.
7. In many cases MOP 8 does not provide criteria but refers to other literature values.

4.4.1.3 Process Design Calculations

As noted previously, design guidelines in standard references are generally conservative. In order to refine the estimated capacity of the aeration basin and adequately consider the particular properties of DELCORA wastewater, a process design calculation was performed using

conventional design models (USEPA 1975, M&E 1991) which are based on nitrification kinetics.

4.4.1.3.1 Assumptions

Input parameters for the model are based on the influent data presented in Table 2-1. Kinetic coefficients for the nitrification process were based on literature values.

The nitrification process is significantly affected by water temperature. For this analysis it was assumed that the future ammonia-nitrogen limit would be applied year round (rather than being seasonally adjusted as was commonly done in the past.) DELCORA reports wintertime minimum temperatures under current conditions as above 60 degrees F (15.6 degrees C) due in part to warm water input from industrial sources, and anticipates that even with a somewhat higher future contribution of cooler municipal wastewaters, the winter temperature is likely to remain above 60 degrees F. Therefore the design calculation was performed at 60 degrees F (15.6 degrees C) winter water temperature as the most conservative case.

4.4.1.3.2 Results

The design calculations indicated that a solids residence time (SRT) of approximately 11 days would be suitable. At current MLSS levels this results in a design hydraulic residence time of approximately 8.5 hours. At the target flow of 60 MGD a total aeration basin volume of approximately 21 MG would be needed under these conditions.

Comparison to Table 4-4shows that the current operation provides an SRT of 10-11 days at 36.65 MGD average flow. Under these conditions the plant typically nitrifies reasonably well.

The process model used conservative assumptions and additional modeling might be used to refine the final estimate. However, the essential conclusion is that the existing aeration basins are well short of providing adequate capacity for the 60 MGD nitrification scenario.

Furthermore, the design calculations indicate that the intended SRT would be achieved at a mixed liquor (MLSS) level of approximately 3,400 mg/L in the indicated reactor volume. Assuming the biomass continues to settle similar to current conditions, such that the recycle concentration can be maintained at approximately 10,000 mg/L, this would require a recycle

ratio (Q_R/Q) of approximately 0.51, (i.e. a recycle rate approximately 51% of the forward flow rate). This value is well below the general design guidelines of 100 to 150%.

4.4.1.4 Options

The most critical design parameter for nitrification is the solids residence time. In this regard a higher throughput could possibly be achieved in the fixed aeration volume by operating at significantly higher MLVSS levels. The WRTP currently operates at a MLSS level of approximately 3,400 mg/L (estimated to provide 2,270 mg/L MLVSS). The ability to significantly increase MLSS (and MLVSS) in the current configuration (e.g., by increasing recycle) is likely limited. Based on historical data (Gannett Fleming, 2009, Envitreat 2009), MLSS levels in the range of 3,600 mg/L were maintained at flows of approximately 36-38 MGD. Even if this value could be maintained at 60 MGD, it would likely not be sufficient to provide the desired operating conditions for nitrification. Options for doing this within the existing aeration basins may include (1) conversion to an integrated fixed film activated sludge (IFAS) process and (2) conversion to a membrane bioreactor (MBR) process.

However as noted above the existing basins also have a hydraulic limitation. At the future peak hourly flow (144 MGD) the water level in the primary effluent channel would approach the bottom of the weir, which was established in the hydraulic analysis as the limiting case. If additional basins are needed to address this hydraulic limitation, conversion to IFAS or MBR may be less favorable than adding new conventional activated sludge basins. Furthermore if additional basins are provided other activated sludge process options, such as step feed and plug flow configurations, could possibly be considered to optimize the aeration volume.

The hydraulic analysis (Section 3) indicates that the flow split between the two trains with all sluice gate valves open is not equal, with approximately 59% of the flow passing through the south train (Tanks T-13 and T-14) and 41% through the north train (T-11 and T-12). At maximum loadings particularly it will be important to balance the flow between the trains. This would presumably be done by adjusting the sluice gate valves on the south train to divert more flow to the north train. It should be noted that throttling the two gates to the south train may have some effect on upstream hydraulics. Since the upstream criterion in the hydraulic analysis was free fall over the primary clarifier weirs (a maximum elevation in the clarifier effluent channel

below the weir v-notch) it is possible that throttling the south train may result in peak flow levels exceeding this criterion.

4.4.2 Aeration System

4.4.2.1 Existing System Description

DELCORA replaced its surface aerators with a submerged diffuser aeration system. The system consists of submerged aeration diffusers and piping grid, centrifugal blowers, dissolved oxygen (DO) control system, interconnection ductwork, electrical controls and blower building. The submerged diffusers are high efficiency flat panel membrane diffusers manufactured by Parkson Corporation. The Parkson panels operate at a low air flux rate and have large floor coverage. The centrifugal blowers have a high efficiency rating and are manufactured by Turblex Corporation. The dissolved oxygen control system modulates the quantity of air and the main header air pressure in response to changing DO concentrations in the aeration basin and is also manufactured by Turblex Corporation. The aeration system was designed to reduce the electricity consumption and operating costs as compared to the surface aerators. Provisions were included in the design for future flow expansion at the WRTP to an influent flow of 50 MGD at then-projected loadings. Also included in the design was the provision for the addition of a fourth blower if needed for flow expansion above 50 MGD. To accommodate the fourth blower, the interconnecting ducting was sized for the increased compressed air flow rate, space was reserved in the blower and electrical rooms for the blower and its motor starter, and the electrical substation was sized for a fourth blower motor.

4.4.2.1.1 Blowers

The design air requirement was 10,200 scfm at average flow and 20,200 scfm at peak load. Average and peak design conditions were based on current operating data at that time.

The blower configuration uses two operating blowers and one installed spare blower. The proposed blowers are sized at 11,000 scfm each for a total capacity of 22,000 scfm (with one unit in reserve.)

4.4.2.1.2 Diffusers

Each basin contains 175 Parkson aeration panels arranged in groups of 25 for a total of 700 panels. The diffuser system was designed for the 50 MGD design basis. They are designed to pass a total of 10,350 scfm at average conditions and 20,200 scfm for the maximum condition (at the 50 MGD design basis.)

In addition there are provisions to place additional panels in each basin without revision to air piping if necessary to accommodate potential future flows above 50 MGD.

The basins were considered complete mix reactors. To provide homogeneous conditions in the tank, the aeration panels were spaced throughout the tank. However, toward the influent side of the tanks, additional panels were placed.

The Parkson diffuser panels are 4 ft by 12 ft long. The diffuser membrane is polyurethane. The airflow flux rate varies from 0.31 scfm/sf at the average flow rate to 0.72 scfm/sf at the maximum flow rate.

4.4.2.2 Comparison to Standard Design Criteria

4.4.2.2.1 Design Guidelines

PADEP and 10 States Standards guidelines for the design of aeration systems include the following narrative criteria:

- Aeration equipment should be capable of supplying 1.1 pounds of oxygen per pound of BOD_5 removed at maximum BOD_5 loadings (PADEP guidelines specify maximum daily BOD_5 while 10 States Standards refer to peak hourly BOD_5 loads). These references further recommend 4.6 pounds of oxygen per pound of TKN removed at maximum loads.
- Dissolved oxygen should be maintained at a minimum of 2.0 mg/l.
- The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant.

4.4.2.2.2 Evaluation

As noted above the existing aeration system was designed for BOD_5 removal at 50 MGD (with provisions for expansion).

This evaluation considers both BOD_5 removal at current and projected influent conditions and the anticipated requirement for nitrification. The nitrification process exerts a significant oxygen demand, typically estimated at 4.57 lb of oxygen per lb of nitrogen, (as compared to 1.1 lb oxygen per lb BOD_5 removed). Note that the theoretical 4.57 lb O_2 value is rounded to 4.6 lb in the design guidelines.

Table 4-6 summarizes the average and peak oxygen requirements for BOD_5 removal alone (i.e. without nitrification). Also provided for comparison are the total oxygen requirements used for the design of the existing aeration system (WESTON 2003b). These values assume 100% BOD_5 and TKN removal at average conditions and 95% removal at peak load conditions. In addition, these calculations assume a minimum DO in the aeration basins of 2.0 mg/L.

Table 4-6
Oxygen Requirements for BOD_5 Removal

	Aeration System Design Basis 50 MGD Average Flow		Current Loadings 60 MGD Average Flow	
	BOD_5 Load removed lb/day	**Oxygen Requirement, lb./day**	**BOD_5 Load removed lb/day**	**Oxygen Requirement, lb./day**
Average	41,300[1]	45,430[2]	72,830[1]	80,115[2]
Peak day	68,780[3]	75,658[2]	141,840[3]	156,080[3]

Notes:
1. Assumes 100% BOD_5 and TKN removal at average load conditions.
2. Assumes 1.1 lb oxygen per lb BOD_5.
3. Assumes 95% BOD_5 and TKN removal at 99th percentile peak load condition.

The significant increase in total oxygen demand for BOD_5 removal results from both the increase in flow (from 50 MGD to 60 MGD) and the substantial increase in waste strength since the time of the previous evaluations. The PIP report and the aeration design were based on a raw wastewater strength in the range of 160 mg/L BOD_5. The recent historical DELCORA waste strength is approximately 199 mg/L BOD_5 (Table 1-1) and the projected waste strength allowing for future contributions is 208 mg/L BOD_5 (Table 2-1).

The total oxygen demand for a combined carbon oxidation/nitrification system can be estimated from the following equation:

$$O_2, \text{ lb/day} = Q(kSo + 4.57\ TKN) \times 8.34$$

where
- Q = flow, MGD
- k = conversion factor, lb O_2/lb BOD_5
- So = BOD_5, mg/L
- TKN = Total Kjeldahl Nitrogen, mg/L

The total oxygen demand for BOD_5 removal and combined BOD_5 removal./nitrification are summarized in Table 4-7.

Table 4-7
Oxygen Requirements for Combined
BOD_5 Removal and Nitrification at 60 MGD

	Total Oxygen Demand, lb/day		
	BOD_5 Removal	**Nitrification**	**Total**
Average Daily Load	80,115	56,885	137,000
Peak Daily Load	156,080	101,550	257,630

The aeration requirements to satisfy this demand is based on the design criteria with respect to water temperature and DO level, and the oxygen transfer characteristics of the aeration equipment. Oxygen transfer characteristics are based on data from Parkson. It is understood that the original aeration panels are being replaced with ones of a modified design. Parkson was consulted to determine whether the oxygen transfer characteristics of the new panel will differ from the original used for the design. Parkson responded that while testing is proceeding, the characteristics of the new panels are expected to be the same as the origin. Therefore data presented in the design report were used for this evaluation.

Table 4-8 summarizes the air supply requirement to meet the demand shown in Table 4-7.

Table 4-8
Aeration Requirements at 60 MGD

	Total Air Requirement, scfm		
	BOD_5 Removal	Nitrification	Total
Average Daily Load	21,270	15,090	36,360
Peak Daily Load [1]	41,420	26,950	68,370

Notes:
1. Assumes 95% BOD5 and TKN removal at 99th percentile peak load condition

Table 4-8 demonstrates that the existing system would not provide adequate capacity even with the fourth blower installed, With the fourth blower installed the maximum aeration provided would be ~33,000 scfm with one unit offline per PADEP guidelines.

Under current average flow conditions, (i.e. approximately 36.65 MGD), two blowers are adequate for nitrification at average flow conditions 18,300 scfm required). Calculated airflow rates indicate a shortfall at the 99th percentile peak loading condition (36,360 scfm required)

BOD5 removal alone (consistent with the current NPDES permit) would of course require significantly less air. However unless process operating conditions (primarily solids retention time) were modified to prevent nitrification, the nitrification demand will consume oxygen.

As noted in Section 4.4.2.1.2, the diffuser system was designed for a maximum flux rate of 0.72 scfm/ft^2 of diffuser area, assuming two blowers in operation at the required peak airflow rate of 20,200 scfm. If the third existing blower were operating (a maximum air flow rate of approximately 33,000 scfm), the flux rate would increase to approximately 1.18 scfm/ft^2 with the existing panels. If, as noted, in Section 4.4.2.1.2, 25 additional panels were installed in each basin using the existing piping, the maximum flux rate with three existing blowers, would be approximately 1.03 scfm/ft^2. Flux rates at peak nitrification conditions, assuming additional blower capacity were provided, may exceed the capacity of the panels. (At the time of publication flux rate curves were not available from the manufacturer. Actual flux rates and performance should be confirmed with the manufacturer.)

As noted in Section 4.4.1, it would be necessary to add aeration basins to meet nitrification requirements. With all eight basins (existing and new) using panel diffusers the peak air flow rate of 68,370 scfm would result in a peak flux rate of approximately 0.92 scfm/ft^2 (assuming the

additional panels are not installed in the existing basins and comparable floor coverage in the new basins). As noted above, at the time of publication flux rate curves were not available from the manufacturer. Since transfer efficiency is affected by flux rate, the actual oxygen transfer efficiency of the new panels, when available from the manufacturer, should be reviewed to confirm performance. If oxygen transfer drops significantly at these higher flux rates, additional blower capacity beyond that estimated above would be needed.

It should be noted that the above values are based on maximum daily loads as calculated from DELCORA data. As noted above, some guidelines recommend aeration to meet maximum hourly loads. Based on standard references, hourly peak load factors may be higher than the daily factors shown in Table 2-2. However data to assess hourly BOD_5 and nitrogen loads (i.e. diurnal fluctuations in influent BOD_5 and TKN) are not normally collected.

4.5 SECONDARY CLARIFICATION

4.5.1 Description

There are five secondary clarifiers at the WRTP. Four clarifiers (Tanks T-15, T-16, T-17, and T-18) have a 130-foot diameter and one clarifier (Tank T-27) has a diameter of 175-feet.

The four smaller clarifiers were included in the original design of the plant while the fifth larger clarifier was added in 1994. Return sludge from the four smaller units is drawn from the bottom well of each clarifier while the larger clarifier uses a suction pipe withdrawal mechanism.

Flow is distributed among the five clarifiers using control valves. Optimally, the flow to each clarifier should be proportioned according to surface area of the tank. As discussed in the PIP report (WESTON 2000), this was not possible with the original weir configuration for Tank T-27 (Clarifier 5). Of the total clarifier surface area, tank T-27 represents 31 percent of the total surface area and clarifiers T-15 to T-18 represent 17 percent of the total surface area each. However using the original weir configuration, tank T-27 had a maximum flow capacity of 24.9 MGD and each of the four smaller clarifiers has a maximum capacity of 25.9 MGD. The analysis of the flow distribution to the secondary clarifiers from the PIP report indicated that the flow would be distributed rather evenly without throttling the control valves to the tans. Under these conditions Tank T-27 would receive 21 percent of the total flow, tanks T-16 and T-18

would receive 19 percent of the total flow each, and tanks T-15 and T-17 would receive 20.5 percent of the total peak flow each.

In 2004 a study was conducted to analyze the flow split among the five final clarifiers and develop recommendations for flow balancing. Since that time DELCORA has implemented adjustments to the weir settings and it is estimated, based on flow meter data, that the intended area proportioned flow spilt can now be obtained. The tables that follow provide the estimated capacity both at the area proportioned split and at the original flow split to illustrate that impact of this difference. Since the secondary clarifiers are likely to be a limiting point in the effort to achieve the 60 MGD target flow it will be appropriate to reconfirm the ability to split flow as necessary.

4.5.2 Design Guidelines

Design criteria for secondary clarifiers are based on SOR, weir overflow rate and solids loading rate. For purposes of this evaluation, Table 4-9 provides the relevant characteristics of the five clarifiers.

Table 4-9
Secondary Clarifier Dimensions

Clarifier	Diameter, ft	Surface Area, sf	Weir Length, ft	Volume, gallons
T-15	130	13,279	728	1,489,856
T-16	130	13,279	728	1,489,856
T-17	130	13,279	728	1,489,856
T-18	130	13,279	728	1,489,856
T-27	175	24,063	1,438	3,671,745
Total		**77,177**	**4,350**	**9,631,169**

4.5.3 Evaluation

Table 4-10 summarizes design guidelines for secondary clarifiers. Table 4-11 provides estimated values of design parameters for the WRTP secondary clarifiers in comparison to design criteria, assuming that the flow is split proportionally among the five clarifiers based on their surface area (in this case the SOR and WLR). Table 4-12 summarizes the operating values at 60 MGD for each tank based on the estimated actual flow split from the hydraulic analysis.

Table 4-10
Secondary Clarifier Design Criteria

Parameter		Guideline			
		1 PADEP	2 Ten States	3 WEF MOP 8 [6]	4 M&E
Surface Overflow Rate, gpd/sf[1]	Average	800	NS[7]	400-700	400-700
	Peak	1,200[2]	1,200	1,000-1,600	1,000-1,600
Weir Loading Rate, gpd/ft	Average	15,000[3]	NS	NS	NS
	Peak		30,000	NS	30,000
Solids Loading Rate, lb/day/sf	Average	30[4]	NS	NS	20-30
	Peak	50[2,4]	35[3,5]	NS	48

Notes:
NS: Not Specified
1. Based on influent flow only.
2. At peak hourly flow.
3. At maximum monthly flow.
4. Based on mixed liquor flow (wastewater + return flow).
5. Peak loading rate for single stage nitrification.
6. In many cases MOP 8 does not provide criteria but refers to other literature values.

Table 4-11
Secondary Clarifier System
Area Proportioned Flow Split

		T-15	T-16	T-17	T-18	T-27
Flow Fraction		0.172	0.172	0.172	0.172	0.312
Surface Overflow Rate, gpd/sf	Average	777	777	777	777	777
	Peak	1,866	1,866	1,866	1,866	1,866
Weir Loading Rate, gpd/ft	Average	15,470	15,470	15,470	15,470	15,470
	Peak	37,123	37,123	37,123	37,123	37,123
Solids loading rate, lb/day/sf[2]	Average	34	34	34	34	34
	Peak	81	81	81	81	81

Notes:
1. assumes 60 MGD design average flow and 144 MGD peak hourly flow.
2. assumes 3,400 mg/l MLSS.

Table 4-12
Secondary Clarifier System
Flow Split Based on PIP Hydraulic Analysis

		T-15	T-16	T-17	T-18	T-27
Flow Fraction		0.205	0.19	0.205	0.19	0.21
Surface Overflow Rate, gpd/sf	Average	926	859	926	859	524
	Peak	2,220	2,060	2,220	2,060	1260
Weir Loading Rate, gpd/ft	Average	16,887	15,651	16,887	15,651	8,761
	Peak	40,540	37,560	40,530	37,560	21,030
Solids Loading rate, lb/day/sf [(2)]	Average	40	37	40	37	20
	Peak	96	90	96	90	55

Notes:
1. assumes 60 MGD design average flow and 144 MGD peak hourly flow.
2. assumes 3,400 mg/L MLSS.

Comparison of Table 4-8 and Table 4-9 indicates the following:

- At the target 60 MGD, the surface overflow rate exceeds design guidelines under either flow split scenario
- However if the flow is not balanced to split proportionally (i.e., if the flow split identified by the hydraulic analysis exists at 60 MGD), the SOR values for the smaller clarifiers are further above typical performance criteria (the larger clarifier, T-27 is within design guidelines under both cases since it is receives a smaller proportion of flow relative to its size).
- The effect of not balancing the clarifiers may result in reduced performance of the smaller four clarifiers at the target flow of 60 MGD.

As noted in Section 3.1.2.2 the current estimated peak hydraulic flow capacity of the aeration basins is 108.7 MGD. If the aeration basin hydraulic limitations were addressed without adding additional clarifiers the situation above would apply.

4.5.4 Options

The secondary clarifier system will exceed conventional design guidelines at the target flow of 60 MGD. An obvious method to resolve this would be to add additional clarifier capacity. However an alternate approach would be to evaluate the potential for optimizing the performance of the existing clarifier system, prior to incurring the capital cost of additional clarifiers. There may be two basic components to this process:

1. Determining the true settling characteristics of the sludge to determine whether higher than typical design parameters can be used. This could be done by field testing for sludge settleability characteristics ("solids flux" testing) and/or by clarifier stress testing (some of which has already been done as noted below).

2. Correcting any hydraulic limitations in the clarifiers, to ensure the full settling characteristics of the sludge can be exploited.

4.5.4.1 Sludge Settling and Thickening

Surface overflow rates and solids loading rates are determined by the settling characteristics of the sludge. Typical clarifier design criteria are based on typical sludge settling rates. For a good settling sludge, higher than typical design values may be used. There are already several lines of evidence suggesting that WRTP sludge characteristics may support higher than normal settling rates (and as noted below some of these data were used to support the re-rate of 50 MGD).

1. The 2003 "Report on DEP Guidelines" (WESTON 2003a) discussed historical data regarding effluent TSS during high loading periods and concluded that good performance was achieved at higher than normal overflow rates. Solids loading rate was within design guidelines so no such determination was necessary).

2. Stress Testing. Clarifier stress testing was conducted by DELCORA in November 2009 by directing additional flow to clarifiers T-16 and T-18. Solids removal remained good at flow rates up to approximately 22 MGD. When flow was increased to approximately 27.5 MGD effluent TSS began to increase and the sludge blanket level rose. These results indicate that on a short term basis peak loading rates in the range of 1600 gpd/sf may be acceptable. The Sludge Volume Index (SVI) on the day of testing was reported at 72. This indicates good settling characteristics (typically SVI values less than 100 are considered good.) Preliminary stress testing was also conducted in T-16 and T-8 on September 12, 206 and on T-27 on October 21, 2008. Results from these tests were variable and may have been affected by operating conditions during the test.

Additional testing to establish the actual operating range of the clarifiers could include (1) additional, and possibly longer term, stress testing and (2) solids flux testing. A procedure for

the latter is termed "State Point Analysis" and consists of bench scale solids flux rate testing. Solids flux rates are interpreted graphically in terms of overflow and underflow (RAS/WAS) rates to establish the range of acceptable loading rates for the clarifiers.

One possible limit on the use of the State Point Analysis procedure is the possibility that settling characteristics at 60 MGD (with a somewhat different wastewater composition) may differ from the current conditions and therefore the result of testing on the current sludge may not be fully representative. State Point Analysis is a procedure to evaluate clarifier performance in terms of its hydraulic operation (overflow and under flow rates) and the site specific settling characteristics of the sludge. It is conducted by performing site specific settling velocity tests at varying solids concentrations to establish a solids flux rate curve for the plant under various conditions. The flux rate relationship is graphically superimposed on the overflow and underflow rate curves to indicate whether the clarifier operating point (the "state point") is within acceptable ranges for the measured flux rate(s). These data may be used to adjust operating parameters or to determine the need for additional clarifiers.

4.5.4.2 Hydraulic Conditions

Hydraulic limitations in clarifiers may affect performance. While some hydraulic limitations may be inherent in the design of the clarifier tank, others could be possible be addressed by retrofits to existing clarifiers (it should be noted that at present there are no definitive data to indicate that the DELCORA clarifiers currently have such limitations).

One such modification is the use of density current baffles (one version of which is the Stamford Baffle, currently installed on DELCORA clarifier T-16. Such baffles have been demonstrated in a number of cases to substantially improve the performance of primary and secondary clarifiers. These are intended to address upward density currents along the clarifier wall carrying solids to the weir. They consist of baffle plates installed in the tank to intercept and redirect upward currents away from the weir and back into the center of the clarifier. As noted above clarifier T-16 has baffles installed. Long-term testing could be considered to evaluate whether its performance differs from the other clarifiers, although at the current low loadings the differences may not be apparent. Side by side comparison during the stress test did not indicate a clear effect of the baffles; in fact the effluent TSS values for T-16 were somewhat more variable than

those for T-18 at intermediate flow rates up to ~26 MGD but somewhat better at flow over 27 MGD. It is possible but not yet known that the decline in clarifier T-18 performance above 27 MGD was attributable at least in part to currents and, if so, baffles may assist in addressing this limitation.

Additional modifications that could be considered if warranted by testing could include Energy dissipating inlets and modifications to the sludge collection and withdrawal system.

These modifications could assist in taking full advantage of the settling characteristics of the sludge but would not provide an inherent improvement in those characteristics.

At present there are no definitive data to indicate whether such modifications would be of value at the DELCORA WRTP. Additional testing, such as dye testing in conjunction with stress testing to evaluate currents, could be considered to investigate this possibility.

Discussion with DELCORA during this project did however identify one potential concern. It was reported that the recycle sludge pumps in T-27 sometimes draw the feed well dry, inferring that the sludge withdraw piping on the clarifier cannot keep up with the intended RAS rate; specifically it was inferred that additional sludge withdrawal pipes may be needed; the range of RAS flow over which this occurs and the depths of the sludge blanket has not been investigated for this study. However the manufacturer of the T-27 clarifier mechanism (EIMCO) was contacted by WESTON regarding this possibility. The manufacturer indicated that the reported condition could occur because the withdrawal piping capacity is in fact low or because the withdrawal pipes are mounted too close to the bottom of the tank. Potential corrective actions could be, (1) to install additional withdrawal pipes, (2) to install larger withdrawal pipes and (3) to ensure that the pipes are mounted at the appropriate distance from the floor. EIMCO also advised that a previous evaluation had been conducted for T-27. WESTON has requested EIMCO to provide additional information on the approach to investigating and resolving this issue.

As a follow-up, WESTON again contacted the equipment manufacturer Ovivo (formerly EIMCO) on February 23, 2011 to request any documentation on the previous evaluation. On March 4, 2011, Ovivo advised that the only available documentation from the test were headloss

calculations and that the possibility of vortexing of the sludge collection box had been discussed. No additional information is available from the manufacturer on this test.

4.6 POST AERATION TANKS

There are two post-aeration tanks at the WRTP. The tanks are square with a length of 48.5 feet, width of 48.5 feet, and side water depth of 11.5 feet.

These tanks are not currently needed for aeration because the current NPDES permit does not specify a minimum dissolved oxygen level in the effluent (effluent DO is not a regulated parameter). In addition, turbulence over the chlorine contact tank weir and in the effluent chamber introduces dissolved oxygen to the effluent.

It should be noted that PADEP guidelines specify that post aeration to meet DO requirements (if such are imposed in the future) should be done after the chorine contact tank. The current WRTP configuration, however, places the post aeration tanks prior to the chlorine contact chambers. Under current permit conditions this is not an issue but modifications could be required if DO limits are imposed in the future.

4.7 DISINFECTION

4.7.1 Chlorine Contact System

4.7.1.1 Description

There are two chlorine contact tanks at the WRTP. The tanks are rectangular with a length of 116 feet, width of 36 feet, and side water depth of 12.5 feet. The tanks are baffled to provide a long flow path and prevent short circuiting, to help in providing adequate contact time. There are also two post-aeration tanks at the WRTP as noted above.

Based on the results of the PIP report, it was determined that it was desirable to operate one of the post-aeration tanks as a chlorine contact chamber to process a maximum peak flow rate of 94.0 MGD.

4.7.1.2 Design Guidelines

The effectiveness of chlorination is a function of chlorine dosage and contact time. As a guideline, however, PADEP specifies a minimum contact time of 15 minutes at peak hourly flow or 30 minutes at maximum monthly average flow, assuming adequate mixing. Other standard references (M&E, 1991) indicate that 15 minutes at peak flow is a commonly accepted value. As discussed below contact time and chlorine dosage should be considered together.

4.7.1.3 Evaluation

Table 4-13 shows the contact time at (1) peak hourly flow and (2) maximum monthly average flow using all four tanks (two chlorine contact tanks and two post aeration tanks) for chlorine contact chambers.

Table 4-13
Chlorine Contact Time as Compared to PADEP Guidelines

	Peak Hourly Flow		Maximum Monthly Flow	
	Required	Provided	Required	Provided
Hydraulic Retention Time, minutes	15	11.8	30	16.4

As shown in Table 4-13 chlorine contact time at the target flow of 60 MGD, at the estimated peaking factors, does not meet PADEP Guidelines.

4.7.2 Chlorine Feed System

4.7.2.1 Description

DELCORA uses a gas chlorination system. One ton chlorine cylinders located in the chlorine storage room within Building B-3 supply chlorine to a chlorine evaporator/feed system. The evaporator/chlorinator room currently has four Wallace and Tiernan (W&T) series 50-200 evaporative units and four W&T V-2000, V-NOTCH chlorinators. The V-2000 series has a range of capacities. The particular units at the WRTP include two units at 5,000 lb/day each and two units at 2,000 lb/day each.

4.7.2.2 Design Guidelines

Typical design guidelines for applied chlorine dosage are provided in Table 4-14.

Table 4-14
Design Criteria
Chlorine Feed Systems

Parameter	Guideline			
	1 PADEP[1]	2 Ten States	3 WEF MOP 8[2]	4 M&E
Chlorine Dosage, mg/L	8	8	NS	2-8

Notes:
1. Minimum dosing capacity.
2. MOP-8 refers to Ten States and M&E, as well as the Chlorine Handbook which provides a range of 6-9 mg/L.

More specifically PADEP guidelines specify that disinfection capacity "shall be adequate to produce an effluent that will meet the fecal coliform limits specified by the Department for that installation. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical. For domestic wastewater, the following minimum dosing capacity may be used as a guide in sizing chlorination facilities."

Table 4-15
Minimum Chlorine Dosing Capacity

Type of Treatment	Chlorine Dosage mg/L
Trickling Filter and Rotating Biological Contactor Effluent	12
Waste Stabilization Pond Effluent	12
Activated Sludge Plant Effluent	8
Tertiary Filtration Effluent	6
Nitrified Effluent	6

PADEP Guidelines do not specify the flow at which these guideline dosages apply. PADEP also specifies that standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns.

4.7.2.3 Evaluation

Table 4-16 summarizes the chlorine feed required for average and peak flow conditions at the target flow of 60 MGD. Assuming one of the larger (5,000 lb/day) feed units is out of service (per PADEP guidelines) the total chlorination capacity is 9,000 lb/day. Based on the values in

Table 4-16, the chlorination feed system has adequate capacity to meet PADEP dosage guidance at average and maximum monthly demands with the largest unit out of service but cannot meet the peak hourly demand.

Table 4-16
Chlorine Feed Requirements

Flow		Chlorine Feed Requirement, lb/day
Condition	Value, MGD	
Average	60	4002
Maximum Monthly	80	5336
Peak Hourly	144	9604

4.7.3 Summary

The existing chlorine feed system has adequate capacity to meet PADEP dosage guidelines at average conditions at the target 60 MGD flow scenario but not for the peak hourly flow. The chlorine contract tank does not meet criteria for chlorine contact time.

If the PADEP design guideline for chlorine feed capacity is to be met an additional chlorine evaporator and chlorinator would be required. However as summarized above PADEP guidelines require disinfection adequate to meet permit requirements. The WRTP typically uses a dosage well below state guidelines with satisfactory performance. This is achieved at a contact time of 38.6 minutes at average flow (16 minutes at peak hourly flow) if all four tanks are used. It is possible therefore that adequate performance could be achieved at a dosage lower than 8 mg/L in the future as well. However the interrelationships between dosage and contact time must be considered.

Disinfection is a function of chlorine dosage and contact time. It might be possible to use a higher chlorine dosage to maintain disinfection efficiency. The maximum applied dosage that could be achieved from the existing system with one unit out of service, (9,000 lb/day total capacity) is approximately 7.5 mg/L at peak hourly flow. While not meeting PADEP guidelines this value is within the range of typical dosages provided by other data and, given the WRTP's past performance, it may be sufficient to provide disinfection *if adequate contact time can be provided.* Since the actual dosage needed depends also on the characteristics of the wastewater,

testing would be warranted to determine whether this dosage provides adequate disinfection performance.

An additional factor to be considered, however, is the WRTP's effluent limit on chlorine residual (0.5 mg/L monthly average, 1.0 mg/L instantaneous maximum). If the higher applied dosage results in an exceedance of the current (and assumed future) TRC limit a dechlorination step would be needed to meet the TRC limit.

4.8 SOLIDS HANDLING

4.8.1 Solids Quantities

Evaluation of solids handling (thickening and dewatering) requires first an estimate of total solids produced in the system.

A typical value for total sludge production from a municipal WWTP is on the order of 1950 pounds of dry solids per day per million gallons of flow, (based upon 1250 lb/MG of primary solids and 700 lb/MG of waste activated sludge (WAS) (M&E, Table 12-7).) This is 0.975 tons dry solids per million gallons of flow (dt/MG).

The following provide estimates of total sludge at the WRTP:

- Waste activated sludge is estimated at 21450 lb/day (based on DELCORA data for WAS sludge pumped from PS-3 and PS-5).
- There are currently two ways to estimate primary solids:
    - Based on data provided by DELCORA for the years 2007 through November 2009, the daily primary sludge production would be estimated at approximately 47,400 lb/day (assuming 36.65 MGD influent flow at 252 mg/L TSS and 59% primary removal efficiency).
    - However primary sludge pumping data indicates a total primary sludge volume of approximately 70,500 /lb/day (169,000 gpd at 5% total solids)

The total sludge quantity is approximately 66,950- lb/day or 0.91 dt/MG at the current average flow using the primary performance data and 91,950 lb/day, (45.98 dt/day) or approximately 1.25 dt/MG of influent flow, using the sludge pumping data

DELCORA's data for sludge fed to the incinerators indicates an average value of 44.2 dt/day for the period Jan 2007-mid November 2009. This would be an apparent value on the order of 1.21 dt/MG and is in reasonable agreement with the total value based on primary sludge pumping data. (Note that this value would also include trucked-in sludge and would normally be slightly higher than the WRTP-generated quantity.) It is assumed that the trucked in sludge quantities will remain approximately the same in the future, and their effect on the total sludge will diminish.

The observed production is based on current influent conditions. As shown in Table 1-2, the future BOD_5 loading is projected to be slightly (5%) higher. This will increase the WAS quantity slightly.

For purpose of this evaluation therefore an overall future sludge generation rate of 1.25 dt/MG is assumed.

Since the thickeners are only used for WAS, this does not affect the DAF analysis.

4.8.2 Thickening

4.8.2.1 Description

The WRTP uses dissolved air flotation (DAF) for thickening the waste activated sludge (WAS) prior to dewatering and thickening. (According to Catania Engineering Associates Drawing 80700-001, sheet 102, primary sludge could be diverted to the DAFs or to the holding tanks; but the DAFs are not used for the primary sludge.)

The system includes four DAF tanks (T-23, T-24, T-25, and T-26) located in Building B-4, each 20 ft wide and 64.5 ft long (in the flotation zone) with a maximum water depth of approximately 10.6 ft. Each DAF tank has its own pressure retention tank; two compressors are provided for the system. Recycle/utility water is fed to the pressure retention tanks; the pressurized water/dissolved air mixture is mixed with influent sludge just prior to entry to the DAF tanks where separation takes place in the flotation zone. Chemical addition (polymer) is used to assist in thickening. The floated solids are removed by a skimmer system. The DAF system dates to the early 1970's.

DELCORA reports that only two of the four DAF tanks can be used for sludge thickening capacity. One cannot be used as a DAF unit because its pressure retention tank no longer meets code requirements for a pressure vessel. This tank is used, with atmospheric air, to separate grease (essentially air flotation, vs. DAF operation.). Of the remaining three DAF tanks, DELCORA reports that, typically, one is out of service and often used to provide repair parts to the other two. Therefore this evaluation assumes that two duty DAF tanks are available for WAS thickening.

4.8.2.2 Current Performance

DAF units typically produce thickened sludge with concentrations up to 4% (40,000 mg/L). Data provided by DELCORA indicates an average of 26,600 gallons per day of "biosolids" pumped from building B-4. Assuming 4% thickened solids, this volume would constitute approximately 8,870 lb/day of solids, which is too low to account for the daily WAS value (~ 21454 lb/day). Capture of the daily WAS in the pumped value would suggest a very high DAF float concentration. Additional evaluation of these values could be of use to confirm existing performance. However DELCORA is in the process of evaluating options for modifying or replacing the thickening system due to the above-noted age and mechanical issues. Therefore this evaluation considers the potential capacity of the DAFs at conventional design values.

4.8.2.3 Design Criteria

General design criteria for DAF units used to thicken WWTP sludge are based primarily on solids loading and hydraulic loading per square foot of tank area. Typical values are provided in Table 4-17.

Table 4-17
Design Criteria
DAF Systems

Parameter		Guideline			
		1 PADEP	2 Ten States	3 WEF MOP 8	4 M&E
Solids loading rate, lb/day/sf	without chemical addition	20	NS	9.6-24	14-30
	with chemical addition	40	NS	"50-100% increase	Up to 45
Hydraulic loading rate, gpm/sf		0.8	NS	0.5-2	0.2-4

Notes:
NS: Not Specified

4.8.2.4 Evaluation

Based upon current data and at the target flow of 60 MGD and the influent conditions in Table 1-2 the estimated WAS loading to the DAF would be approximately 38,400 lb/day of slides and 460,600 gpd of WAS. Peak loads would be approximately 75,000 lb/day and 899,600 gpd. Table 4-18 provides estimated operating values for solids loading rate and hydraulic loading rate at the target value of 60 MGD.

Table 4-18
Estimated DAF Operating Loadings at 60 MGD

Parameter	Value at average loading	Value at peak loading
Solids Loading Rate, lb/day/sf	14.9	29
Hydraulic loading rate, gpm/sf [1]	0.13	0.25

Notes:
1. assumes estimated WAS at 60 MGD settles to 10,000 mg/L.

4.8.3 Sludge Holding Tanks

The WRTP has four (4) tanks (ET-1, ET-2, ET-3, and ET-4) currently used for sludge holding (note these tanks were originally designed as digesters prior to construction of the incinerator. Based upon the design drawings (Catania Engineering Associates, Dwg. 80700-101) each tank is 52 ft in diameter with a 18.5 ft wall height and 16 ft SWD and a 6 ft cone bottom. The estimated

liquid volume for each tank is approximately 250,000 gallons and the combined liquid capacity is approximately 1,000,000 gallons.

The primary sludge is pumped from the primary clarifiers and stored in one of the four sludge storage tanks. The waste activated sludge (WAS) is thickened in the dissolved air flotation (DAF) system. The trucked in grease is also separated in one of the DAF tanks (as noted above, under atmospheric conditions). The WAS and thickened grease are then combined and stored in tank ET-2. This system was recently modified to allow the WAS/grease to be metered into the incinerator feed to help control localized hotspot resulting from the high-BTU value grease in the system. The trucked in sludge is also directed to one of the holding tanks.

4.8.4 Dewatering

4.8.4.1 Description

The WRTP uses belt filter presses (BFPs) for dewatering primary, secondary and trucked-in sludge. There are three (3) Ashbrook 2-meter BFPs installed in building B-3 with space allotted for a fourth BFP.

4.8.4.2 Current Performance

The sludge is pumped from the sludge storage tanks to any one or more of three belt filter presses. Sludge cake from the belt presses have ranged generally from 21% to 26% solids. This indicates good dewatering characteristics of the sludge and good performance by the belt filter presses.

4.8.4.3 Design Criteria

Typical operating values for BFPs, depending on sludge type and feed concentrations are summarized in Table 4-19.

Table 4-19
Loading Criteria
BFP Systems

Parameter	Guideline			
	1 PADEP	2 Ten States	3 WEF MOP 8	4 M&E
Solids loading rate, lb/meter/hour	NS	NS	396-704	200-1,500
Hydraulic throughput, gal/meter/min	NS	NS	20.6-50.7	25-100

NS: Not Specified

Note that PADEP design guidelines do not specify loading rates but do state that the number of mechanical dewatering units "should be sufficient to dewater the sludge produced with one unit out of service. If standby dewatering facilities are not available, adequate storage facilities equivalent to a three-month sludge production, or other means of sludge disposal shall be provided." Even if all sludge was thickened prior to storage the existing WRTP storage tank system does not provide the specified three month capacity.

4.8.4.4 Evaluation

At the conservatively projected sludge generation rate of 1.25 dt/MG the estimated sludge load is summarized in Table 4-20. The peak value is based on the peak day data since short term peaks (i.e. hourly peaks) will not have a major effect on sludge quantity and could be accommodated in the storage system.

Table 4-20
Estimated Sludge Quantity

	Daily Sludge	
	Dt/day	Gallons per day (1)
Average	75	449,800
Peak Daily	165(2)	992,400

Notes:
1. Assumes thickened sludge at 4% total solids.
2. Assumes peak sludge load is determined by peak BOD_5 and TSS loading factors.

Table 4-21 summarizes BFP solids loading rates for average and maximum conditions. Table 4-22 summarizes hydraulic loading rates.

Table 4-21
Belt Filter Press Solids Loading Rates

Condition	Solids Loading Rate, lb/m/day		
	Two Operating 24 hours per day, One Standby[1]	Three Operating 24 hours per day, One Standby [2]	Four Operating 24 hours per day (peak only)
Average	1,560	1,040	--
Peak Daily	3,450	2,300	1,730

Notes:
1. Current condition with three installed BFP.
2. Assumes fourth BFP is installed.

Table 4-22
Belt Filter Press Hydraulic Loading Rates

Condition	Hydraulic Loading Rate, gal/m/min		
	Two Operating 24 hours per day, One Standby[1]	Three Operating 24 hours per day, One standby [2]	Four Operating 24 hours per day (peak only)
Average	78	52	NA[3]
Peak Daily	172	114	86

Notes:
1. Current condition with three installed BFP.
2. Assumes fourth BFP is installed.
3. Not applicable; a spare press is intended at average conditions.

Overall these data indicate that the three existing presses would not be adequate at the target flow of 60 MGD. If a fourth press is added loading rates for three operating presses are within normal ranges. Even with the fourth press operating on peak days, the loading rate is high. However it is possible a combination of four operating presses and optimal use of storage could be used to accommodate this peak day.

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5. SUMMARY

5.1 SUMMARY OF CAPACITY

Based upon the process evaluation, the WRTP does not have sufficient capacity to meet the target conditions (60 MGD capacity). While some of the limitation is based on the increased flow (and the increased wastewater strength over the past several years) an additional and significant constraint is the possible need to nitrify in the future. The effect of the nitrification requirement most directly impacts the aeration basins, the aeration system and the secondary clarifier capacity, where significantly additional capacity is required for nitrification as compared to BOD_5 removal.

5.2 RECOMMENDED UPGRADES TO PROVIDE 60 MGD AVERAGE CAPACITY

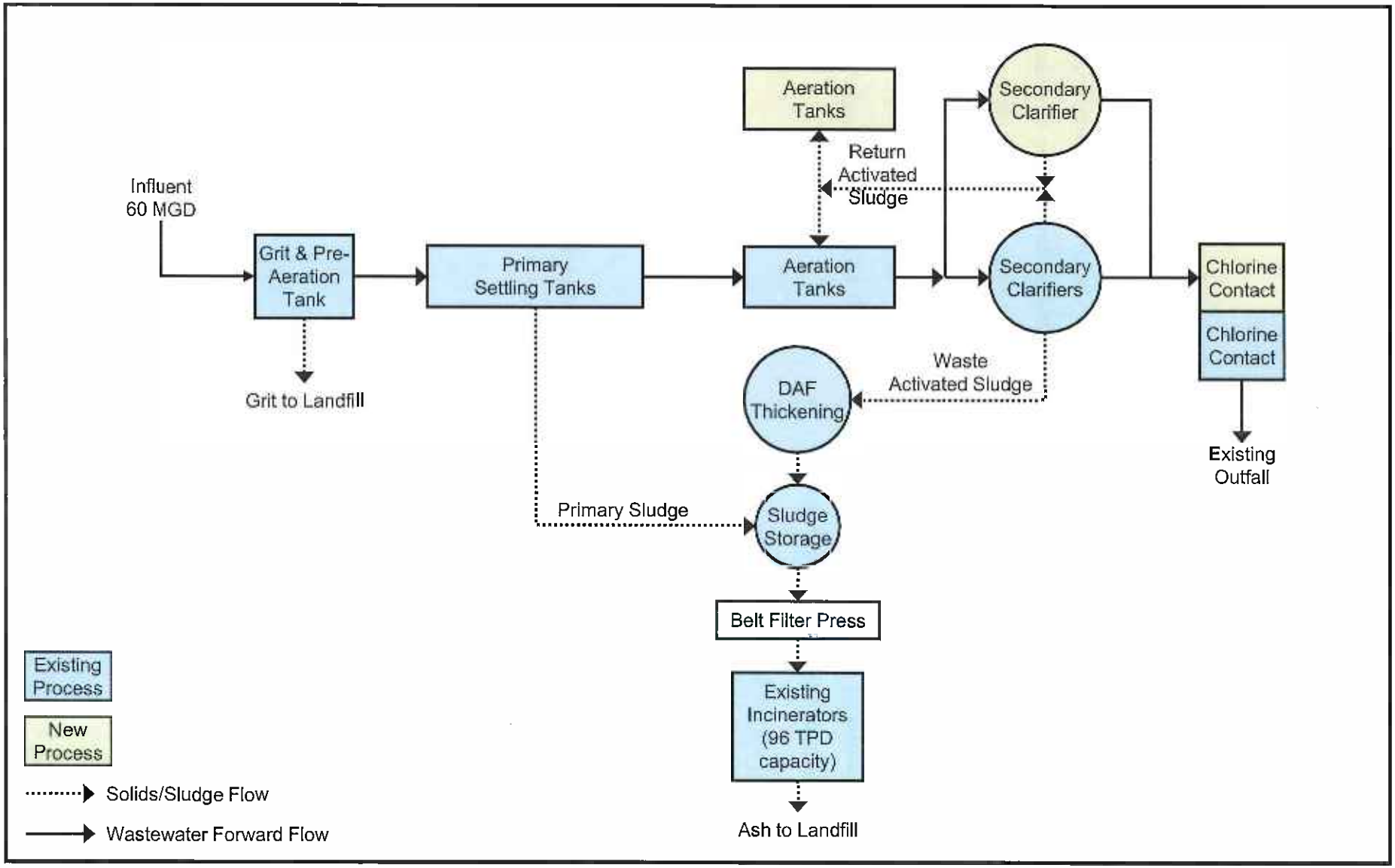
The following process upgrades would be needed to provide 60 MGD capacity under the conditions summarized in Section 2 of this report:

- Additional activated sludge capacity
  - Aeration basins
  - Aeration system
- Secondary clarification system
- Disinfection system
- Dewatering system

A conceptual block flow diagram is shown in Figure 5-1. The following sections outline the nature of these upgrades and provide an estimate of their cost. Figure 5-2 and Figure 5-3 provide conceptual layouts for these upgrades.

5.2.1 Activated Sludge System

Additional activated sludge capacity is needed to provide for BOD_5 removal and nitrification at 60 MGD average flow. This would include both additional aeration basin capacity and additional aeration (blowers).

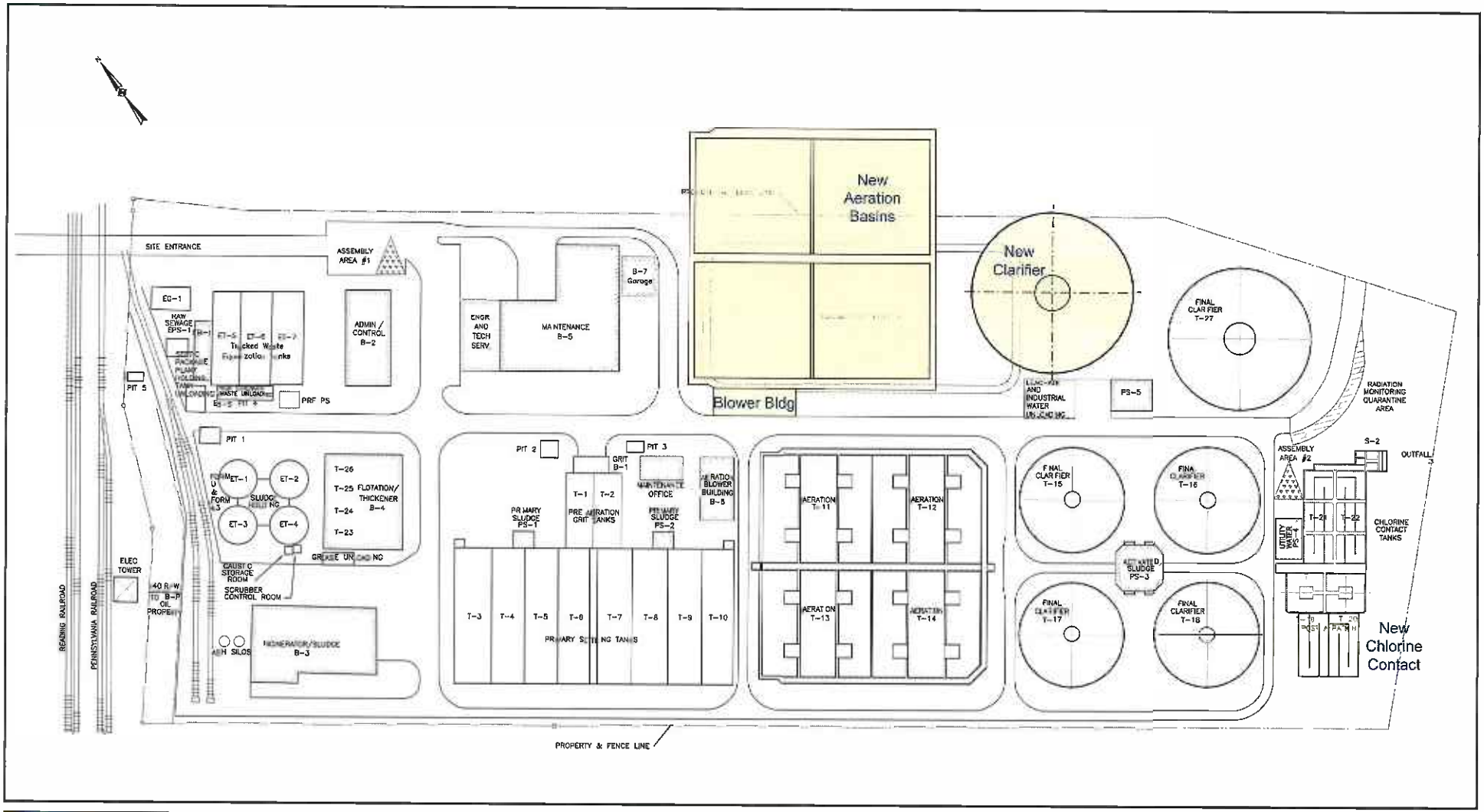


WRTP Process and Hydraulic Evaluation

Delaware County Regional Water Quality Control Authority

WESTON SOLUTIONS
Restoring Resource Efficiency

FIGURE 5-1
WRTP CONCEPTUAL BLOCK FLOW DIAGRAM



WRTP Process and Hydraulic Evaluation Delaware County Regional Water Quality Control Authority	WESTON SOLUTIONS Restoring Resource Efficiency	FIGURE 5-2 WRTP CONCEPTUAL LAYOUT PLAN

Figures 1.ppt

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WRTP Process and Hydraulic Evaluation

Delaware County Regional Water
Quality Control Authority

WESTON SOLUTIONS
Restoring Resource Efficiency

FIGURE 5-3

WRTP CONCEPTUAL LAYOUT AERIAL

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Based upon preliminary process calculations, a total aeration volume of approximately 21 million gallons would be needed at operating conditions (MLSS, SRT) comparable to those currently used (which are providing for nitrification). As noted in Section 4, conversion to MBR or IFAS configurations could be considered; however this evaluation assumes expansion with a conventional activated sludge system.

Four new aeration basins would be constructed to the north of the existing system in the area occupied by the former ash lagoon. The new tanks would be pile-supported concrete structures. The foot print would be slightly larger than the existing to provide 11 million gallons of capacity as compared to 10 MG in the existing. As shown on Figure 5-2 and Figure 5-3, this upgrade, along with others, would likely require expansion to the property to the north of the current site. In an effort to reduce this impact the basins could be rectangular as compared to the current square configuration. However space constraints are also present to the east and west (including the need for additional clarification).

5.2.1.1 Aeration Capacity

The total aeration capacity required for nitrification at the 99th percentile peak loads is estimated at approximately 53,900 scfm. This would require additional aeration capacity. Adding four (4) additional blowers in addition to the existing three blowers at 11,000 scfm each would provide a total capacity of 66,000 scfm, slightly less than the calculated value. However, these estimates are based upon preliminary information and the final sizing will need to be determined during preliminary design. It is possible to use slightly larger blowers for the new units with appropriate controls to balance total air flow among the eight aeration basins. For purposes of this budgetary estimate, it is assumed that the four new blowers of the same configuration as the existing would be used. In order to provide for full aeration capacity with one unit offline, per PADEP guidelines, a sixth blower would be needed.

Therefore this upgrade would include three new blowers; a new blower building, similar to the existing, would be constructed. The new aeration basins would use the same panel diffusers as the existing. The building would be a pile-supported foundation with precast panel walls. Another option would be to expand the existing Aeration Blower Building (B-6) and provide an overhead duct to the new aeration basins. Depending upon the space requirements of the

additional blowers, the relocation of other facilities (e.g., Maintenance Office) may be required to accommodate an expansion of B-6.

5.2.1.2 Cost

An order of magnitude estimate for cost for the upgraded activated sludge system is provided in Table 5-1.

Table 5-1
Order of Magnitude Estimate of Cost
Activated Sludge System

Item	Total Cost
Aeration Basins Tankage	$11,700,000
Aeration Basin Pilings	$1,200,000
Blower Control Building, including foundations and pilings	$850,800
Blowers, Installed	$2,163,100
Diffused Aeration System, in basin	$1,765,000
Aeration Header Piping	$645,000
Influent Pipe	$300,000
Influent Pipe Support Pilings	$90,000
Tank Inlet Sluice Gates	$100,000
Subtotal	**$18,813,900**
Power Distribution @ 15%	$2,822,085
Electrical and Controls @2%	$376,378
Total Construction Cost (rounded)	**$22,012,263**

5.2.2 Secondary Clarifier System

5.2.2.1 Description

One additional clarifier would be provided making a total of six units. In order to reduce loading rates for the system the new clarifier would be 200 ft in diameter. For purposes of this evaluation it is assumed the clarifier type would be the overall configuration as T-27.

The new clarifier would be constructed to the west of clarifier T-27 and would tie into pump station PS-5. The new tank would be a pile-supported concrete structure. The feed to the six clarifiers would be modifies to allow the correct area-proportioned flow split among the units and the return from the six clarifiers together would be modified as necessary to provide the necessary RAS split between the old and new aeration basins. As shown on Figure 5-2 and

Figure 5-3 the new clarifier would also require an expansion of the site to the north of the current WRTP property.

5.2.2.2 Cost

An order of magnitude estimate for cost for the upgraded activated sludge system is provided in Table 5-2.

Table 5-2
Order of Magnitude Estimate of Cost
Secondary Clarifier System

Item	Total Cost
Clarifier Tankage	$2,990,000
Clarifier Pilings	$480,000
Clarifier Equipment	$542,000
Piping (Influent, Effluent, RAS, WAS)	$1,410,000
Pipe Support Pilings (Influent, Effluent, RAS, WAS)	$630,000
Pumps (WAS, RAS)	$600,000
Subtotal	**$6,652,000**
Power Distribution[1]	--
Instrumentation and Controls @2%	$133,040
Total Construction Cost (rounded)	**$6,785,000**

Notes:
1. Assumed existing.

5.2.3 Disinfection System

5.2.3.1 Description

The expanded chlorination system would include additional chlorine contact tanks to provide the required contract time and one additional chlorine evaporator/chlorinator.

The new chlorine contact tanks would be constructed on the south side of the post aeration tanks (Figure 5-2 and Figure 5-3) and the system would be modified to allow flow from the new tanks then through the existing. Some demolition in the area south of the post aeration tanks would be needed construct the new tanks. Baffles would be installed in the post aeration tanks to better provide the flow path desired for chlorination and minimize short circuiting. The new tanks would be pile-supported concrete structures.

As shown on Figure 5-2 and Figure 5-3, space in this area for construction is limited, and construction near the existing bulkhead would be complicated.

The new chlorine evaporators and chlorinator would be installed in the chlorine room (in Building B-3).

5.2.3.2 Cost

An order of magnitude estimate for cost for the upgraded activated sludge system is provided in Table 5-3.

Table 5-3
Order of Magnitude Estimate of Cost
Disinfection System

Item	Total Cost
Demolition	$50,000
Chlorine Contact Tank	$1,100,000
Chlorine Contact Tank Pilings	$80,000
Chlorine Evaporator	$14,000
Chlorinator	$8,000
Chlorine Feed Piping	$200,000
Subtotal	**$1,452,000**
Power Distribution[1]	
Electrical and Controls, ls	$10,000
Total Construction Cost (rounded)	**$1,462,000**

Notes:
1. Assumed existing.

5.2.4 Dewatering System

5.2.4.1 Description

To provide the required dewatering capacity with one unit off line, a fourth 2-meter belt filter press would be installed in the filter press room in Building B-3. Space was allotted in this room for a fourth filter press and modifications to the building are therefore not required for this addition.

5.2.4.2 Cost

An order of magnitude estimate for cost for the upgraded activated sludge system is provided in Table 5-4.

Table 5-4
Order of Magnitude Estimate of Cost
Dewatering System

Item	Total Cost
Belt Filter Press, Installed	$335,000
Total Installed Cost (rounded)	**$335,000**

5.2.5 Summary of Upgrades

Table 5-5 provides a summary of the total estimated cost for all process upgrades to provide the target 60 MGD capacity.

Table 5-5
Order of Magnitude Estimate of Cost
Combined Upgrades

Item		Total Cost
Activated Sludge System		$21,496,500
Secondary Clarifier System		$6,785,000
Disinfection System		$1,462,000
Dewatering System		$335,000
Subtotal		**$30,078,200**
Engineering and Legal	20%	$6,015,700
Contingency	25%	$7,519,625
Total (rounded)		**$43,614,000**

5.3 NEW OUTFALL DIFFUSER

5.3.1 Description

In addition the process upgrades discussed above DELCORA is investigating the possible need for an outfall diffuser system. Effluent from the WRTP is currently discharged through three 42-inch diameter openings essentially at the property bulkhead. A new outfall pipe and diffuser would be used to extend the discharge further into the river and better mix the discharge into the stream flow. This would be useful to help address possible future effluent limits that would be based on in-stream quality criteria (primarily Water Quality Based Effluent Limitations (WQBEL's) which may in the future be required to meet DRBC Water Quality Criteria. This section prices an order or magnitude cost for an outfall diffuser system. It should be noted that the degree of mixing required for any particular WQBEL parameter has not been established.

Once the mixing objectives are quantified the design of the diffuser to provide that mixing would be based on, generally by dilution modeling using, for example, the Tidal Cormix model.

5.3.2 Cost

For purposes of this preliminary evaluation it is assumed that a new outfall would be constructed approximately 455 ft into the river, roughly perpendicular to the bulkhead. The outfall would be a pile supported pipe to control settling into the anticipated soft river bottom in the area.

Based upon these assumed design parameters, an order of magnitude estimate for cost for the upgraded activated sludge system is provided in Table 5-6.

Table 5-6
Order of Magnitude Estimate of Cost
Outfall Diffuser System

Item	Total Cost
New Outfall and Diffuser	$2,330,000
Admin / Legal (2%)	$46,600
Contingency (15%)	$349,500
Bond / Insurance (4%)	$93,200
Total Installed Cost (rounded)	**$2,819,300**

6. REFERENCES

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Gannett Fleming 2009, *Delaware County Regional Water Quality Control Authority, Chester County (sic) Pennsylvania, Western Regional Treatment Plant, Final Preliminary Evaluation of Denitrification Process Conceptual Design*, May 2009.

Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. *Recommended Standards for Wastewater Facilities*, 2004 Edition

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APPENDIX A

PROJECTED WASTEWATER CHARACTERISTICS

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Table A-1 summarizes the data for the capacity evaluation. This estimate uses a weighted average approach to estimate the combined characteristics at 60 MGD from the three main anticipated wastewater sources: DELCORA's existing sources, the Southwest Delaware County Municipal Authority (SWDCMA) and other future flows.

Table A-1
Estimated Wastewater Characteristics for Capacity Evaluation

Parameter	Source			Weighted Average Characteristics (rounded)
	DELCORA	SWDCMA	Other Future Sources [1]	
Flow, MGD	36.65	6	17.35	
BOD_5, mg/L	199	317	190	208
COD, mg/L	471	718	430	484
TSS, mg/L	252	351	210	250
Total Nitrogen, mg/L	19.7	40	40	28
Ammonia Nitrogen, mg/L	10.7	25	25	16
Oil and Grease, mg/L	21.6	90	90	48
Alkalinity, as $CaCO_3$, mg/L	90	90	90	90

Notes:
1. Parameter values from M&E, Fourth Edition, 2003, Table 3-15.

Wastewater Flow

Average daily waste water flows included:

- Existing DELCORA flow, approximately 36.65 MGD average based on January 2007-November 2009 data.
- Anticipated SWDCMA flow using the full rated capacity of 6 MGD. Based on the Chapter 94 Report, the projected 2013 flow is 5.8 MGD. It is assumed DELCORA would take over the full rated capacity of 6 MGD.
- Remaining flow from other sources up to a maximum of 60 MGD daily average.

Wastewater Characteristics;

The following estimates were used:

- For those parameters for which DELCORA has influent data (BOD_5, COD, Total Nitrogen, Ammonia, Oil and Grease), the values in Table A-1 are the averages based on 2007-2009 data.
- For the SWDCMA plant, the BOD_5 value is based upon the projected 2013 BOD_5 loading (15,346 lb/day) and the projected 2013 flow of 5.8 MGD. It is assumed the concentration will remain the same as the flow increases to the rated 6 MGD.
- For all other flow, this evaluation uses typical medium strength wastewater characteristic values from Metcalf and Eddy, Wastewater Engineering, Fourth Edition 2003, Table 3-15. Note that PADEP's Municipal WWTP guidance and Recommended Standards for Wastewater Facilities, 2004 Edition ("Ten States Standards") do not provide constituent data to be used for planning. (PADEP guidance for BOD_5 only provides loads on a per capita basis.) Ten States Standards references M&E Fourth Edition waste strength data in Appendix A (related to septage handling and treatment).
- The those parameters for DELCORA for which data are not available have been estimated from the M&E data using the ratio of DELCORA's BOD_5 (199 mg/L) to the M&E value (220 mg/L), assuming that the other parameters would vary in proportion to the BOD_5 levels. The same procedure was used for SWDCMA data except for nitrogen and O& G levels for which, at DELCORA's recommendation the M&E values were used.

Assumed alkalinity values are provided because the nitrification evaluation would need to consider whether there is adequate alkalinity in the system.

APPENDIX B

DISCUSSION WITH DRBC REGARDING $CBOD_{20}$

WASTE LOAD ALLOCATION

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1400 Weston Way
West Chester, PA 19380

MEMO

10 December 2009

To: Rob Hindt

From: Bill Lowe, Weston Solutions, Inc.

Subj: Possible transfer of DRBC $CBOD_{20}$ Waste Load Allocation to WRTP

I spoke with Steve Walsh of DRBC regarding whether, if one plant closes and connects to another, the closing facility's $CBOD_{20}$ Waste Load Allocation (WLA) would be transferred to the receiving facility. I did not identify the specific situation or the plants involved. Since the answer to the question depends in part on where the plants are, I indicated only that the facilities would be in Zones 4 or 5 of the estuary (DELCORA's WRTP is in Zone 4).

As a point of clarification the $CBOD_{20}$ WLAs are applied only to plants discharging to the estuary, i.e. the Delaware River or the tidal portions of its tributaries. For plants located on the non-tidal portions of tributaries, the BOD_5 limits are based on DRBC's Water Quality Criteria for those tributaries.

SCENARIO 1: Assuming both plants discharge to the estuary and therefore have WLAs:

- In general the receiving plant would get some or all of the allocation from the closing plant.
- How much of a closing plant's allocation would be transferred to the receiving plant depends where the plants are located.
    - If they are located in the same Zone and if that Zone has capacity remaining, the receiving plant could get all or most of the closing plant's allocation. (This is the case for Zone 4 where DELCORA is located and may have been the situation when, for example, the Muckinapates and Darby Creek Plants were closed in 1977).
    - By contrast, in Zone 2, which is already over-allocated, the receiving plant would probably not get the allocation.
- If both plants discharge to the estuary but in different Zones, the transfer of allocation would not likely be linear, since the available capacity in the two Zones may differ.

SCENARIO 2: Assuming the closing plant does not discharge to a tidal tributary:

- If the closing plant discharges to a non tidal tributary, such that it doesn't have an allocation, then whether the receiving plant's allocation is adjusted for taking the new load would be case-specific.

In general if the receiving plant has room in its existing allocation to accommodate the closing plant, they probably won't increase the allocation. Basically this situation would require them to review the case to make a determination.
Based upon my review of the existing Waste Load Allocation document (revision dated 1 October 2000) it does not appear that the Southwest plant has an allocation. I infer it does not discharge to a tidal portion of a tributary. If this is the case then I think Scenario 2 above would apply.

As a matter of information DRBC also advises that they are working on a revision to the waste load allocation document and it will likely be promulgated in 2010.

APPENDIX C
HYDRAULIC CALCULATIONS

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Maximum Forward Flow Analysis (Individual Processes): Pre-aeration Tank and Primary Clarifier

Primary Clarifier

Weir Type	90°	V-notch
Notch 5pacing	6	inches
Weir Length	2,644	feet
No. of Notches	5,288	
Bottom Weir EL.	24.64	feet
Max Weir Head	**2.50**	inches
Max W.L.EL. in Primary	24.85	feet
Flow/Notch	22.23	gpm
Max Flow	**169.3**	MGD

Grit and Pre-aeration Tanks

Estimated Head Loss	
(2) 6ft sluice gates	0.1
(2) Grit Chambers	
(2) 8ft slide gates	
Influent Flume	
(2) 2ft slide gates	

W.L.EL. Grit & Pre-aeration Tanks (ft) **24.95**

Maximum Forward Flow Analysis (Individual Processes): Aeration Basins - Minimum Effluent Weir Elevation

North Train = T -11 and T -12 operating in series
South Train = T-13 and T -14 operating in series

Forward Flow	108.6	MGD
Recycle Ratio	0.53	
Recycle Rate	57.6	MGD
Total Flow	166.2	
Friction Factor 'C'	100	

Head Loss Through 60-in Daimeter Steel Influent Pipe

	Total Flow %	Pipe Flow %	Pipe Flow (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90 ° Elbow	Thru-Tee	Gate Valve	Branch - Tee	Sluice Gate	hf	Influent Box	Pipe Entrance	Pipe Exit	Delta Z	Total Head
To B	**0.391**	1.000	109	8.56	86	450					2.63		0.888			**4.24**
		0.391	42	3.35					300	40	0.29			0.17	0.26	
To C	**0.206**	1.000	109	8.56	86	450					2.63		0.888			**4.25**
		0.609	66	5.21	70		100				0.33					
		0.206	22	1.76					300	40	0.09			0.05	0.26	
To D	**0.212**	1.000	109	8.56	86	450					2.63		0.888			**4.25**
		0.609	66	5.21	70		100				0.33					
		0.403	44	3.45	80		100	40			0.20					
		0.212	23	1.81					300	40	0.09	**0.051**		0.05		
To E	**0.191**	1.000	109	8.56	86	450					2.63		0.888			**4.25**
		0.609	66	5.21	70		100				0.33					
		0.403	44	3.45	80		100	40			0.20					
		0.191	21	1.64	70		100				0.04					
		0.191	21	1.64					300	40	0.08	**0.042**		0.04		

Check: **1.000**

Discharge from (4) 12-ft Rectangular Effluent Weirs Per Trair

	Total Flow (MGD)	Weir Head (ft)	Minimum Crest EL. (ft)	Basin W.L. EL. (ft)
South Train (B,C)	99	0.99	19.32	20.31
North Train (D,E)	67	0.76	19.32	20.08

Max WL EL in primary effluent channel (ft) 24.56

W.L. EL. In Primary Effluent Channel (ft) **24.56** **OK!**

Maximum Forward Flow Analysis (Individual Processes): Secondary Clarifiers - Minimum Aeration Basin Effluent Weir Elevation

Forward Flow	118.2	MGD
Recycle Ratio (α)	0.53	
Recycle Rate	62.6	MGD
Total Flow:	180.8	

W.L. EL in Clarifiers

	Area (ft^2)	% Area	Apportioned Flow (gpm)	Circumference (ft) Inboard Trough Inner[1]	Inboard Trough Outer[2]	Periferal[3]	Flow per Notch (gpm)	Weir Head (ft)	Bottom V-Notch EL. (ft)	Max W.L. EL. (ft)	Clarifier W.L. EL. (ft)	
T-27	24053	31.2%	25592	446	465	533	18.4	0.19	15.50	15.71	15.69	OK!
T-15	13273	17.2%	14123	360	364	NA	9.8	0.15	15.34	15.55	15.49	OK!
T-16	13273	17.2%	14123	360	364	NA	9.8	0.15	15.34	15.55	15.49	OK!
T-17	13273	17.2%	14123	360	364	NA	9.8	0.15	15.34	15.55	15.49	OK!
T-18	13273	17.2%	14123	360	364	NA	9.8	0.15	15.34	15.55	15.49	OK!
Total:	77146	100%	82083									

1. 6-inch v-notch spacing
2. 24-inch v-notch spacing on T-27 only
3. 24-inch v-notch spacing on T-27 only

Flow Rate	118.2	MGD
Flow Rate	82,083	gpm
Friction Factor 'C'	100	

	Line Size (in)	Area Apportioned Flow %	Flow Rate (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90 ° Elbow	45 ° Elbow	Thru-Tee	Branch -Tee	Gate Valve	Control Valve	Head Loss (Feet) friction loss (ft)	Reducer	Enlarger	Pipe Entrance	Pipe Exit	CV Head	Weir Head	Total Head	Bottom V-Notch EL. (ft)	Clarifier W.L. EL.
To T-27	72	31.2%	37	2.02	287.5		384	120				0.22			0.049			0.19	3.53	15.50	15.69
	42		37	5.93	237.5	210	112			26.7	63	2.44	0.08			0.55	0.00				
To T-15	72	17.2%	81	4.45	150				360			0.21			0.240						
	42		20	3.27	110	105	56					0.34				0.17		0.26	3.53	15.34	15.60
	36		20	4.45	10					22.7	55	0.23	0.05	0.012			2.02				
To T-16	72	17.2%	81	4.45	150			120				0.22	0.02		0.240						
	54		41	3.96	45				270			0.42									
	42		20	3.27	110	105	56					0.34				0.17		0.26	3.53	15.34	15.60
	36		20	4.45	10					22.7	55	0.23	0.04	0.012			1.58				
To T-17	72	17.2%	81	4.45	150				360			0.21			0.240						
	42		20	3.27	110	105	56					0.34				0.17		0.26	3.53	15.34	15.60
	36		20	4.45	10					22.7	55	0.23	0.05	0.012			2.02				
To T-18	72	17.2%	81	4.45	150			120				0.22	0.02		0.240						
	54		41	3.96	45				270			0.42									
	42		20	3.27	110	105	56					0.34				0.17		0.26	3.53	15.34	15.60
	36		20	4.45	10					22.7	55	0.23	0.04	0.012			1.58				
Check:		100.0%																			

Maximum Allowable Aeration Basin Effluent W.L. EL. (ft)	19.22	
Aeration Basin Effluent W.L EL. (ft)	**19.22**	OK!

Maximum Forward Flow Analysis (Individual Processes): Chlorine Contact Tanks

Flow Rate	131.1	MGD
Flow Rate	91,042	gpm
Friction Factor 'C'	100	

Check water surface elevation in the secondary clarifier effluent channel

	Max Crest Elevation (ft)	Total Weir Length (ft)	Wier Head (ft)	Contact Tank W.L. EL (ft)
Contact Tank Effluent Weir	12.65	40	0.96	13.61

					Equivalent Pipe Length (Feet)			Head Loss (Feet)				
	Line Size (in)	Area Apportioned Flow %	Flow Rate (MGD)	Velocity (ft/sec)	Horiz. Pipe	90 ° Elbow	45 ° Elbow	hf (ft)	Pipe Entrance	Expansion	Pipe Exit	Total Head
T-27 Effluent	42	31.2%	41	6.57	25	125	55	0.93	0.34	0.03		1.80
	60		41	3.22	190		240	0.35			0.16	
T-15 Effluent	42	17.2%	23	3.63	140	125		0.40	0.10	0.01		1.58
	60		45	3.55	35		80	0.11				
	60		90	7.11	50			0.17			0.78	
T-16 Effluent	42	17.2%	23	3.63	30	125		0.24	0.10	0.01		1.58
	60		90	7.11	50		80	0.45			0.78	
T-17 Effluent	42	17.2%	23	3.63	140	125		0.40	0.10	0.01		1.58
	60		45	3.55	35		80	0.11				
	60		90	7.11	50			0.17			0.78	
T-18 Effluent	42	17.2%	23	3.63	30	125		0.24	0.10	0.01		1.58
	60		90	7.11	50		80	0.45			0.78	
	Check:	100.0%										

Bottom V-Notch EL. (ft)	Max Clarifier Effluent W.L. EL. (ft)	Clarifier Effluent W.L. EL. (ft)	
15.50	15.42	**15.42**	OK!
15.34	15.26	**15.20**	OK!
15.34	15.26	**15.20**	OK!
15.34	15.26	**15.20**	OK!
15.34	15.26	**15.20**	OK!

Check water elevation in the chlorine contact tank effluent channel

	Line Size (in)	Flow Rate (MGD)	Velocity (ft/sec)	Pipe Entrance	Pipe Exit	Total Head (ft)
Single Mag Meter Losses	54	131	12.75	1.26	2.02	3.28

	Min Crest Elevation (ft)	Flow Rate (MGD)	Weir Length (ft)	Wier Head (ft)	MeterTank W.L. EL (ft)
Outfal Weir	7.00	131	11	2.28	9.28

Crest Contact Tank Effluent Weir Elevation (ft)	12.65	
Max Outfall W.L. EL. Elevation (ft)	12.57	
W.L. EL. Downstream of Contact Tank Weir (ft)	**12.56**	OK!

Check influent water elevation at the outfall structure

High Tide Elevation (ft)	3.2
Outfall Pipe Invert (ft)	-3

	Line Size (in)	Flow Rate (MGD)	Velocity (ft/sec)	Pipe Entrance	Pipe Expansion	Pipe Exit	Total Head (ft)
Triple Outfall Pipe Losses	42	44	7.03	0.38	0.03	0.77	1.18

Crest Outfall Weir Elevation (ft)	7.00	
W.L. EL. Downstream of Outfall Weir (ft)	**4.38**	OK!

Maximum Forward Flow Analysis (Entire Treatment Works): Pre-aeration Tank and Primary Clarifier

Primary Clarifier

Maximum Forward Flow	**95.5**	MGD

Downstream

Weir Type	90°	V-notch	given	
Notch Spacing	6	inches	given	
Weir Length	2644	feet	given	
No. of Notches	5288		given	
Flow/Notch	12.54	gpm	calc	
Bottom Weir EL.	24.64	feet	given	
Weir Head	1.99	inches	calc	OK!
W.L.EL. Primary Settling Forward Flow	24.81	feet	calc	
W.L.EL. Primary Settling Backwater	24.56	feet	calc	
Max of forward flow and backwater	24.81	feet	calc	
Slide gate area 2'x2'	4.0	ft^2	given	
Flow per gate (12 gates)	7.96	MGD	calc	
Head loss through gate	0.3953	ft	calc (submerged rectangular orifice)	
Influent Flume WL EL	25.201	ft	calc	
Invert slide gate (8'x5')	21.2	ft	given	
Slide gate width	8	ft	given	
Preaeration Tank WL EL for given Q	25.2239	ft	2xQgate= [illegible] MDG	match? (submerged weir)
Head loss through gate	0.0229	ft	calc	
Baffle Wall Crest Elevation	22.75	ft	given	
Baffle Length	30	ft	given	
Grit Tank WL EL for given Q	25.2262	ft	2xQbaffle= [illegible] MDG	match? (submerged weir)
Head loss over baffle	0.0023	ft	calc	
Invert slide gates (6'x5.5')	21.5	ft	given	
Slide gate width	6.0	ft	given	
Grit Tank Influent WL EL for given Q	25.2883	ft	2xQgate= [illegible] MDG	match? (submerged weir)
Head loss through gate	0.0621	ft	calc	

Upstream

Maximum Forward Flow Analysis (Individual Processes): Aeration Basins - Maximum Effluent Weir Elevation

North Train = T -11 and T -12 operating in series
South Train = T-13 and T -14 operating in series

Forward Flow	95.5	MGD
Recycle Ratio (α)	0.53	
Recycle Rate	50.6	MGD
Total Flow	145.1	
Friction Factor 'C'	100	

Head Loss Through 60-in Daimeter Steel Influent Pipe — last turn discharge

	Total Flow %	Pipe Flow %	Pipe Flow (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90° Elbow	Thru-Tee	Gate Valve	Branch - Tee	Sluice Gate	hf	Influent Box	Pipe Entrance	Pipe Exit	Delta Z	Total Head
To B	0.386	1.000	96	7.53	86	450					2.07		0.686			3.37
		0.386	37	2.90					300	40	0.23			0.13	0.26	
To C	0.187	1.000	96	7.53	86	450					2.07		0.686			3.37
		0.615	59	4.63	70		100				0.27					
		0.187	18	1.41					300	40	0.06			0.03	0.26	
To D	0.226	1.000	96	7.53	86	450					2.07		0.686			3.37
		0.615	59	4.63	70		100				0.27					
		0.428	41	3.22	80		100	40			0.18					
		0.226	22	1.70					300	40	0.08	0.045		0.04		
To E	0.202	1.000	96	7.53	86	450					2.07		0.686			3.37
		0.615	59	4.63	70		100				0.27					
		0.428	41	3.22	80		100	40			0.18					
		0.202	19	1.52	70		100				0.03					
		0.202	19	1.52					300	40	0.07	0.036		0.04		

Check: **1.000**

Discharge from (4) 12-ft Rectangular Effluent Weirs Per Train

	Total Flow (MGD)	Weir Head (ft)	Maximum Crest EL. (ft)	Basin W.L. EL. (ft)
South Train (B,C)	84	0.88	20.3	21.18
North Train (D,E)	62	0.72	20.3	21.02

Max WL EL in primary effluent channel (ft) 24.56

W.L. EL. In Primary Effluent Channel (ft) **24.56** OK!

Maximum Forward Flow Analysis (Individual Processes): Secondary Clarifiers - Maximum Aeration Basin Effluent Weir Elevation

Forward Flow	135.5	MGD
Recycle Ratio	0.53	
Recycle Rate	71.8	MGD
Total Flow.	207.3	

W.L. EL in Clarifiers

	Area (ft^2)	% Area	Apportioned Flow (gpm)	Circumference (ft) Inboard Trough Inner[1]	Outer[2]	Periferal[3]	Flow per Notch (gpm)	Weir Head (ft)	Bottom V-Notch EL. (ft)	Max W.L. EL. (ft)	Clarifier W.L. EL. (ft)	
T-27	24053	31.2%	29338	445	465	533	21.1	0.20	15.50	15.71	**15.70**	OK!
T-15	13273	17.2%	16190	360	364	NA	11.2	0.16	15.34	15.55	**15.50**	OK!
T-16	13273	17.2%	16190	360	364	NA	11.2	0.16	15.34	15.55	**15.50**	OK!
T-17	13273	17.2%	16190	360	364	NA	11.2	0.16	15.34	15.55	**15.50**	OK!
T-18	13273	17.2%	16190	360	364	NA	11.2	0.16	15.34	15.55	**15.50**	OK!
Total:	77146	100%	94097									

1. 6-inch v-notch spacing
2. 24-inch v-notch spacing on T-27 only
3. 24-inch v-notch spacing on T-27 only

Flow Rate	135.5	MGD
Flow Rate	94,097	gpm
Friction Factor 'C'	100	

	Line Size (in)	Area Apportioned Flow %	Flow Rate (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90 ° Elbow	45 ° Elbow	Thru-Tee	Branch -Tee	Gate Valve	Control Valve	Head Loss (Feet) friction loss (ft)	Reducer	Enlarger	Pipe Entrance	Pipe Exit	CV Head	Weir Head	**Total Head**	Bottom V-Notch EL. (ft)	Clarifier W.L. EL
To T-27	72	31.2%	42	2.31	287.5		384	120				0.28			0.065			0.20	**4.52**	15.50	15.70
	42		42	5.79	237.5	210	112			26.7	63	3.15	0.11			0.72	0.00				
To T-15	72	17.2%	93	5.10	150				360			0.27			0.315			0.28	**4.52**	15.34	15.62
	42		23	3.75	110	105	56					0.44				0.22					
	36		23	5.10	10					22.7	55	0.30	0.06	0.016			2.63				
To T-16	72	17.2%	93	5.10	150			120				0.28	0.03		0.315			0.28	**4.52**	15.34	15.62
	54		47	4.54	45				270			0.54									
	42		23	3.75	110	105	56					0.44				0.22					
	36		23	5.10	10					22.7	55	0.30	0.05	0.016			2.05				
To T-17	72	17.2%	93	5.10	150				360			0.27			0.315			0.28	**4.52**	15.34	15.62
	42		23	3.75	110	105	56					0.44				0.22					
	36		23	5.10	10					22.7	55	0.30	0.06	0.016			2.63				
To T-18	72	17.2%	93	5.10	150			120				0.28	0.03		0.315			0.28	**4.52**	15.34	15.62
	54		47	4.54	45				270			0.54									
	42		23	3.75	110	105	56					0.44				0.22					
	36		23	5.10	10					22.7	55	0.30	0.05	0.016			2.05				
	Check:	100.0%																			

Maximum Allowable Aeration Basin Effluent W.L. EL. (ft)	20.22	
Aeration Basin Effluent W.L EL. (ft)	**20.22**	OK!

Maximum Forward Flow Analysis (Individual Processes): Aeration Basins - Maximum Effluent Weir Elevation

North Train = T -11 and T -12 operating in series
South Train = T-13 and T -14 operating in series

Forward Flow	144.0	MGD
Recycle Ratio (α)	0.53	
Recycle Rate	76.3	MGD
Total Flow	220.3	
Friction Factor 'C'	100	

Head Loss Through 60-in Daimeter Steel Influent Pipe — last turn discharge

	Total Flow %	Pipe Flow %	Pipe Flow (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90° Elbow	Thru-Tee	Gate Valve	Branch - Tee	Sluice Gate	hf	Influent Box	Pipe Entrance	Pipe Exit	Delta Z	Total Head
To B	0.402	1.000	144	11.35	86	450					4.43		1.561			7.09
		0.402	58	4.56					300	40	0.52			0.32	0.26	
To C	0.233	1.000	144	11.35	86	450					4.43		1.561			7.09
		0.598	86	6.79	70		100				0.54					
		0.233	34	2.64					300	40	0.19			0.11	0.26	
To D	0.192	1.000	144	11.35	86	450					4.43		1.561			7.09
		0.598	86	6.79	70		100				0.54					
		0.365	53	4.14	80		100	40			0.28					
		0.192	28	2.18					300	40	0.13	0.074		0.07		
To E	0.173	1.000	144	11.35	86	450					4.43		1.561			7.10
		0.598	86	6.79	70		100				0.54					
		0.365	53	4.14	80		100	40			0.28					
		0.173	25	1.96	70		100				0.05					
		0.173	25	1.96					300	40	0.11	0.060		0.06		

Check: 1.000

Discharge from (4) 12-ft Rectangular Effluent Weirs Per Train

	Total Flow (MGD)	Weir Head (ft)	Maximum Crest EL. (ft)	Basin W.L. EL. (ft)
South Train (B,C)	140	1.24	20.3	21.54
North Train (D,E)	80	0.86	20.3	21.16

Max WL EL in primary effluent channel (ft)	24.56
W.L. EL. In Primary Effluent Channel (ft)	**28.64**

FAIL!

144MGD Forward Flow Analysis: Secondary Clarifiers

Forward Flow	144.0	MGD
Recycle Ratio	0.53	
Recycle Rate	76.3	MGD
Total Flow:	220.3	

W.L EL in Clarifiers

	Area (ft^2)	% Area	Apportioned Flow (gpm)	Circumference (ft) Inboard Trough Inner[2]	Inboard Trough Outer[2]	Periferal[3]	Flow per Notch (gpm)	Weir Head (ft)	Bottom V-Notch EL. (ft)	Max W.L. EL. (ft)	Clarifier W.L EL. (ft)	
T-27	24053	31.2%	31178	446	465	533	22.4	0.21	15.50	15.71	**15.71**	OK!
T-15	13273	17.2%	17205	360	364	NA	11.9	0.16	15.34	15.55	**15.50**	OK!
T-16	13273	17.2%	17205	360	364	NA	11.9	0.16	15.34	15.55	**15.50**	OK!
T-17	13273	17.2%	17205	360	364	NA	11.9	0.16	15.34	15.55	**15.50**	OK!
T-18	13273	17.2%	17205	360	364	NA	11.9	0.16	15.34	15.55	**15.50**	OK!
Total:	77146	100%	100000									

1 6-inch v notch spacing
2 24-inch v-notch spacing on T-27 only
3 24-inch v-notch spacing on T-27 only

Flow Rate	144.0	MGD
Flow Rate	100,000	gpm
Friction Factor 'C'	100	

	Line Size (in)	Area Apportioned Flow %	Flow Rate (MGD)	Velocity (ft/sec)	Equivalent Length (Feet) Horiz. Pipe	90 ° Elbow	45 ° Elbow	Thru-Tee	Branch -Tee	Gate Valve	Control Valve	Head Loss (Feet) friction loss (ft)	Reducer	Enlarger	Pipe Entrance	Pipe Exit	CV Head	Weir Head	Total Head	Bottom V-Notch EL. (ft)	Clarifier W.L. EL.
To T-27	72	31.2%	45	2.46	287.5		384	120				0.31			0.073			0 21	**5.05**	15.50	15.71
	42		45	7.22	237.5	210	112			26.7	63	3.52	0.12			0.81	0.00				
To T-15	72	17.2%	99	5.42	150				360			0.30			0.356			0.28	**5.05**	15.34	15.62
	42		25	3.98	110	105	56					0 49				0.25					
	36		25	5.42	10					22.7	55	0.34	0.07	0.018			**2.95**				
To T-16	72	17.2%	99	5.42	150			120				0.31	0.04		0.356			0.28	**5.05**	15.34	15.62
	54		50	4.82	45				270			0.60									
	42		25	3 98	110	105	56					0.49				0.25					
	36		25	5.42	10					22 7	55	0.34	0.06	0.018			**2.31**				
To T-17	72	17.2%	99	5.42	150				360			0.30			0.356			0.28	**5.05**	15.34	15.62
	42		25	3.98	110	105	56					0.49				0.25					
	36		25	5.42	10					22.7	55	0.34	0.07	0.018			**2.95**				
To T-18	72	17.2%	99	5.42	150			120				0.31	0.04		0.356			0.28	**5.05**	15.34	15.62
	54		50	4.82	45				270			0.60									
	42		25	3.98	110	105	56					0.49				0.25					
	36		25	5.42	10					22.7	55	0.34	0.06	0.018			**2.31**				
Check:		100.0%																			

Maximum Allowable Aeration Basin Effluent W.L. EL. (ft)	20.22	
Aeration Basin Effluent W.L EL. (ft)	**20.76**	FAIL!

144MGD Forward Flow Analysis: Chlorine Contact Tanks

Flow Rate	144	MGD
Flow Rate	100,000	gpm
Friction Factor 'C'	100	

Check water surface elevation in the secondary clarifier effluent channel

	Max Crest Elevation (ft)	Total Weir Length (ft)	Wier Head (ft)	Contact Tank W.L. EL (ft)
Contact Tank Effluent Weir	12.65	40	1.03	13.68

					Equivalent Pipe Length (Feet)			Head Loss (Feet)				
	Line Size (in)	Area Apportioned Flow %	Flow Rate (MGD)	Velocity (ft/sec)	Horiz. Pipe	90 ° Elbow	45 ° Elbow	hf (ft)	Pipe Entrance	Expansion	Pipe Exit	Total Head
T-27 Effluent	42	31.2%	45	7.22	25	125	55	1.11	0.40	0.03		2.15
	60		45	3.54	190		240	0.41			0.19	
T-15 Effluent	42	17.2%	25	3.98	140	125	80	0.48	0.12	0.01		1.90
	60		50	3.90	35			0.13				
	60		99	7.81	50			0.21			0.95	
T-16 Effluent	42	17.2%	25	3.98	30	125	80	0.28	0.12	0.01		1.90
	60		99	7.81	50			0.54			0.95	
T-17 Effluent	42	17.2%	25	3.98	140	125	80	0.48	0.12	0.01		1.90
	60		50	3.90	35			0.13				
	60		99	7.81	50			0.21			0.95	
T-18 Effluent	42	17.2%	25	3.98	30	125	80	0.28	0.12	0.01		1.90
	60		99	7.81	50			0.54			0.95	
	Check:	100.0%										

Bottom V-Notch EL. (ft)	Max Clarifier Effluent W.L. EL. (ft)	Clarifier Effluent W.L. EL. (ft)	
15.50	15.42	**15.83**	FAIL!
15.34	15.26	**15.57**	FAIL!
15.34	15.26	**15.57**	FAIL!
15.34	15.26	**15.57**	FAIL!
15.34	15.26	**15.57**	FAIL!

Check water elevation in the chlorine contact tank effluent channel

	Line Size (in)	Flow Rate (MGD)	Velocity (ft/sec)	Pipe Entrance	Pipe Exit	Total Head (ft)
Single Mag Meter Losses	54	144	14.01	1.52	2.44	3.96

	Min Crest Elevation (ft)	Flow Rate (MGD)	Weir Length (ft)	Wier Head (ft)	MeterTank W.L. EL (ft)
Outfal Weir	7.00	144	11	2.43	9.43

Crest Contact Tank Effluent Weir Elevation (ft)	12.65
Max Outfall W.L. EL. Elevation (ft)	12.57
W.L. EL. Downstream of Contact Tank Weir (ft)	**13.39**

FAIL!

Check influent water elevation at the outfall structure

High Tide Elevation (ft)	3.2
Outfall Pipe Invert (ft)	-3

	Line Size (in)	Flow Rate (MGD)	Velocity (ft/sec)	Pipe Entrance	Pipe Expansion	Pipe Exit	Total Head (ft)
Triple Outfall Pipe Losses	42	48	7.72	0.46	0.04	0.92	1.42

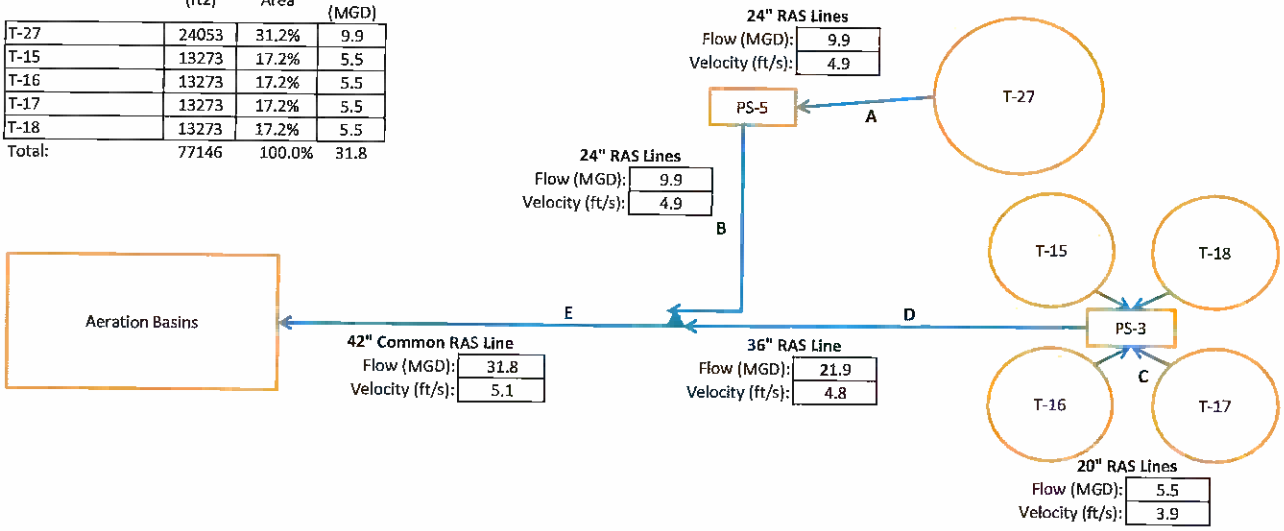
Crest Outfall Weir Elevation (ft)	7.00
W.L. EL. Downstream of Outfall Weir (ft)	**4.62**

OK!

Existing RAS Flow Analysis

Max Forward Flow	60	MGD
Recycle Ratio (α)	0.53	
Max Return Flow	31.8	MGD

	Area (ft2)	% Area	RAS Flow (MGD)
T-27	24053	31.2%	9.9
T-15	13273	17.2%	5.5
T-16	13273	17.2%	5.5
T-17	13273	17.2%	5.5
T-18	13273	17.2%	5.5
Total:	77146	100.0%	31.8

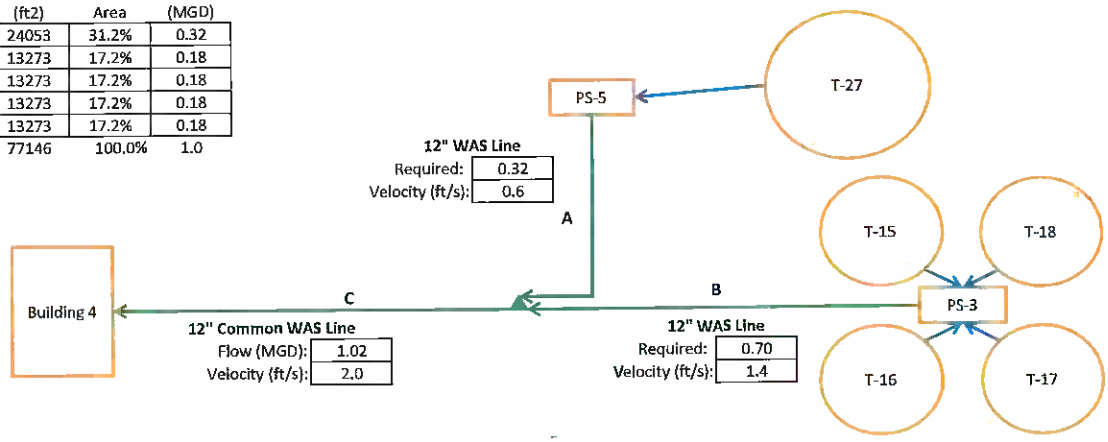


Forward Flow (MGD)	A		B		C		D		E	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	9.9	4.9	9.9	4.9	5.5	3.9	21.9	4.8	31.8	5.1
80	13.2	6.5	13.2	6.5	7.3	5.2	29.2	6.4	42.4	6.8
104	17.2	8.5	17.2	8.5	9.5	6.7	37.9	8.3	55.1	8.9
144	23.8	11.7	23.8	11.7	13.1	9.3	52.5	11.5	76.3	12.3

Existing WAS Flow Analysis

Max Forward Flow	60	MGD
Waste Ratio	0.017	
Max Return Flow	1.0	MGD

	Area (ft2)	% Area	RAS Flow (MGD)
T-27	24053	31.2%	0.32
T-15	13273	17.2%	0.18
T-16	13273	17.2%	0.18
T-17	13273	17.2%	0.18
T-18	13273	17.2%	0.18
Total:	77146	100.0%	1.0

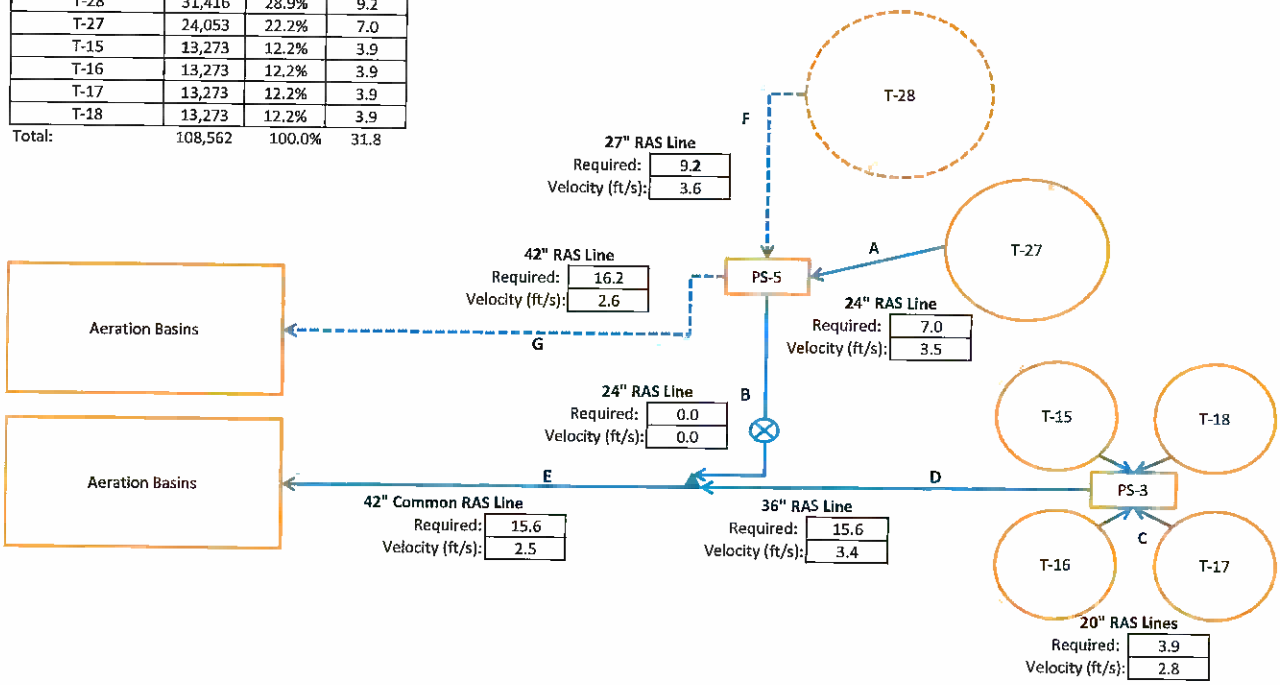


Forward Flow (MGD)	A		B		C	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	0.3	0.6	0.7	1.4	1.0	2.0
80	0.4	0.8	0.9	1.8	1.4	2.7
104	0.6	1.1	1.2	2.4	1.8	3.5
144	0.8	1.5	1.7	3.3	2.4	4.8

Proposed RAS Flow Analysis

Forward Flow	60.0	
Recycle Ratio (α)	0.53	
Max Return Flow	31.8	MGD

	Area (ft2)	% Area	RAS Flow (MGD)
T-28	31,416	28.9%	9.2
T-27	24,053	22.2%	7.0
T-15	13,273	12.2%	3.9
T-16	13,273	12.2%	3.9
T-17	13,273	12.2%	3.9
T-18	13,273	12.2%	3.9
Total:	108,562	100.0%	31.8

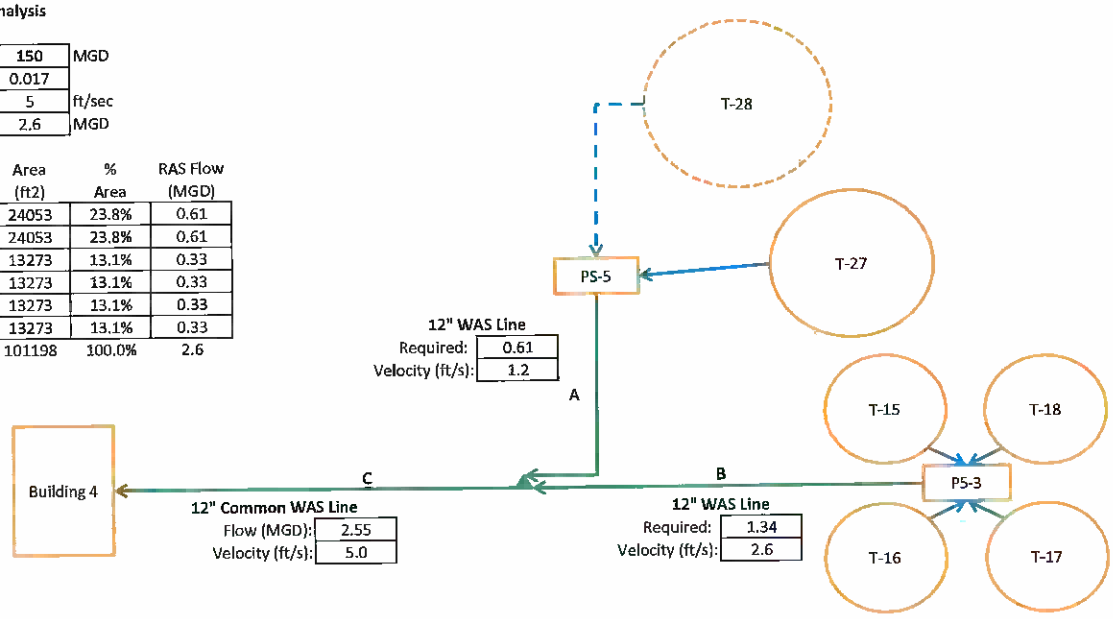


Forward Flow (MGD)	A		B		C		D		E		F		G	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	7.0	3.5	0.0	0.0	3.9	2.8	15.6	3.4	15.6	2.5	9.2	3.6	16.2	2.6
80	9.4	4.6	0.0	0.0	5.2	3.7	20.7	4.5	20.7	3.3	12.3	4.8	21.7	3.5
104	12.2	6.0	0.0	0.0	6.7	4.8	27.0	5.9	27.0	4.3	16.0	6.2	28.2	4.5
144	16.9	8.3	0.0	0.0	9.3	6.6	37.3	8.2	37.3	6.0	22.1	8.6	39.0	6.3

Proposed WAS Flow Analysis

Max Forward Flow	150	MGD
Waste Ratio	0.017	
Max Velocity	5	ft/sec
Max Return Flow	2.6	MGD

	Area (ft2)	% Area	RAS Flow (MGD)
T-27	24053	23.8%	0.61
T-27	24053	23.8%	0.61
T-15	13273	13.1%	0.33
T-16	13273	13.1%	0.33
T-17	13273	13.1%	0.33
T-18	13273	13.1%	0.33
Total:	101198	100.0%	2.6



Forward Flow (MGD)	A		B		C	
	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)	Flow (MGD)	Velocity (ft/s)
60	0.6	1.2	1.3	2.6	2.6	5.0
80	0.4	0.8	0.9	1.8	1.4	2.7
104	0.6	1.1	1.2	2.4	1.8	3.5

APPENDIX Q

Draft Feasibility Study for Pipe Repairs

- DELCORA Draft Feasibility Study for Pipe Repairs from M.H. 329 to M.H. 3070 and Combination Flow Mitigation for C.S.O. No. 18 dated December 23, 2016 prepared by Gilmore and Associates, Inc.

DRAFT

FEASIBILITY STUDY

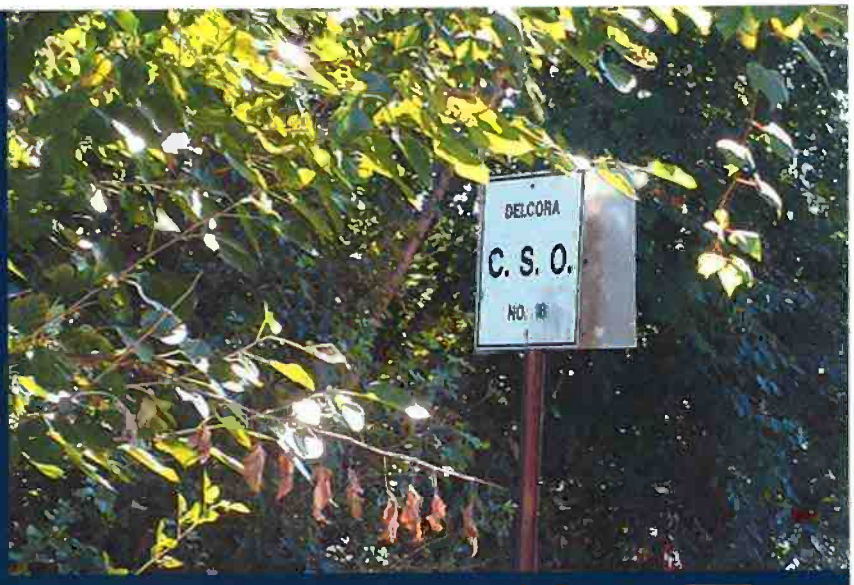
FOR

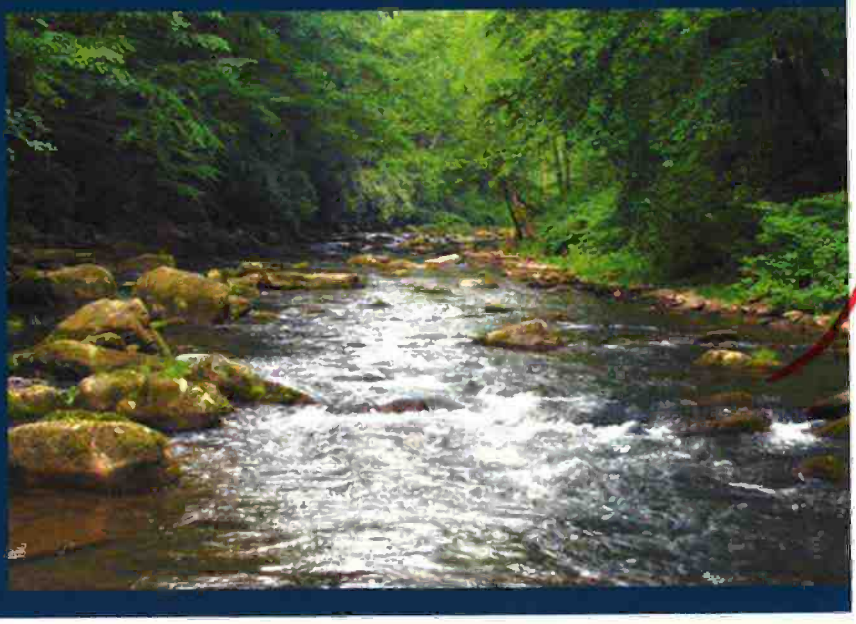
PIPE REPAIRS FROM

M.H. 329 TO M.H. 3070 AND

COMBINATION FLOW MITIGATION FOR

C.S.O. NO. 18





PREPARED FOR THE

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY

(DELCORA)

G&A PROJECT NO. 16-05053

DRAFT: DECEMBER 23, 2016

GILMORE & ASSOCIATES, INC.
ENGINEERING & CONSULTING SERVICES

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DRAFT

FEASIBILITY STUDY

FOR

PIPE REPAIRS FROM M.H. 329 TO M.H. 3070

AND COMBINATION FLOW MITIGATION FOR CSO 18

PREPARED FOR

Delaware County Regional Water Quality Control Authority
(DELCORA)
100 EAST FIFTH STREET
CHESTER, PA 19013

FILE NO. 16-05053

DRAFT: DECEMBER 23, 2016

PREPARED BY:

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FEASIBILITY STUDY FOR ELIMINATION OF CSO 18

1.0 INTRODUCTION

Gilmore & Associates, Inc. (G&A) has been tasked by the Delaware County Regional Water Quality Control Authority (DELCORA) with investigating the feasibility of removing the stormwater component of the overall sewer flow to Combined Sewer Outfall (CSO) 18. The combined sewer outfall is located on the southern side of the I-95 Bridge over Ridley Creek adjacent to the intersection of Hancock Street and Sun Drive. The removal of stormwater runoff to CSO 18 would permit the elimination of the CSO and permit the remaining sanitary sewer component of the CSO 18 sewer system to be introduced exclusively into the Ridley Creek Interceptor. A map of the general project area is shown in Figure 1. DELCORA has requested that options for redirecting stormwater flow toward both Ship Creek & Chester Creek and Ridley Creek be investigated for feasibility.

Currently, the combined sewer system that discharges to CSO 18 is extensive, with facilities extending to the southwest along I-95, through Widener University, along 13th Street and then northward on Providence Avenue to the vicinity of 22nd street. These facilities include a variety of separate storm sewer components and combined sewer components consisting of various materials, some dating back to the original development of the area. The CSO 18 storm drainage area crosses watersheds with the Providence Avenue portion being directed to Ridley Creek whereas Ship Creek & Chester Creek are the natural discharge points for stormwater runoff. The stormwater drainage area and combined sewer service areas connect to a 68"x43" reinforced concrete pipe (RCP) sewer main that serves as the primary collector of the CSO 18 system. This RCP main has signs of deterioration and is in need of repair in a key location beneath the I-95 highway.

Overall, the removal of CSO 18 from DELCORA's service area would serve to mitigate several issues that exist within the current infrastructure. The multiple benefits of the elimination of stormwater runoff flows from CSO 18 include: 1) reduction of sewage volume required to be conveyed by the Ridley Interceptor and associated conveyance appurtenances; 2) reduction of sewage requiring treatment at the treatment plant; 3) possible mitigation of the 68"x43" combined sewer pipe structural issues, and; 4) overall reduction of untreated combined sewage discharged into natural waterways from the DELCORA sewer network.

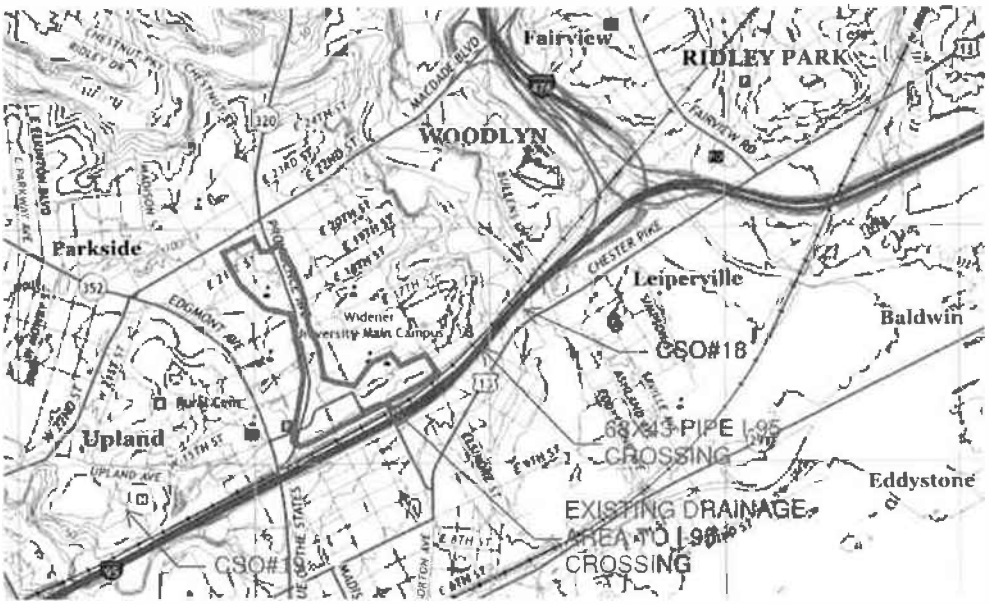

Figure 1 – Project Location Map (Excerpt from U.S.G.S. map)

DRAFT

2.0 PROJECT BACKGROUND

G&A was originally introduced to CSO 18 by DELCORA via our investigation of a structural issue within the 68"x43" sewer main located beneath I-95. However, the combination of potentially complex repair and mitigation options associated with that sewer crossing, and DELCORA's ongoing monitoring of the issue, led to a shift in focus from an immediate structural repair-only solution to a desire by DELCORA for a more comprehensive solution to address global issues inherent with the stewardship of operating and maintaining the current infrastructure considering both the pipe repairs and CSO elimination.

As with most infrastructures, the existing sewer system is subject to long and short term maintenance requirements and updating to meet the requirements of modern regulations and environmental protection standards. The complexity of these issues often hampers planning and global mitigation efforts, but the CSO 18 sewage network appears to contain a unique mix of existing elements that appear to allow for development of a workable solution.

One of the possible design solutions for mitigation involves redirecting storm runoff from Providence Avenue toward the original discharge point of CSO 19. For the preparation of this study, G&A was tasked with investigating portions of the CSO 19 network in order to help delineate the boundary between CSO 18 and 19 and help identify suitable routes for stormwater redirection.

G&A utilized several sources of information for this investigation. None of the sources were comprehensive and each provided only a small portion to add to understanding of the overall system. Two (2) site visits were made by G&A survey crews to determine the as-constructed existing conditions of the pipe networks. It should be noted that information gathered from these survey visits was limited by difficult site conditions including deep manhole depths, live and large active flows, inaccessible manhole lids, and oversized structures with limited access. These survey visits were completed

within a limited time frame for exploratory purposes only.

G&A utilized the following resources and site investigations to obtain information on the existing sewer system(s) within the studied areas of interest for this assignment:

- information provided by DELCORA for the I-95 crossing including video monitoring of pipe run between existing MH-329 and MH-3070;
- June 2, 2016 site visit and June 22, 2016 confined space entry into MH-3070 to investigate pipe condition issues within the I-95 crossing between MH-329 and MH-3070;
- GIS data files provided by DELCORA of their global conveyance network.
- construction plans for S.R. 1018 for original construction of I-95; procured though PennDOT;
- construction plans for S.R. 225, Section 17 (Providence Ave) for road widening and storm sewer improvements; procured through PennDOT;
- 9/14/2016 field survey of various sewer structures with observation of flow and pipe connections when possible;
- 10/5/2016 follow-up field survey of various sewer structures;
- various record plans and construction drawings procured from the Chester City Engineer's office;
- Lidar contour information available from GIS networks;
- aerial mapping provided by Delaware County.

G&A notes that this list is not comprehensive with regard to all information that may be available for the studied areas of interest. Additional information is required to develop a design solution for CSO mitigation and preparation of construction plans & specifications.

The following are descriptions of CSO 18 and CSO 19 networks as currently recognized by G&A:

3.0 GENERAL DESCRIPTION OF CSO 18 and ASSOCIATED FACILITIES

Upon review of the available information regarding CSO 18, networks of combined sewers were noted as being constructed in the early 20th century and generally followed street layout and drainage areas to Ridley Creek and the Delaware River. It appears that some of the local combined sewers in the 13th and Potter/Chestnut/Walnut Street areas may have extended south into 12th Street prior to the construction of the 68"x43" RCP sewer and I-95.

Construction plans for the PennDOT LR 225 project dated 1976-77 indicate that the original sewer system within Providence Avenue was a combined system and may have been connected to both CSO 19 and CSO 18. The improvement plan from this era shows road widening for Providence Avenue with a new separate storm sewer system that was then connected directly to the 68"x43" RCP run to CSO 18. The sanitary portion of the sewer remained within Providence Ave. PennDOT plans show an interconnection of sanitary sewer with both CSO 18 and CSO 19 (Sheet 22 of 29) but G&A field survey observations suggest that the sanitary flows are now directed toward CSO 19 only.

Earlier plans from 1973 indicate that a storm sewer system was installed along Potter Street from 18th Street north of 22nd Street. This system was connected to the Providence Street combined sewer and later tied into the LR 225 project's storm sewer of 1977.

Details contained in the PennDOT SR 1018 plans indicate that the 68"x43" sewer was constructed prior to installation of I-95. The depth of the existing pipe does not appear to have been modified by I-95 construction. Presumably, CSO 18 may have been created in its current form when the 68"x43" sewer was constructed. Although the construction date of the 68"x43" sewer is not identified on the construction plans, the size of this sewer suggests that local combined sewers along 13th Street, and between Potter and Walnut Streets, were connected to CSO 18 prior to I-95 construction.

A portion of the 68"x43" sewer runs between Widener University and the I-95 corridor. Limited information was available for the Widener University site, but the depth of the 68"x43" pipe and the deep cut of I-95 suggest that the southern side of Widener University drains to, and is serviced by, CSO 18.

4.0 GENERAL DESCRIPTION CSO 19 and ASSOCIATED FACILITIES

Similar to CSO 18, networks of combined sewers were constructed in the early 20th century within the CSO 19 drainage area that generally followed street alignment and Ship Creek/Chester Creek drainage areas to the Delaware River. The original eastern portion of the drainage area to CSO 19 appears to have included the Providence Avenue corridor as well as areas farther east near the Widener University Campus. Drainage areas to the north generally include 22nd Street, following Edgemont Ave. in the northwest direction. As previously mentioned, it appears that some of the local combined sewer runs in the 13th Street and Potter/Chestnut/Walnut Street areas may have extended south into 12th Street prior to the construction of the 68"x43" RCP sewer and I-95.

The following is a list of the known components of the CSO 18 combined sewer system. This list is based on information reviewed during this investigation:

1. CSO Regulator 18 and associated outfall to Ridley Creek;
2. the Ridley Creek sanitary sewer interceptor;
3. a 3,000+ foot 68"x43" elliptical RCP pipe, installed with the longer pipe axis in the vertical direction, running from the intersection of 13th Street and Providence Avenue to CSO Regulator 18. This pipe run is the main trunk line of CSO 18;
4. the crossing of the 68"x43" RCP under I-95;
5. the Providence Avenue separate storm sewer system and its connection to the 68"x43" RCP at Providence Avenue and 13th Street;
6. connection of storm and sanitary sewers to the 68"x43" RCP through the

original combined sewer system and within local streets located north of I-95 and east of Providence Avenue;

7. collection of stormwater runoff and sanitary sewage from the Widener University campus;
8. collection of sanitary sewage along Hancock Street, south of the I-95 crossing;
9. collection of stormwater runoff from street inlets along local streets south of the I-95 crossing;
10. connection of a small stormwater runoff network within I-95 that connects to the 68"x43".

The CSO 19 component investigation was limited to facilities along the Upland/14th Streets corridor. The following is a list of the known components of the CSO 19 combined sewer system. This list is based on information procured during this investigation.

1. Ship Creek and its man-made components;
2. CSO Regulator 19 and associated outfall to Ship Creek;
3. the Chester Creek East Interceptor;
4. the combined sewer main within Upland/14th Streets running from Providence Avenue to CSO 19;
5. separate storm facilities within Upland/14th Streets.

5.0 EVALUATION METHODOLOGY

5.1 3-D MODEL

For this study, G&A utilized existing records, survey information, GIS information, LIDAR contour information, and aerial mapping in conjunction with 3-dimensional (3-D) AutoCAD mapping to build a working digital model of existing features. The digital 3-D model is updated continually as new information is gathered, and this model is used as

a tool to evaluate multiple sources of information and create views of the various project conditions and constraints.

G&A evaluated the information that was available for this study to create a 3-D model of existing utilities within the project areas. Survey work performed by G&A was utilized to tie-in data points that were included in the various sources in order to normalize the vertical datum.

The 3-D model of existing utilities was combined with LIDAR and aerial information to create a working digital model and used as the basis for this engineering feasibility study. The working model was used to develop conceptual site plans and profiles to assist with feasibility evaluation. We note that the working model continues to evolve as additional information is obtained. Ideally, if a suitable solution for CSO mitigation is reached and funded, this model can serve as the basis for engineering design.

From the model created for DELCORA, drainage areas to specific points of interest were calculated and pipe sizes determined for feasibility of re-routing storm sewer along select alternate routes.

5.2 IDENTIFICATION OF STUDIED AREAS OF INTEREST

In order to evaluate options for CSO 18, the overall stormwater drainage area and sanitary sewage sources were studied for the areas affecting mitigation options.

Areas for the study included stormwater runoff drainage areas, overall sewer service areas, and pipe networks of CSO 18 as well as CSO 19, located to the west of Providence Avenue. Identification of these areas and layout of pipe networks within these areas were key components of this study. This information contributed to the determination of overall flows to CSOs, pipe sizes for alternate pipe runs, and potential routes for alternate pipe runs. Additionally, the separate storm and sanitary systems

that are located within E. 14th Street and run toward Maggie May's and the Widener ball field were considered during the evaluation. These systems are in the general vicinity of routing options for CSO 18 components.

Based on G&A's investigative effort to date, the areas contributing to CSO 18 appear to be bounded by (clockwise in plan-view starting at CSO 18) Hancock Street, the 68"x43" RCP I-95 crossing, the I-95 highway, Providence Avenue, Upland Avenue, 22nd Street, portions of the block between Walnut and Chestnut Streets, portions of Widener University, the I-95 highway and returning to CSO 18 at Sun Drive and Hancock Street. See Appendix B for additional information regarding this area.

CSO 19 is located within the headwaters of Ship Creek, which is a small tributary to Chester Creek. The CSO 19 drainage area shares its eastern drainage boundary with the western boundary of CSO 18.

5.3 IDENTIFICATION AND EVALUATION OF OPTIONS

Options for CSO 18 mitigation were developed with assistance from and in coordination with DELCORA and are based primarily on the information that was furnished for the study by both DELCORA and obtained G&A from other sources.

A list of options is contained in Section 7.0. Evaluation of each option includes the following considerations:

1. overall level of constructability;
2. overall cost potential;
3. future maintenance considerations;
4. potential permitting issues;
5. overall benefit with regard to DELCORA's consent decree.

6.0 MODEL LIMITATIONS

The working digital 3-D model of existing conditions is based upon limited information and is subject to verification in the field. Some of the known issues with information obtained as part of this study include:

- survey work completed for feasibility was performed on a cursory basis to gain an understanding of the general layout of existing conditions. Most of the structures identified in the field require confined space entry for detailed survey including sizing of structures, confirmation of inverts of pipe connections, sizes and types of connected pipes, information on internal weirs and possible plugs for abandoned pipe systems;
- reference plans obtained from the Chester City Engineer do not represent an exhaustive search of information available from the city records. A complete catalog of city record information was not available and information included in the model is based upon a limited amount of research time;
- some information obtained from the referenced sources conflicts with other information that is available and may not reflect as-constructed conditions. All information included in developing the model should be considered approximate at this feasibility study stage.

Issues for final design consideration include the following:

- full separation of sanitary facilities from the Providence Avenue separate storm sewer system has not been verified;
- historical plans and DELCORA GIS information do not provide definitive flow directions of stormwater runoff or flow directions from existing inlet connections for some areas. Areas of Chestnut Street, 17th Street and Upland Road north of Providence Avenue, but south of 18th Street, are currently areas where the least information is known or verified. The

feasibility study provides assumptions based on known information, but final design is dependent upon collection and evaluation of additional information;

- full connectivity and flow direction of the original combined sewer system within Providence Avenue is assumed to be toward CSO 19 based on DELCORA GIS records and visual observations made in the field. However, there is conflicting information on some of the reference plans that suggest some connectivity may exist with the CSO 18 system;
- a Pennsylvania One-Call notification was made by G&A for feasibility purposes and to help identify major utility conflicts. However, the 3-D model does not include a full investigation of non-sewer utilities such as gas, water, communications, electric and other miscellaneous services that may be present. Additional investigation is required for final design;
- configuration of historical CSO conditions in the vicinity of Upland Avenue and Ship Creek is unknown. This could potentially affect layout of the Route B option.

7.0 PROJECT MITIGATION OPTIONS

Current project direction was driven in part by mitigation options that were investigated for the initial structural issue at the 68"x43" RCP I-95 crossing. Further coordination with DELCORA evolved into including storm re-routing along "Route A" and "Route B" as generally described in Appendix A.

Overall, in order to meet the design goal of CSO 18 elimination, separation of storm runoff is required from any flow that enters the Ridley Creek Interceptor. Route A and Route B were proposed by DELCORA as possible routes for separation of stormwater from the CSO 18 sanitary flow. DELCORA also expressed an interest in eliminating the 68"x43" RCP I-95 crossing altogether. In pursuit of a workable solution the following project mitigation options were considered for storm and sanitary discharge flow within the CSO 18 drainage area:

7.1 DESCRIPTIONS OF MITIGATION OPTIONS

A. The following mitigation options for sanitary sewage separation were considered:

Option 1 - Remove sanitary flow from the 68"x43" sewer main at MH 329 and re-route in a northerly direction to the existing separate sanitary sewer within E 14th Street.

Option 2 - Remove sanitary flow from the 68"x43" sewer main via a pump station, and lift to a point along E 14th Street to the existing separate sanitary sewer within E 14th Street.

Option 3 - Remove storm sewer runoff from the 68"x43" sewer main and route sanitary sewage through the existing 68"x43" RCP I-95 crossing via a new 8" or 12" sanitary sewer installed and grouted within the existing pipe.

B. The following storm sewer separation options were investigated with discharge to Ridley Creek:

Option 4 - As shown in Appendix A, remove storm runoff from the 68"x43" sewer main from a point east of Walnut Street and re-direct along Melrose Avenue to E 14th Street, and then along E 14th Street down to Ridley Creek to a point near the existing I-95 storm outlet located just north of the railroad bridge (a/k/a "Route A").

Option 5 - Remove storm runoff from the entire existing CSO 18 drainage area from the 68"x43" sewer main and re-direct along Melrose Avenue, similar to and following the route described in Option 4.

Option 6 - Separation of storm runoff from the existing 68x43" sewer main above MH329 and place a second pipe, only for storm runoff conveyance, above the new separate sanitary sewer conduit described in Option 3 to fully utilize the existing 68"x43" RCP I-95 crossing and address the existing structural issue. A new storm conduit would be run along Hancock Street to convey the I-95 crossing flows as well as those introduced within Hancock St. The existing headwall along Ridley Creek would be utilized for outfall. Route B would be used in order to limit pipe size for this Option and raise the invert to work with the proposed I-95 crossing modification.

C. The following options are storm routings along Route B. Note that installation of additional storm pipes may be required along Upland Ave and Walnut Streets to separate storm runoff from combined sewers contained in these streets:

Option 7 - Route B as shown in Appendix A without additional separation area from CSO 19.

Option 8 – Option 7 with revised storm runoff routing to follow Upland St. to a discharge point within Ship Creek.

Option 9 – Option 8 including the additional CSO 19 separation drainage area as depicted in Appendix A. There is limited information available for this area at this time. However, a larger pipe size will be necessary than that required for Option 7 and Option 8.

D. The following option is for structural repair of the 68"x43" RCP I-95 crossing only, with no combined sewer flow mitigation other than within the partially collapsed RCP between M.H. 329 and M.H. 3070:

Option 10 – Repair and rehabilitation of the existing 68"x43" RCP crossing under I-95 between M.H. 329 and M.H. 3070. This option includes installation of two

(2) doghouse manholes at strategic locations, to be determined via a detailed study, between existing M.H. 329 and M.H. 3070 and probable modification of both existing manholes to facilitate construction of repairs and rehabilitation of the existing 68"x43" RCP I-95 crossing. Temporary bypass of the sanitary sewer flow will be required during construction of the expected repairs. It is anticipated that the temporary bypass system will be installed within the existing 68"x43" RCP after the pipe is temporary shored internally (and externally where necessary). The existing pipe will be repaired, new casing pipes will be installed and the remaining annular space will be fully grouted between the exterior of the casing pipes and the interior of the existing 68"x43" RCP for the full length of this pipe run between M.H. 329 and M.H. 3070. Significant traffic control will be required along with coordination with the County, City of Chester, the railroad, local property owners, businesses and Widener University. Jurisdictional agency permitting will be required.

7.2 OPTION EVALUATION

Option 1

This option includes removing sanitary sewage flows from MH-329 and re-routing flow via a new gravity sewer to an existing separate sanitary sewer system within E 14th Street.

Pros

This routing would eliminate the need for sanitary sewage to be discharged through the 68"x43" RCP under I-95.

Cons

This option does not appear to be desirable or cost-effective based on the elevations of sanitary services located within the CSO 18 drainage area when compared to the elevation of sanitary facilities within E 14th Street.

Current Study Status

Other sanitary sewage options appear to be less costly and more feasible.

Option 2

This option introduces a pump station to re-route sanitary sewage flows to E. 14th Street and down to DELCORA's existing separated sanitary sewer.

Pros

This option would eliminate the need for sanitary sewage to be discharged through the 68"x43" RCP under I-95.

Cons

Currently, the volume of sanitary sewage required to be lifted via pump station is unknown. Portions of the existing separate system within E. 14th Street would require detailed assessment for adequacy to convey additional flows.

Current Study Status

This option adds long term operations and maintenance costs to the system with the introduction of a pump station. Additional information is required for comprehensive assessment.

Option 3

This option includes making no changes to the conveyance of sanitary sewage except maintaining the existing 68"x43" RCP I-95 crossing with a repair including am 8" to 12" sanitary sewer pipe grouted within the existing 68"x43" main and revising the CSO 18 regulator to eliminate the existing storm outfall to Ridley Creek.

Pros

This option appears to be relatively simple. Grouting of the existing 68"x43" RCP I-95 crossing may be robust enough to reduce long term maintenance issues to tolerable levels.

Cons

Pipe size for sanitary sewer must be verified. The 68"x43" RCP I-95 crossing will remain.

Current Study Status

This is currently the recommended sanitary sewer mitigation option.

Option 4

This option includes collecting overland storm runoff from the parking area behind the Widener University Center and Residence Hall/ROTC building that is located adjacent to I-95 and providing conveyance along Route A. Also, this option would intercept existing conduits that collect drainage from the Widener University grounds.

Pros

The stormwater drainage area is small enough to limit the required size of pipe to 30". Connection to existing conveyance pipes is currently unknown, but connections will be limited to conveyance pipes located behind the referenced Widener Buildings making re-routing of the storm water drainage relatively easy. This option would eliminate the requirement for storm runoff to be directed through the existing 68"x43" RCP I-95 crossing.

Cons

The elevation of the Widener parking lot lowers the overall proposed storm system to a depth that will require shallow pipe slope and 15 ft. – 20 ft. deep cuts in some locations along Melrose Avenue and portions of E. 14th Street. The proposed pipe installation along this route may be hampered by clearance issues at the low end of E. 14th Street (near Maggie May's) and there appears to be a difficult pinch point along the access road to Ridley Creek created by the recently constructed Widener ball field, the Railroad Right-of-Way and two existing sewer conduits - one that conveys I-95 storm runoff and one that conveys separate City sanitary sewage. Also, a new outfall at Ridley Creek may be difficult to permit and construct based upon the steep embankments and existing erosion that are present.

Current Study Status

This option is included in the overall alternate analysis but is currently not preferred over Option 6.

Option 5

This option is similar to Option 4 except that the entire existing CSO 18 drainage area was considered to be conveyed along Route A.

Pros

This option may eliminate the need for Route B to be considered. This option would eliminate the requirement for storm runoff to be directed through the existing 68"x43" RCP I-95 crossing.

Cons

The pipe size required would most likely be large, 54" or 60", and the routing limitations may not permit this large pipe size. A much lower pipe invert would be needed to capture the Providence Avenue system thus increasing the depth of cuts required to install new conduit.

Current Study Status

This option appears to be less desirable than other studied options due to routing and pipe size limitations.

Option 6

This option is similar to Option 4, but includes expanding on the re-use of the existing 68"x43" RCP I-95 crossing and utilization of the existing Ridley Creek outfall in lieu of re-routing storm runoff to E. 14th Street and a new outfall near the ball field.

Pros

Proposed storm pipe size and length is minimized compared to the original Route A; disturbance to residential streets is minimized; re-use of existing outfall will minimize permitting for the Ridley Creek outfall; existing storm sewer within Hancock St. can be replaced with the proposed system.

Cons

Existing 68"x43" RCP I-95 crossing will remain.

Current Study Status

This is currently one of the recommended storm water re-routing options.

Option 7

This option includes re-directing the Providence Ave. storm water system and the storm runoff component of Upland St. and Walnut St. toward Ship Creek via E. 14th Street.

Pros

Providence Avenue runoff would be directed back toward Ship Creek/Chester Creek which appears to replicate the original design of the Providence Ave. storm water system. This routing minimizes construction issues for storm routing toward Ridley Creek.

Cons

It is currently unknown to what extent permitting will be required for this storm water re-direction. FEMA computations for Chester/Ridley Creek may or may not already account for this runoff direction within the "AE" flood zone areas shown on current Flood Insurance Rate Maps (FIRMs). A detailed study is necessary to evaluate this storm flow component for the studied drainage area. The route along 13th Street includes private property and will most likely require easements.

Current Study Status

Option 8 appears to be more desirable.

Option 8

This option is similar to Route B shown in Appendix A but with a routing less likely to require easements and less right-of-way conflicts.

Pros

Same as Option 7 with fewer easement and/or right-of-way conflicts.

Cons

Same as Option 7

Current Study Status

This is currently a recommended option, but additional information is needed to study and address potential FEMA issues.

Option 9

This option adds the "Potential Additional Separation Area" noted for Route B as shown in Appendix A.

Pros
Additional drainage area will be removed from CSO 18 or CSO 19

Cons
The extent of existing facilities and prospective connections are unknown at this time.

Current Study Status
Larger pipe sizes can be used to accommodate more drainage runoff in this direction. More information is required. A detailed study is needed.

Option 10

This option considers repairs, rehabilitation to the partially collapsed 68"x43" RCP I-95 crossing and separation of combined flow only within the existing RCP from M.H. 329 to M.H. 3070.

Pros
This option is the least immediate cost option; combined flow will be separated within the existing pipe; the fully grouted 68"x43" RCP will be relatively maintenance-free after it is repaired and grouted. Storm and sanitary flows are separated within the 68"x43" I-95 crossing and can be conveyed downstream from M.H. 3070 in separate storm water and sanitary sewer if and when that combined flow is eventually separated.

Cons
Combined flow will only be separated within the existing 68"x43" RCP I-95 crossing; extensive traffic control will be necessary particularly at and near the existing M.H. 329 and M.H. 3070 as well as at I-95 and streets feeding I-95; confined space requirements apply for the project; equipment access is restricted; jurisdictional agency, County, State, Federal & Local coordination and approvals are necessary; storm water & sanitary sewer are still conveyed under I-95.

Current Study Status
Detailed information for the pipe sizes for carrier and casing pipes is needed for both the storm water and sanitary sewer pipes. This Option is considered to be a

recommended Alternate due to its least-cost status. A "no Action" option is not viable since the existing pipe is partially collapsed and in need of repair and rehabilitation.

The following includes additional commentary regarding select sanitary and storm sewer Options:

Option 3

Assuming stormwater flow is removed from MH 329, the structural issue within the 68"x43" RCP I-95 crossing can be mitigated by grouting-in a smaller pipe that will accommodate sanitary sewer flows only. This option will require but minimize disruption to the traveling public that use the I-95 corridor. Grouting of the existing pipe will improve the strength of the crossing to a point that future maintenance costs will be reduced as well.

Option 4

From initial feasibility evaluation computations, storm runoff from Route A areas can be conveyed within a single 30" HDPE pipe installed at a minimum of 0.005 ft/ft slope, or a 24" HDPE pipe with a minimum of 0.015 ft/ft slope. With regard to the original "Route A", it appears that such a pipe could be routed via the originally suggested alignment.

However, there are several design, construction and cost issues associated with this mitigation option. Given the elevation of the Widener University Center parking area, the upstream end of the new storm sewer would need to be set at an elevation of approximately 46 ft. Using the 30" HDPE and 0.005 ft/ft slope there would be an extended length of significant trench cut within Melrose Ave. and E 14th St. Excavation depths up to 20 feet +/- with temporary shoring would be required along the collector road and residential street.

The existing condition from Maggie May's to Ridley Creek is such that there may be obstruction issues with existing pipe systems that include a PennDOT storm main and DELCORA sanitary sewer main that connects to the Ridley Interceptor. It also appears

that a recently constructed ball field for Widner University encroaches upon the sewer right(s)-of-way in that area. The ball field, railroad right-of-way and embankment taper to approximately 10 ft to 15 ft for a limited distance (see Figure 2), further restricting access at this location.

Attempting to abate or resolve the issues mentioned above will increase costs and reduce the desirability of proceeding with Option 4.

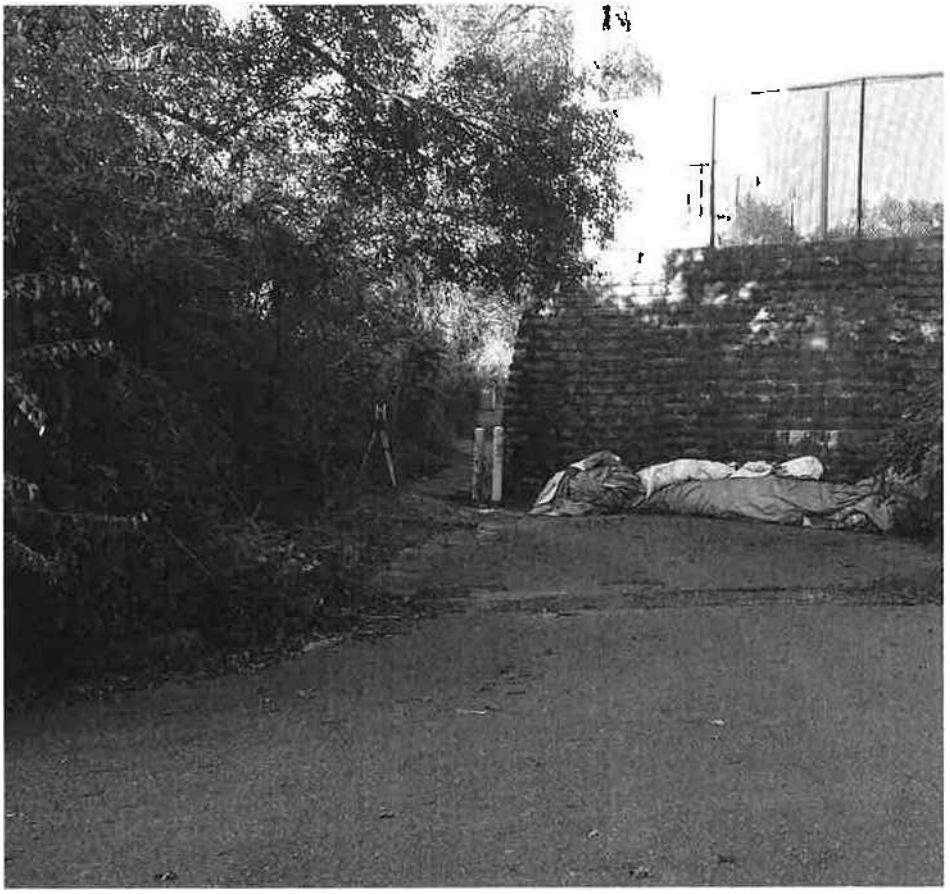

Figure 2 – View from Ridley Creek of ball field/Railroad R.O.W. Restriction for Route A (Option 4)

Option 6

This alternate is similar to Option 4 from Walnut Street to Melrose Avenue. At this point, the proposed route heads toward MH 329 and the existing 68"x43" RCP I-95 crossing. Utilizing a 24" pipe with 0.015 ft/ft slope, it is possible to select a route to place the proposed pipe through the existing 68"x43" RCP I-95 crossing. Additionally, an alternate sanitary sewer pipe of 8"-12" diameter will fit in the same existing I-95 crossing while maintaining virtually the same existing route towards Ridley Creek. New manholes adjacent to MH-329 and MH-3070 would serve as introduction and removal points for the proposed stormwater conduit. Along Hancock Street, this alternate could replace the existing separate stormwater pipes and ultimately utilize the existing CSO 18 outfall along Ridley Creek.

Option 8

Storm sewer runoff toward Route B is anticipated to include (as shown on the Overall Site Plan in Appendix B):

1. storm runoff from the combined sewer system within Potter and Walnut Streets;
2. the existing storm sewer system within Providence Avenue.

From initial feasibility evaluation computations, storm runoff from these areas can be conveyed within a single 48" RCP pipe installed at a minimum of 0.015 ft/ft slope. The initial pipe run from Walnut Street to Upland Street can be conveyed within a 36" diameter at a minimum slope of 0.005 ft/ft.

With regard to "Route B", it appears that such a pipe could be routed utilizing the originally suggested alignment with the exception that Upland Street would be included as part of the proposed alignment in lieu of W. 13th Street.

The outlet of this pipe would be near the original regulator for CSO 19 and within the portion of Ship Creek that remains an open channel.

Note that the introduction of new storm flow to Ship Creek/Chester Creek may potentially increase flood levels in those waterways during certain flood stages. Further investigation is needed to verify FEMA flood computations provided in the FEMA Flood Insurance Study (FIS) and determine what drainage areas were utilized in the preparation of the current Flood Rate Insurance Maps (FIRM). With the re-routing of storm runoff from Route B serving to potentially restore the natural drainage areas, it is possible that the current FIRM may be based upon the assumption that the storm flow from Route B already reaches the proposed location.

8.0 SELECT ALTERNATE ASSESSMENT

From the list of mitigation options and initial option evaluation, select sanitary and storm routing options have been identified as preferred methods for mitigation. More than one option is required in order to achieve full mitigation for CSO 18. Two separate groups of preferred options are combined under Alternate 1 and Alternate 2. These alternatives may provide for full mitigation at CSO 18. For comparison purposes, an additional Alternate 3 is also included for consideration as a least-cost option. Alternate 3 differs from the first two in that it is not a full CSO mitigation option and is limited to be a solution to the structural issue at the existing 68"x43" I-95 crossing. Conceptual layout for the options utilized in Alternate 1 and Alternate 2 are depicted on plans included in Appendix B.

The following is a general description of each Alternate:

Alternate 1

This alternate includes Option 3, Option 4 and Option 8. The target outcome of Alternate 1 is CSO 18 mitigation by removing stormwater inflow from the existing

68"x43" combined sewer main via "Route A" and "Route B" with storm discharge to Ridley Creek and Ship Creek, respectively.

As referenced in Appendix B, the overall scope of work includes removal of Providence Avenue stormwater flow as well as storm flow from the existing local street combined sewer system and conveyance to a new endwall within Ship Creek via either a new 36"or 48" separate storm pipe installed within 13th Street and Upland Street. This referenced inflow area comprises the overall stormwater drainage area of CSO 18 west of Chestnut Street, shown on Sheet 2 of G&A mitigation plans with green hatching. The work scope also includes removal of stormwater runoff from the Widener University area (depicted as red hatched area on Sheet 2) and conveyance via a new 30" conduit along Melrose Avenue, down 14th Street, and through the access road adjacent to the Widener ball field to a new stormwater outfall at Ridley Creek. Additional right-of-way may be required as well as a structural solution to support the encroaching ball field retaining wall along the access road. Route A is depicted in red on Sheet 2.

Sanitary sewage would remain within the existing 68"x43" sewer main. Structural mitigation of the existing partially collapsed 38"x43" RCP I-95 crossing would include introduction of a smaller sized pipes installed within the existing RCP to be sized for existing sanitary flow and grouted into the RCP pipe as a permanent structural repair.

Stormwater within Hancock Street would be redirected to the existing the CSO 18 outfall within the Ridley Creek stream.

The existing CSO regulator would be abandoned or modified to include sanitary sewer outflow exclusively to the Ridley Interceptor.

Alternate 2

This alternate includes Option 3, Option 6 and Option 8. The target outcome of Alternate 2 is CSO 18 mitigation via removal of stormwater inflow from the 68"x43" combined sewer main via a revised "Route A" and "Route B" with stormwater discharge to Ridley Creek and Ship Creek, respectively.

Sanitary sewage would remain within the existing 68"x43" sewer main. Structural mitigation of the existing partially collapsed 38"x43" RCP I-95 crossing would include introduction of a smaller sized pipes installed within the existing RCP to be sized for existing sanitary flow and grouted into the RCP pipe as a permanent structural repair.

As referenced in Appendix B, the work scope includes removal of Providence Avenue stormwater flow as well as stormwater flow from the existing local street combined sewer system and conveyance to a new endwall within Ship Creek via either a new 36" or 48" separate stormwater pipe installed within 13th Street and Upland Street. This referenced inflow area comprises the overall stormwater drainage area of CSO 18 west of Chestnut Street, shown on Sheet 2 of G&A mitigation plans with green hatching. The work scope also includes also includes remove storm runoff from the Widener University area (depicted as the red hatched area on Sheet 2) and conveyance via a new 24" pipe

installed adjacent to the existing 68"x43" sewer main route to a new manhole located adjacent to existing MH 329. The new 24" pipe would then run above the referenced grouted-in sanitary pipe within the existing 68"x43" RCP I-95 crossing and then out to a new manhole located adjacent to existing MH 3070. Re-aligned stormwater pipe would then replace the existing 15" stormwater pipe located within Hancock Street, with new connections for runoff from existing Hancock St., and be routed to the existing CSO 18 outfall. This revised Route A is depicted in blue on Sheet 2.

Stormwater within Hancock Street would be redirected to the existing CSO 18 Endwall within the Ridley Creek stream bank.

The existing CSO regulator would be abandoned or modified to include sanitary sewer outflow exclusively to the Ridley Interceptor.

Alternate 3

This alternate includes Option 10. The target outcome of Alternate 3 includes Structural repairs to partially collapsed 68"x43" RCP at I-95 crossing and combined flow separation in the existing partially collapsed 68"x43" RCP main as part of the repair procedure for this pipe.

Two (2) doghouse manholes would be installed at strategic locations between existing MH 329 and MH 3070 as determined during the design phase for repairs to the existing partially collapsed 68"x43" RCP main. Temporary supports and shoring would then be installed within the existing partially collapsed 68"x43" RCP main. Sanitary sewage

would be temporarily bypassed through a system installed within the existing 68"x43" RCP main so that a new 12" diameter sewer main could be installed within the existing 68"x43" RCP main. The existing 68"x43" RCP main would then be partially grouted to an elevation approximately 6" higher than the top of the new 12" diameter sanitary sewer pipe. A storm sewer pipe would then be installed at an elevation above the 12" diameter pipe. After completing this storm sewer pipe installation, the remaining annular space within the 68"x43" RCP main would be grouted solid. This flow separation would eliminate combined flow within the existing 68"x43" RCP main and serve as the permanent repair to the partially collapsed existing 68"x43" RCP main.

Operation and Maintenance Statement

Future operation and maintenance costs of all three alternatives are anticipated to be similar to existing with the following exceptions:

- the existing 68"x43" RCP I-95 crossing, by virtue of fully-grouting the RCP around the proposed storm and sanitary pipes the repaired RCP, is expected to provide a 100+ year usable life.

- elimination of stormwater flow through existing CSO 18 pipes will be a benefit to future operation and maintenance costs of the sanitary sewer system.

9.0 FEASIBILITY STUDY RECOMMENDATIONS

After review of all of the received documents, known parameters, preliminary calculations, and mitigation options, G&A recommends that Alternate 2 be pursued by DELCORA for further consideration and design. The corresponding stormwater options for this Alternate are depicted in Blue and Green on the plans provided in Appendix B.

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10.0 ESTIMATED COSTS

Estimated costs for the three alternates are as follows:

Alternate 1

$5.5-$6.5 million

Alternate 2

$4.5-$5.5 million

Alternate 3

$2.5-$3.4 million

These estimated costs are based upon the current value of construction and projected forward through December 31, 2018. No additional escalation is accounted for in the estimates. Costs of permits and other fees paid to the jurisdictional agencies are excluded from the cost estimate. Taxes are not included.

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11.0 STUDY CRITERIA AND ASSUMPTIONS

- unknowns of the existing storm and sanitary facility locations and depths of system components as described in the full report;
- unknown locations of all other existing utilities and potential conflicts for proposed routing Alternates;
- unknown resolution of flood elevation status of Chester Creek and whether Route B can, or must be, justified through: A) existing FEMA Flood Insurance Study means and methods; B) additional Hydrologic and Hydraulic study; C) storage and attenuation of proposed storm discharge from Route B;
- the potential for environmentally sensitive issues (wetlands, bog and/or red-belly turtles, plant species, etc. that may be uncovered with a PNDI search and/or additional site investigation) within Ship Creek that would need mitigation;
- study of the existing enclosed portion of Ship Creek located under the existing railroad and I-95 for flows introduced from Route B;
- acceptance (or lack of acceptance) of new stormwater facilities for dedication to the City of Chester;
- unknown extent of lands (if any) that would require acquisition of right-of-way, construction and/or permanent easements, etc., in order to carry out any of the studied options or alternates;
- granting of applicable jurisdictional agency permits that are required to perform the work contemplated within this study;
- permission of PennDOT, USDOT and affected municipalities to perform the work

via detours, lane outages, lane and ramp restrictions, redirection of traffic, temporary traffic control and work zone traffic control, as may be required to complete the project on and under I-95, Providence Road and local collector roadways;

- permission of the railroad to perform work at or near their facilities;
- permission of local property Owners and Widener University to perform the work contemplated within and/or adjacent to their properties;
- anticipated extensive coordination with existing utility owners and service providers to avoid facility conflicts, obstructions and service interruptions;
- anticipated extensive coordination with local businesses and the general public regarding the project and potential impacts to the local community and traveling public.

DRAFT EXECUTIVE SUMMARY REPORT

OF

FEASIBILITY STUDY FOR PIPE REPAIRS FROM M.H. 329 TO M.H. 3070 AND COMBINATION FLOW MITIGATION FOR CSO 18

PREPARED FOR

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY (DELCORA)
100 EAST FIFTH STREET
CHESTER, PENNSYLVANIA

FILE NO. 16-05053

DRAFT: DECEMBER 23, 2016

PREPARED BY:

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1.0 ISSUE STATEMENT

DELCORA is assessing corrective measures to repair a structural failure issue within a partially collapsed combined sewer main located within the combined sewer system tributary to the outfall designated by DELCORA as CSO 18. The structural issue is located within a portion of a 68"x43" reinforced concrete sewer main that crosses below route I-95.

CSO 18 includes storm runoff from a drainage area of approximately 78 acres and includes sanitary service inflows collected from Providence Avenue to Ridley Creek within an approximate corridor bounded to the north and south by 14th Street & Hancock Street. The CSO 18 area main facility components include:

- the 68"x43" RCP sewer main;
- a combined sewage regulator located at Hancock and Sun Streets;
- the Ridley Creek sewage interceptor;
- the CSO 18 overflow outfall into Ridley Creek;
- inflow networks including:
    - the Providence Avenue storm sewer network;
    - historic combined sewer networks within local streets that connect to the 68"X43" combined sewer main;
    - storm and sanitary connections from Widener University including lawn and parking lot inlets on University grounds.

Gilmore & Associates, Inc. has been tasked with investigating possible solutions to repair structural issues within the I-95 crossing of the 68"x43" main as well as possible elimination of CSO 18. Solutions to be investigated include a structural repair limited to the subject sewer main and possible mitigation (removal) of the entire CSO 18 network by separating storm and sanitary sewer components in accordance with the Consent Decree among DELCORA, the US EPA and the PA DEP.

Several options for mitigation of sanitary sewage flow and stormwater runoff separation have been identified as described in the full report. Three (3) select Alternates are provided herein that combine preferred options from the full report together in order to provide mitigation scenarios that are currently the most feasible based upon our investigation to date.

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2.1 ALTERNATE 1 - ROUTE A AND ROUTE B STORMWATER SEPARATION

TARGET OUTCOME

CSO 18 mitigation through removal of stormwater inflow from 68"x43" combined sewer main via "Route A" and "Route B" with storm discharge to Ridley Creek and Ship Creek, respectively.

STUDIED SOLUTION

Option 3, Option 4 and Option 8 from the Feasibility Study

Remove Providence Avenue storm network flow as well as storm flow from the existing local street combined sewer system and convey to a new endwall within Ship Creek via a new 36"/48" separate sewer along 13th Street and Upland street. This referenced inflow area comprises the overall stormwater drainage area of CSO 18 west of Chestnut Street shown on Sheet 2 of G&A mitigation plans with green hatching. Remove storm runoff from the Widener University area (depicted as red hatched area on Sheet 2) and convey via a new 30" conduit along Melrose Avenue, down 14th Street, and through the access road adjacent to the Widener ball field to a new storm endwall at Ridley Creek. Right of way may be required and/or a structural solution to the encroaching ball field retaining wall along the access road. Route A is depicted in red on Sheet 2.

Sanitary sewage would remain within the existing 68"x43" sewer main. I-95 crossing structural mitigation would include introduction of a smaller sized conduit within the crossing to be sized for existing sanitary flows and grouted into the larger pipe as a permanent structural fix.

Stormwater within Hancock Street would be rerouted to the existing CSO 18 Endwall within the Ridley Creek bank.

The existing CSO regulator would be abandoned or revised to include outflow exclusively to the Ridley Interceptor.

ESTIMATED COST RANGE (PRELIMINARY)

$5.5 million to $6.5 million

END OF ALTERNATE 1 SUMMARY

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2.2 ALTERNATE 2 – REVISED ROUTE A AND ROUTE B STORMWATER SEPARATION

TARGET OUTCOME

CSO 18 mitigation through removal of stormwater inflow from 68"x43" combined sewer main via a revised "Route A" and "Route B" with storm discharge to Ridley Creek and Ship Creek, respectively.

STUDIED SOLUTION

Option 3, Option 6 and Option 8 from the Feasibility Study

Sanitary sewage would remain within the existing 68"x43" sewer main. I-95 crossing structural mitigation would include introduction of a smaller sized conduit within the crossing to be sized for existing sanitary flows and grouted into the larger pipe as a permanent structural fix.

Remove Providence Avenue storm network flow as well as storm flow from the existing local street combined sewer system and convey to a new endwall within Ship Creek via a new 36"/48" separate storm sewer along 13th Street and Upland street. This referenced inflow area comprises the overall stormwater drainage area of CSO 18 west of Chestnut Street shown on Sheet 2 of G&A mitigation plans with green hatching. Remove storm runoff from the Widener University area (depicted as red hatched area on Sheet 2) and convey via new 24" conduit adjacent to the existing 68"x43" sewer main route to a new manhole located adjacent to existing MH 329. The new 24" conduit would then run above the referenced grouted-in sanitary pipe within the I-95 crossing and then out to a new manhole located adjacent to existing MH 3070. New conduit would then replace the existing 15" storm pipe located within Hancock Street, with new connections for existing Hancock St. runoff, and be routed to the existing endwall of CSO 18. This revised Route A is depicted in blue on Sheet 2.

Stormwater within Hancock Street would be rerouted to the existing CSO 18 Endwall within the Ridley Creek bank.

The existing CSO regulator would be abandoned or revised to include outflow exclusively to the Ridley Interceptor.

ESTIMATED COST RANGE (PRELIMINARY)

$4.5 million to $5.5 million

END OF ALTERNATE 2 SUMMARY

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2.3 ALTERNATE 3 - I-95 CROSSING SOLUTION WITH NO CSO MITIGATION

TARGET OUTCOME

Combined flow separation in the existing partially collapsed 68"x43" RCP main as part of the repair procedure for this pipe. Structural repairs to partially collapsed 68"x43" RCP at I-95 crossing

STUDIED SOLUTION

Two (2) doghouse manholes would be installed at strategic locations between existing MH 329 and MH 3070 as determined during the design phase for repairs to the existing partially collapsed 68"x43" RCP main. Temporary supports and shoring would then be installed within the existing partially collapsed 68"x43" RCP main. Sanitary sewage would be temporarily bypassed through a system installed within the existing 68"x43" RCP main so that a new 12" diameter sewer main could be installed within the existing 68"x43" RCP main. The existing 68"x43" RCP main would then be partially grouted to an elevation approximately 6" higher than the top of the new 12" diameter sanitary sewer pipe. A storm sewer pipe would then be installed at an elevation above the 12" diameter pipe. After completing this storm sewer pipe installation, the remaining annular space within the 68"x43" RCP main would be grouted solid. This flow separation would eliminate combined flow within the existing 68"x43" RCP main and serve as the permanent repair to the partially collapsed existing 68"x43" RCP main.

ESTIMATED COST RANGE (PRELIMINARY)

$2.5 million to $3.4 million

END OF ALTERNATE 3 SUMMARY

DRAFT

3.0 OPERATION &MAINTENANCE STATEMENT

Future operation and maintenance (O&M) costs of all three alternates are anticipated to be similar to the existing O&M costs with the following exceptions:

- The I-95 crossing, by virtue of installation of new carrier pipes and fully grouting the existing 68"x43" RCP main, is expected to provide a 100+ year usable life for this component of the system,.

- Elimination of stormwater flow through existing CSO 18 conduits will likely reduce future O&M costs of the sanitary sewer system.

DRAFT

4.0 STUDY CRITERIA AND ASSUMPTIONS

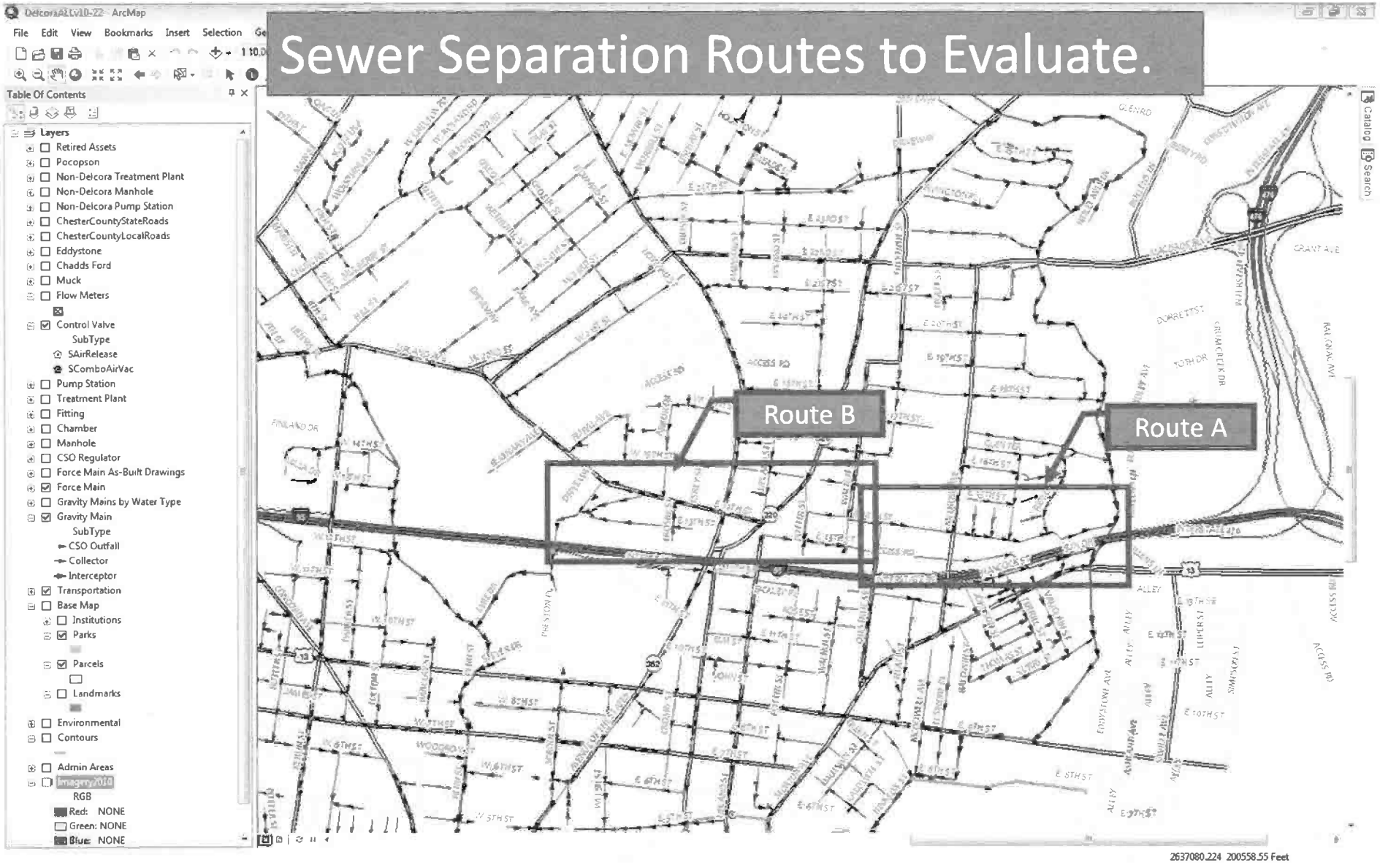
- unknowns of the existing storm and sanitary facility locations and depths of system components as described in the full report;
- unknown locations of all other existing utilities and potential conflicts for proposed routing Alternates;
- unknown resolution of flood elevation status of Chester Creek and whether Route B can, or must be, justified through: A) existing FEMA Flood Insurance Study means and methods; B) additional Hydrologic and Hydraulic study; C) storage and attenuation of proposed storm discharge from Route B;
- the potential for environmentally sensitive issues (wetlands, bog and/or red-belly turtles, plant species, etc. that may be uncovered with a PNDI search and/or additional site investigation) within Ship Creek that would need mitigation;
- study of the existing enclosed portion of Ship Creek located under the existing railroad and I-95 for flows introduced from Route B;
- acceptance (or lack of acceptance) of new stormwater facilities for dedication to the City of Chester;
- unknown extent of lands (if any) that would require acquisition of right-of-way, construction and/or permanent easements, etc., in order to carry out any of the studied options or alternates;
- granting of applicable jurisdictional agency permits that are required to perform the work contemplated within this study;
- permission of PennDOT, USDOT and affected municipalities to perform the work via detours, lane outages, lane and ramp restrictions, redirection of traffic, temporary traffic control and work zone traffic control, as may be required to complete the project on and under I-95, Providence Road and local collector roadways;
- permission of the railroad to perform work at or near their facilities;
- permission of local property Owners and Widener University to perform the work contemplated within and/or adjacent to their properties;
- anticipated extensive coordination with existing utility owners and service providers to avoid facility conflicts, obstructions and service interruptions;
- anticipated extensive coordination with local businesses and the general public regarding the project and potential impacts to the local community and traveling public.

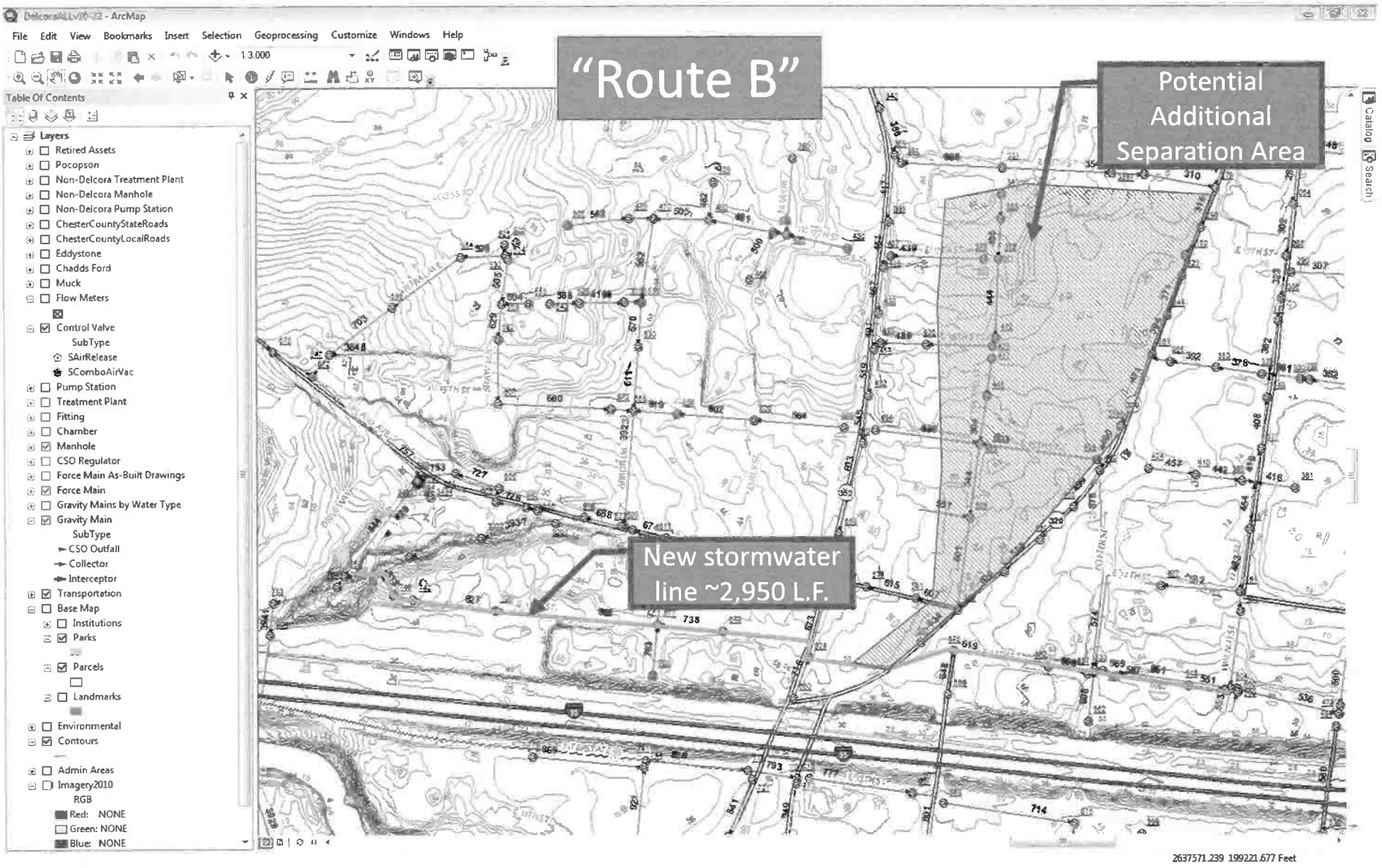
DRAFT

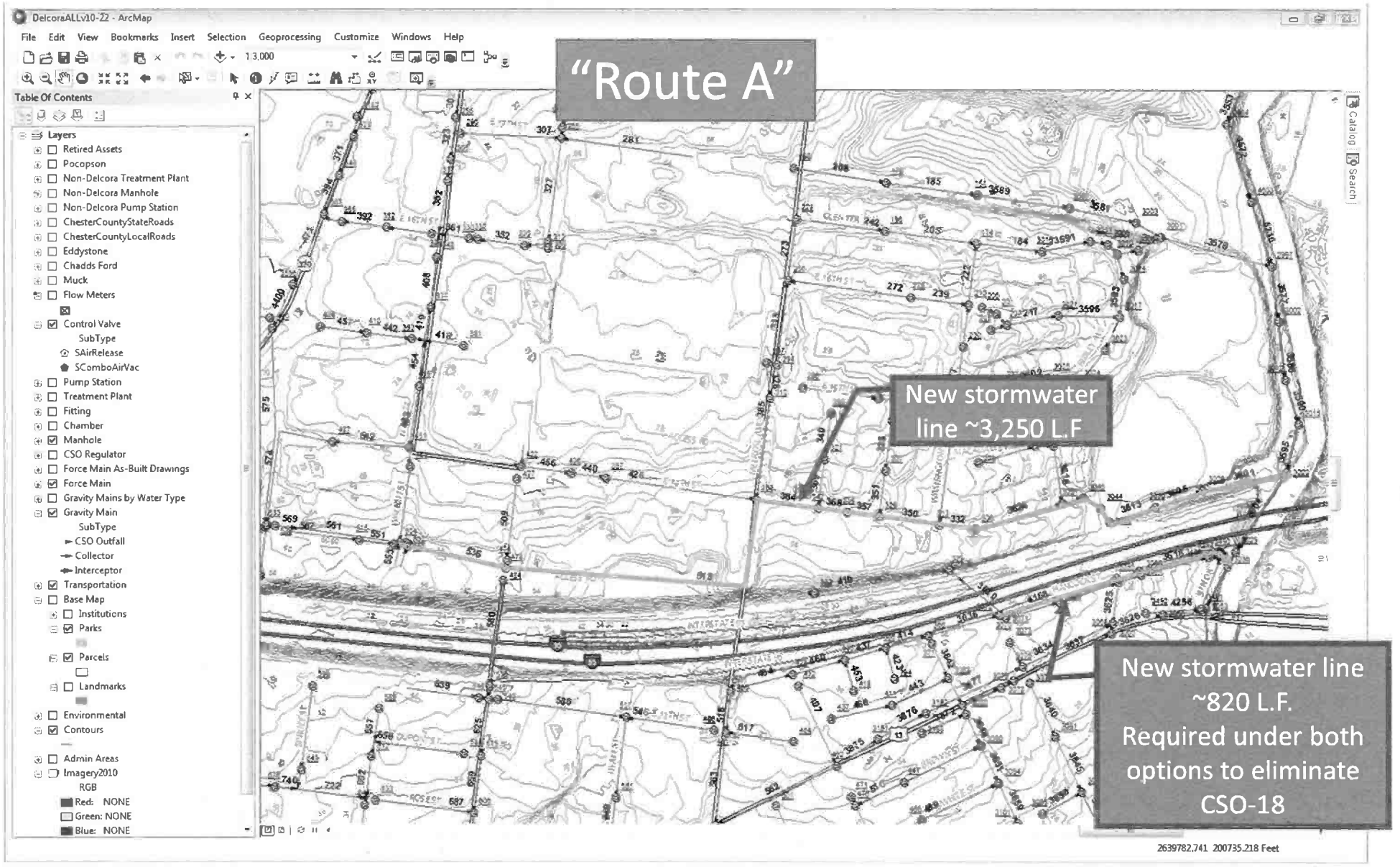
APPENDIX A

SEWER SEPARATION ROUTE REQUEST FORM DELCORA

Sewer Separation Routes to Evaluate.




"Route B"
Potential Additional Separation Area
New stormwater line ~2,950 L.F.
ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
Table Of Contents
Layers
Retired Assets
Pocopson
Non-Delcora Treatment Plant
Non-Delcora Manhole
Non-Delcora Pump Station
ChesterCountyStateRoads
ChesterCountyLocalRoads
Eddystone
Chadds Ford
Muck
Flow Meters
Control Valve
SubType
SAirRelease
SComboAirVac
Pump Station
Treatment Plant
Fitting
Chamber
Manhole
CSO Regulator
Force Main As-Built Drawings
Force Main
Gravity Mains by Water Type
Gravity Main
SubType
CSO Outfall
Collector
Interceptor
Transportation
Base Map
Institutions
Parks
Parcels
Landmarks
Environmental
Contours
Admin Areas
Imagery2010
RGB
Red: NONE
Green: NONE
Blue: NONE
Catalog
Search
2637571.239 199221.677 Feet


DelcoraALLv10-22 - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:3,000
Table Of Contents
Layers
Retired Assets
Pocopson
Non-Delcora Treatment Plant
Non-Delcora Manhole
Non-Delcora Pump Station
ChesterCountyStateRoads
ChesterCountyLocalRoads
Eddystone
Chadds Ford
Muck
Flow Meters
Control Valve
SubType
SAirRelease
SComboAirVac
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Manhole
CSO Regulator
Force Main As-Built Drawings
Force Main
Gravity Mains by Water Type
Gravity Main
SubType
CSO Outfall
Collector
Interceptor
Transportation
Base Map
Institutions
Parks
Parcels
Landmarks
Environmental
Contours
Admin Areas
Imagery2010
RGB
Red: NONE
Green: NONE
Blue: NONE
Catalog
Search
"Route A"
New stormwater line ~3,250 L.F
New stormwater line ~820 L.F. Required under both options to eliminate CSO-18
2639782.741 200735.218 Feet

APPENDIX B

CSO 18 MITIGATION CONCEPT PLANS

APPENDIX C

DELCORA GIS PLAN

APPENDIX D

DRAINAGE COMPUTATIONS FOR SELECT OPTIONS

CHAPTER 7, APPENDIX A

FIELD MANUAL FOR PENNSYLVANIA DESIGN RAINFALL INTENSITY CHARTS FROM NOAA ATLAS 14 VERSION 3 DATA

7A.0 INTRODUCTION

Previously used procedures to estimate design rainfall intensities, usually obtained from the *U.S. Weather Bureau Technical Paper No. 40* (Hershfield, 1961) or the *1986 Field Manual of PennDOT Storm-Intensity-Duration-Frequency Charts PDT-IDF* (Aron et al., 1986), have been updated in this appendix. The regional rainfall design curves in this Pennsylvania field manual were developed from frequency analyses based on hourly records from 278 daily and 139 hourly rainfall gages in Pennsylvania plus gages in surrounding states for a period of record from April 1, 1863 through December 31, 2000. The analysis leading to the design curves is fully described in this Appendix.

In performing the PDT-IDF analysis, it was found that there were regional differences in rainfall patterns between storm durations. For example, the lowest intensities and amounts for the five (5) minute storms are located in north central PA, whereas the lowest intensities and amounts for the twenty-four (24) hour storm are located in western PA. It was determined that one rainfall region map would not adequately represent the rainfall patterns. Therefore, the maps were developed based upon storm duration and frequency as shown in Table 7A.1.

7A.1 PROCEDURE FOR FINDING DESIGN INTENSITY VALUES

A. Objective. To obtain the design rainfall or return periods from 1 to 100-years and durations from 5 minutes to 24 hours and to obtain the 500-year, 24-hour precipitation.

Step 1 Determine the rainfall duration of the storm that will need to be analyzed. For the rational method, the required storm duration will be equal to the time-of-concentration.

Step 2 From Table 7A.1, determine what Rainfall Region Map should be utilized for the design storm duration of interest.

Table 7A.1 Appropriate Rainfall Region Map for each Storm Duration and Frequency

	Frequency							
Duration	**1 year**	**2 year**	**5 year**	**10 year**	**25 year**	**50 year**	**100 year**	**500 year**
5 min	C	C	C	C	B	B	B	-
10 min	C	C	C	C	C	C	C	-
15 min	A	A	A	A	C	C	C	-
30 min	A	A	A	A	A	C	C	-
60 min	A	A	A	A	A	C	C	-
2 hr	E	E	E	E	E	E	E	-
3 hr	E	E	E	E	E	E	E	-
6 hr	D	D	D	D	D	D	D	-
12 hr	F	F	F	F	F	F	F	-
24 hr	F	F	F	F	F	F	F	F

Step 3 Locate the area of interest on the Pennsylvania map for the Map determined in Step 2 (Figures 7A.1 through 7A.6) and note the region into which this area falls.

Figure 7A.1 Map A. 15-, 30- and 60-minute durations for storms occurring with an ARI of 1-, 2-, 5-, 10-years and 30- and 60-minute durations for storms occurring with an ARI of 25-years.

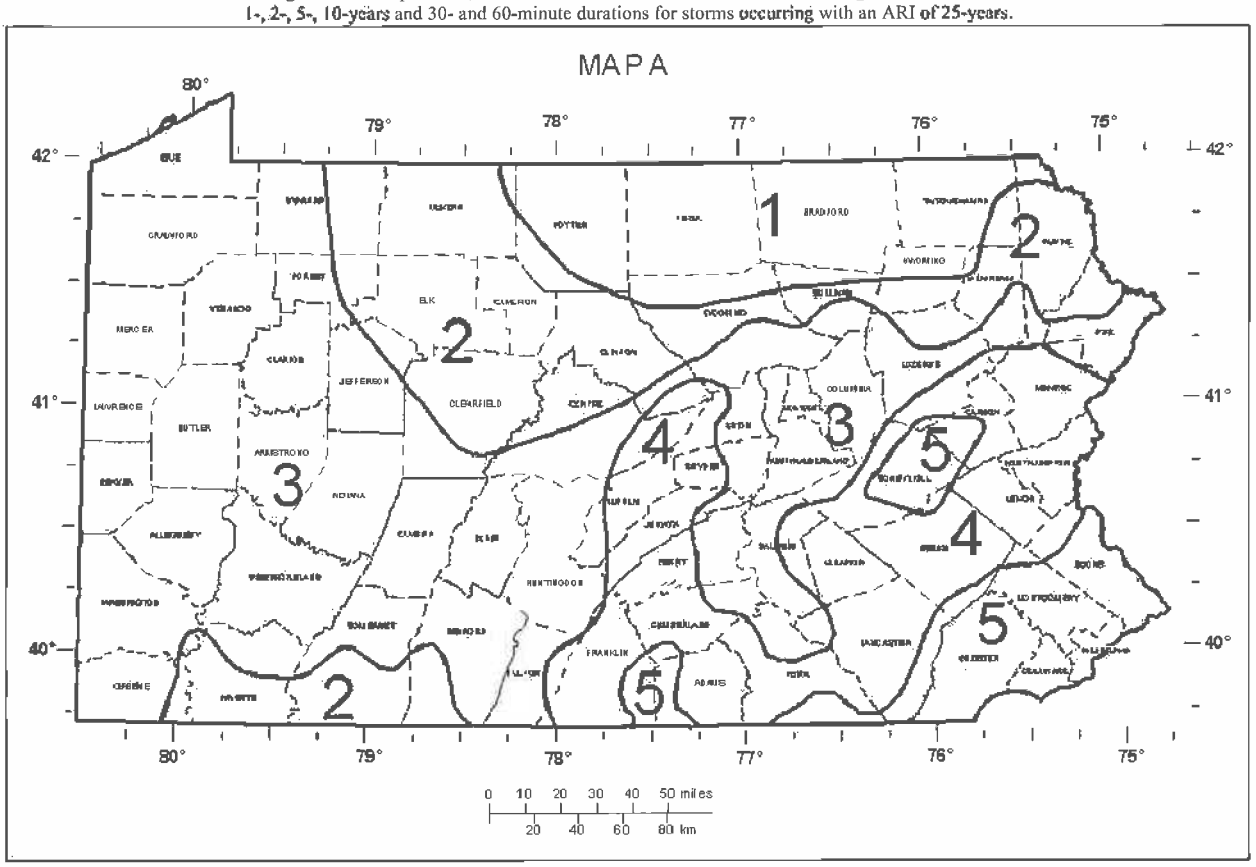


Figure 7A.2 Map B. 5-minute durations for storms occurring with an ARI of 25-, 50- and 100-years.

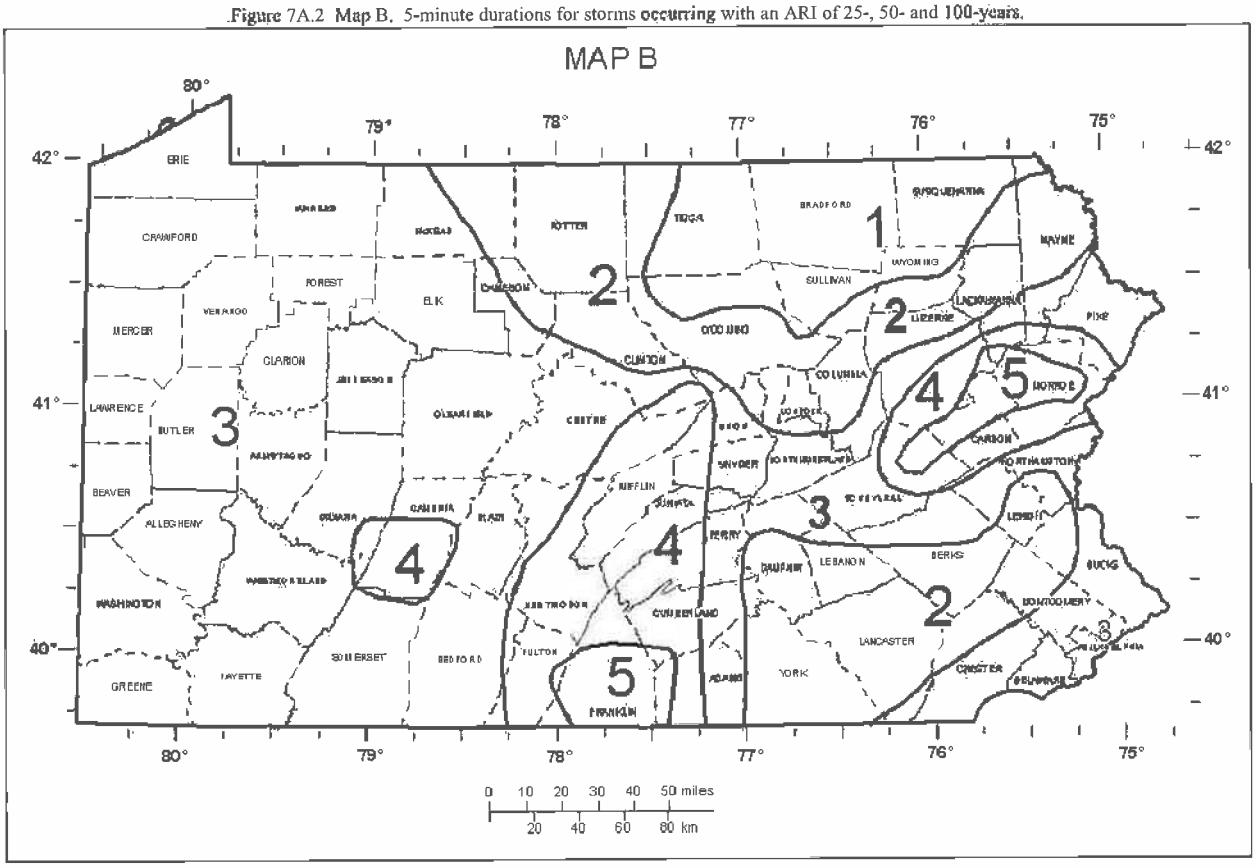


Figure 7A.3 Map C. 5- and 10-minute durations for storms occurring with an ARI of 1-, 2-, 5-, and 10-years, 10- and 15-minute durations for storms occurring with an ARI of 25-years and 10-, 15-, 30-, 60-minute durations for storms occurring with an ARI of 50- and 100-years.

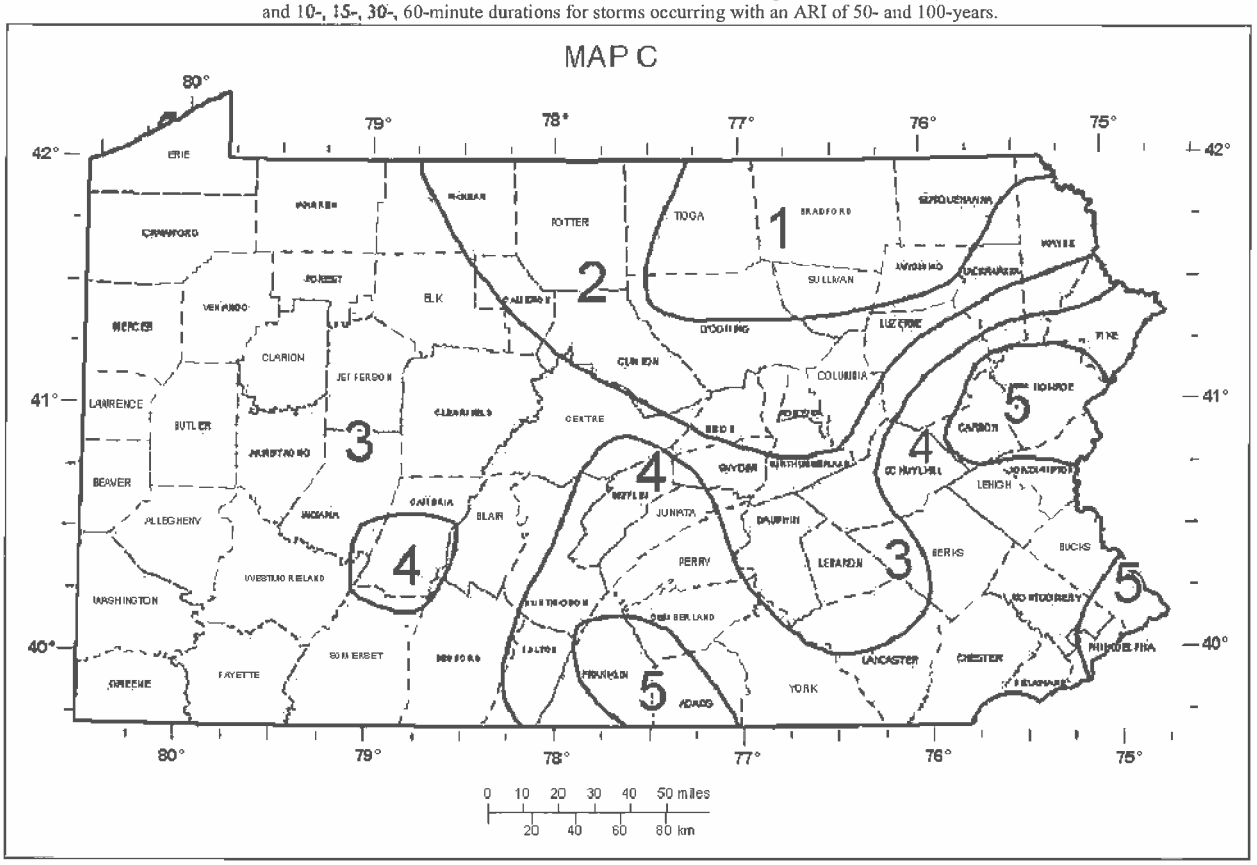


Figure 7A.12(a) Rainfall Intensity for 1- through 100-year Storms for Region 3 (U.S. Customary).

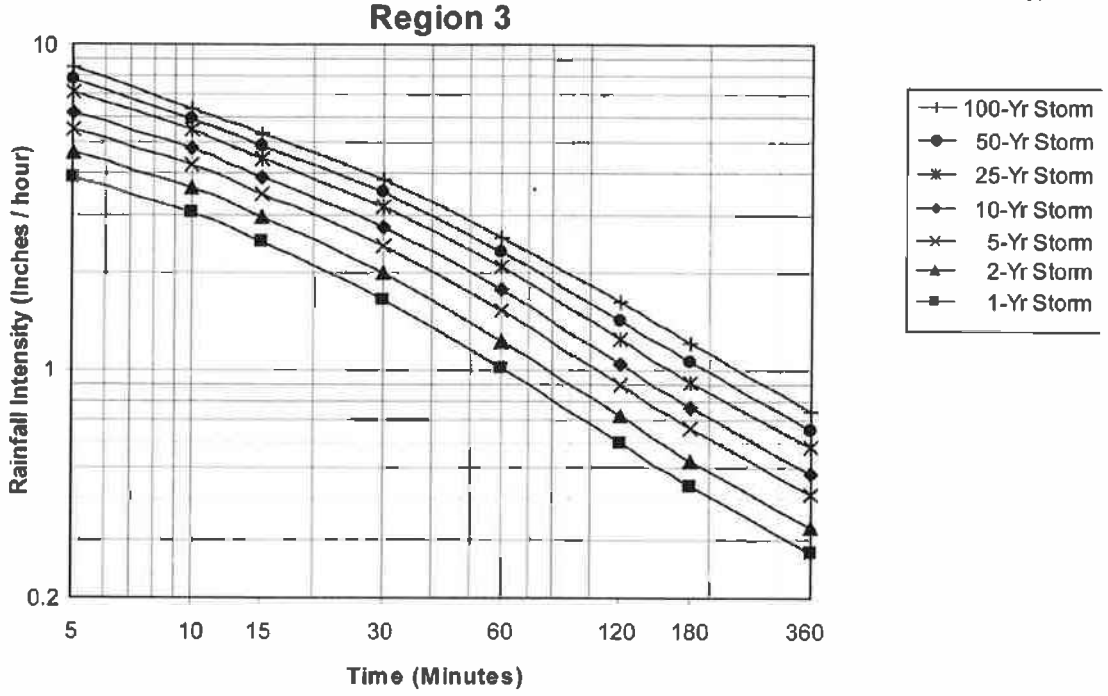


Figure 7A.12(b) Rainfall Amount for 1- through 100-year Storms for Region 3 (U.S. Customary).

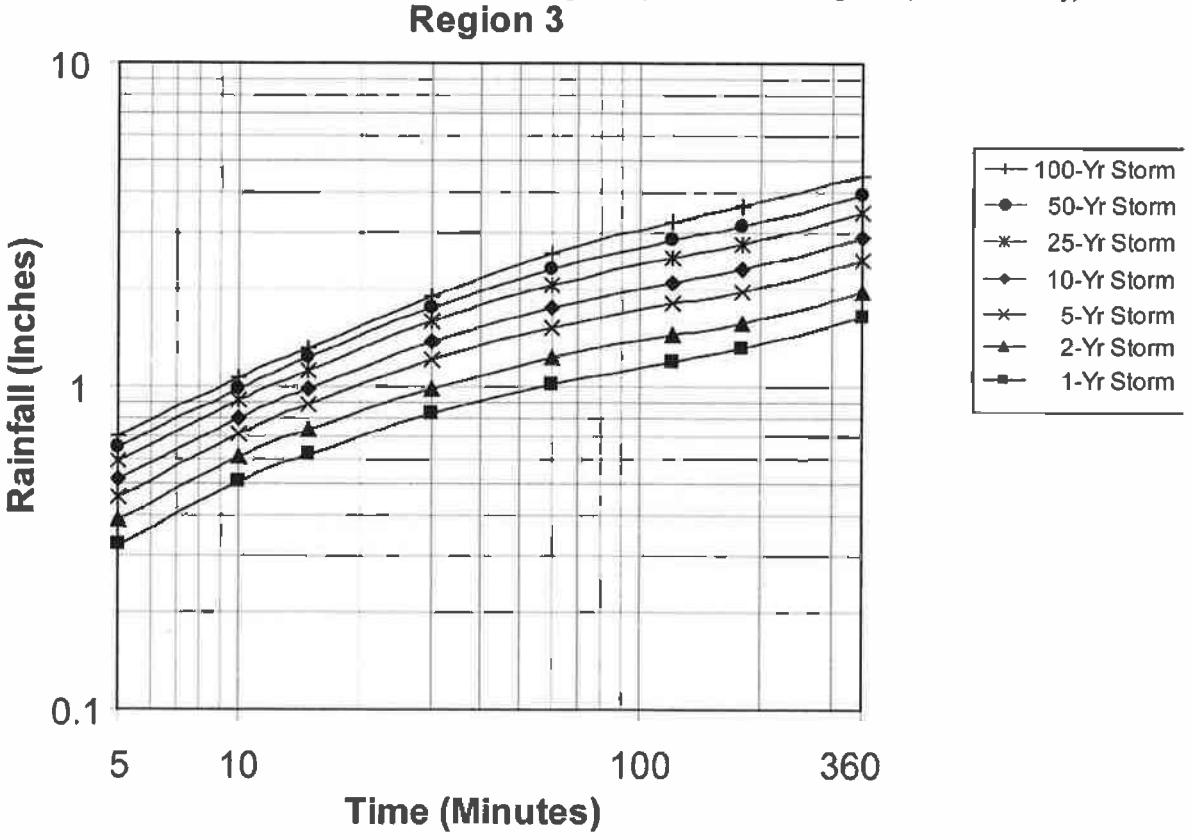


Figure 7A.14(a) Rainfall Intensity for 1- through 100-year Storms for Region 4 (U.S. Customary).

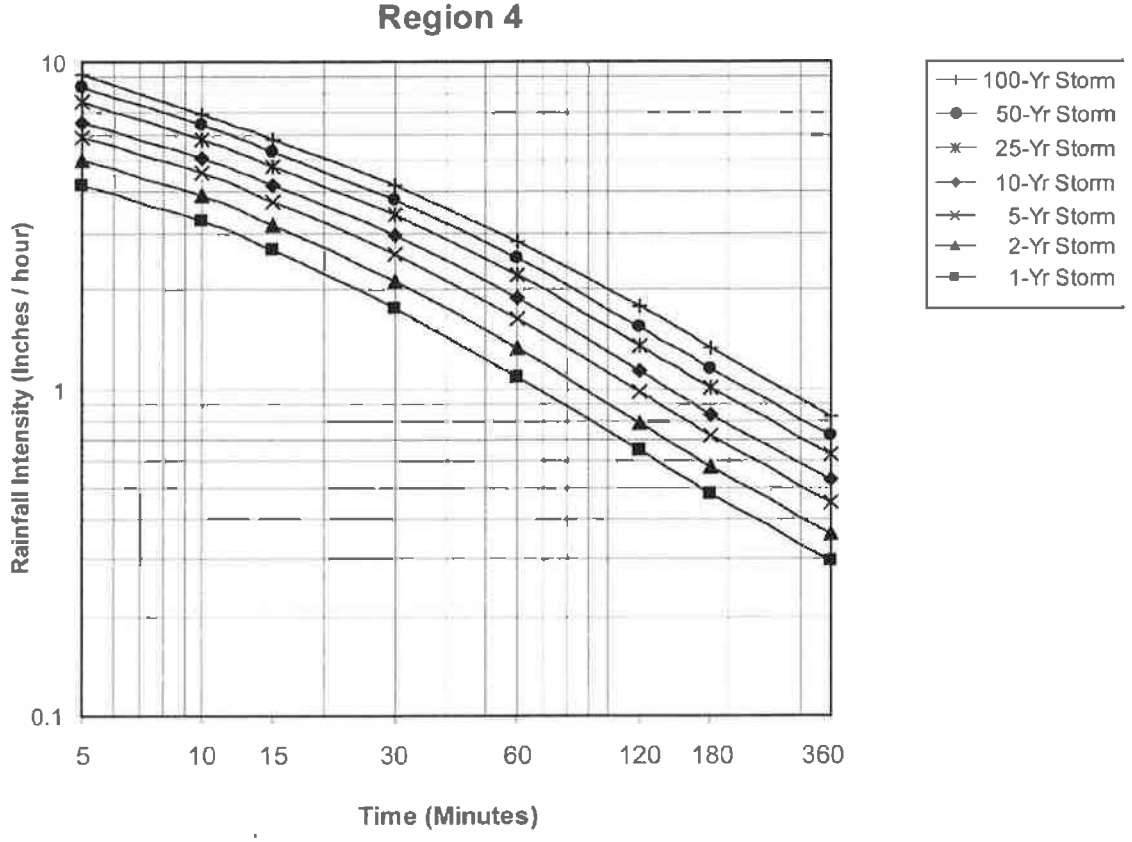


Figure 7A.14(b) Rainfall Amount for 1- through 100-year Storms for Region 4 (U.S. Customary).

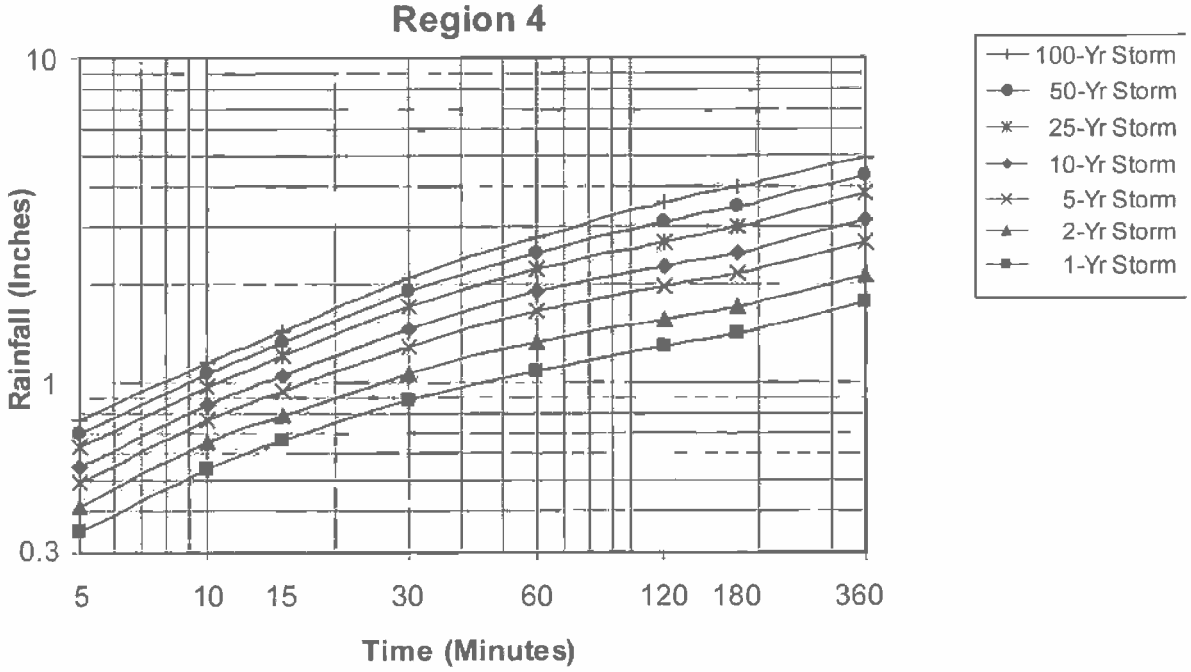


Figure 7A.16(a) Rainfall Intensity for 1- through 100-year Storms for Region 5 (U.S. Customary).

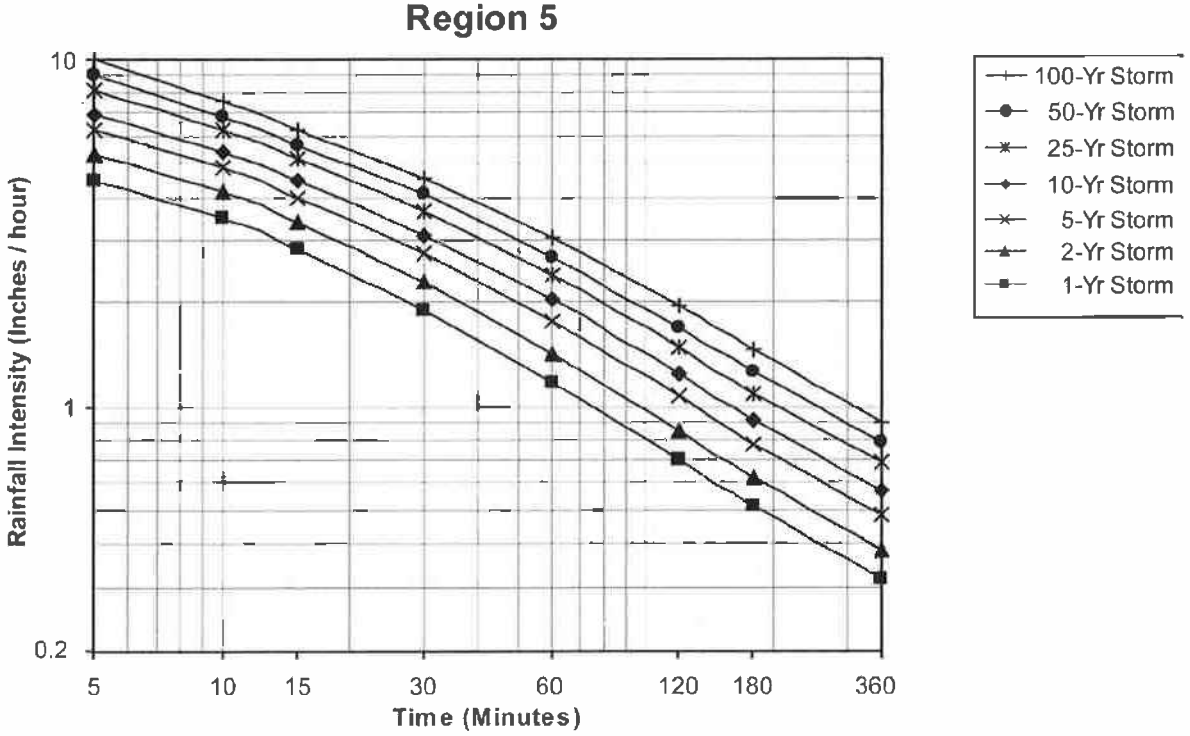
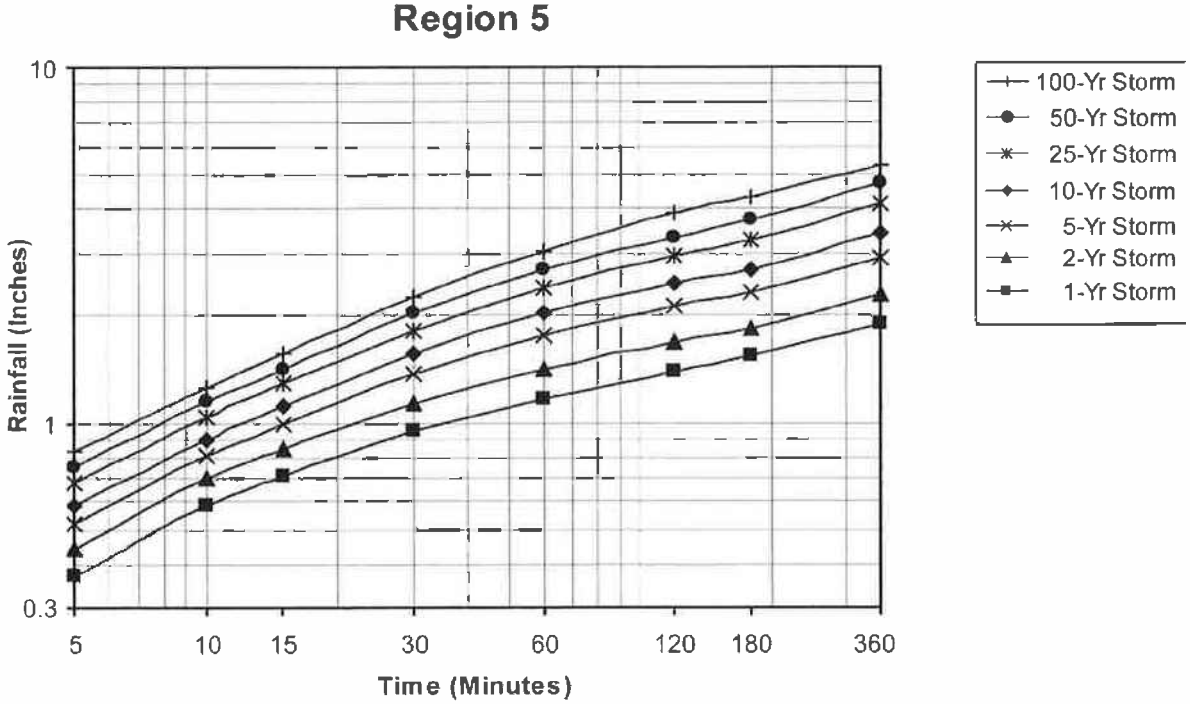


Figure 7A.16(b) Rainfall Amount for 1- through 100-year Storms for Region 5 (U.S. Customary).



STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 3)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	50%	158000	SF
APPOX LAWN(SF)	50%	158000	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	158000	3.627
Lawn (B)	0.35	158000	3.627
Total Area			**7.3**
Rational 'C'			0.475
I (IN/HR)	**8.5**	Q (CFS) =	**29.29**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **24** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=		FEET
DELTA ELEV=		FEET
S=	0.015	FT/FT
n=	0.011	
R=	0.5	
A=	3.14	

PIPE CAPACITY = **32.74** cfs

PIPE CAPACITY > REQUIRED Q?	YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	60%	189600	SF
APPOX LAWN(SF)	40%	126400	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	189600	4.353
Lawn (B)	0.35	126400	2.902
Total Area			**7.3**
Rational 'C'			0.500
I (IN/HR)	**8.5**	Q (CFS) =	**30.83**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **24** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.015	FT/FT
n=	0.011	
R=	0.5	
A=	3.14	

PIPE CAPACITY = **32.74** cfs | PIPE CAPACITY > REQUIRED Q? | YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	70%	221200	SF
APPOX LAWN(SF)	30%	94800	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q				
Cover Type	C	Area (SF)	Area (AC)	
Impervious	0.6	221200	5.078	
Lawn (B)	0.35	94800	2.176	
Total Area			**7.3**	
Rational 'C'			0.525	
I (IN/HR)	**8.5**	Q (CFS) =	**32.37**	cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **24** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.015	FT/FT
n=	0.011	
R=	0.5	
A=	3.14	

PIPE CAPACITY = **32.74** cfs | PIPE CAPACITY > REQUIRED Q? | YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 3)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	50%	158000	SF
APPOX LAWN(SF)	50%	158000	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q				
Cover Type	C	Area (SF)	Area (AC)	
Impervious	0.6	158000	3.627	
Lawn (B)	0.35	158000	3.627	
Total Area			**7.3**	
Rational 'C'			0.475	
I (IN/HR)	**8.5**	Q (CFS) =	**29.29**	cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **30** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=		FEET
DELTA ELEV=		FEET
S=	0.005	FT/FT
n=	0.011	
R=	0.625	
A=	4.9063	

PIPE CAPACITY = **34.298** cfs

PIPE CAPACITY > REQUIRED Q?	YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	60%	189600	SF
APPOX LAWN(SF)	40%	126400	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	189600	4.353
Lawn (B)	0.35	126400	2.902
Total Area			**7.3**
Rational 'C'			0.500
I (IN/HR)	**8.5**	Q (CFS) =	**30.83**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **30** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.005	FT/FT
n=	0.011	
R=	0.625	
A=	4.9063	

PIPE CAPACITY = **34.298** cfs

PIPE CAPACITY > REQUIRED Q? YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE A

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.08	hr
Tc(min)=	5	MIN
I(@ tc)=	**8.5**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		316000	SF
		7.3	AC
APPROX IMPERV(SF)	70%	221200	SF
APPOX LAWN(SF)	30%	94800	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	221200	5.078
Lawn (B)	0.35	94800	2.176
Total Area			**7.3**
Rational 'C'			0.525
I (IN/HR)	**8.5**	Q (CFS) =	**32.37**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **30** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.005	FT/FT
n=	0.011	
R=	0.625	
A=	4.9063	

PIPE CAPACITY = **34.298** cfs | PIPE CAPACITY > REQUIRED Q? | YES

DELCORA								
Address/TMP						16-05053		
Chester City, Delaware County, PA						11/8/2016		
Time of Concentration Computations								
Route B Bottom								
P2=	3.2	inches						
Flow Type	Variables					Flow Time		
Sheet Flo	n			L	S	T		
				feet		hours		
1		0.24		165	0.04	0.269		
Shallow C	Surface	Gradient		L	Velocity			
		ft/ft		feet	fps			
2	Unpaved	0.014		96	1.9	0.014		
2	Paved	0.013		0	2.3	0.000		
Channel F	Mannings	Hyd.Radius	Gradient	L	Velocity			
	n	R	S - ft/ft	feet	fps			
3	0.013	0.38	0.015	603	7.3	0.023		
4	0.013	1.00	0.008	2045	10.3	0.055		
Totals				2909		0.361		

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE B TOP

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.23	hr
Tc(min)=	14	MIN
I(@ tc)=	7	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		465250	SF
		10.7	AC
APPROX IMPERV(SF)	50%	232625	SF
APPOX LAWN(SF)	50%	232625	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	232625	5.340
Lawn (B)	0.35	232625	5.340
Total Area			10.7
Rational 'C'			0.475
I (IN/HR)	7	Q (CFS) =	35.51

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): 36 in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=		FEET
DELTA ELEV=		FEET
S=	0.005	FT/FT
n=	0.013	
R=	0.75	
A=	7.065	

PIPE CAPACITY = 47.221 cfs

PIPE CAPACITY > REQUIRED Q? YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE B TOP

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.23	hr
Tc(min)=	14	MIN
I(@ tc)=	7	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		465250	SF
		10.7	AC
APPROX IMPERV(SF)	60%	279150	SF
APPOX LAWN($F)	40%	186100	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	279150	6.408
Lawn (B)	0.35	186100	4.272
Total Area			**10.7**
Rational 'C'			0.500
I (IN/HR)	**7**	Q (CFS) =	**37.38**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **36** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.005	FT/FT
n=	0.013	
R=	0.75	
A=	7.065	

PIPE CAPACITY = **47.221** cfs

PIPE CAPACITY > REQUIRED Q?	YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE B TOP

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.23	hr
Tc(min)=	14	MIN
I(@ tc)=	7	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		465250	SF
		10.7	AC
APPROX IMPERV(SF)	70%	325675	SF
APPOX LAWN(SF)	30%	139575	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	325675	7.476
Lawn (B)	0.35	139575	3.204
Total Area			10.7
Rational 'C'			0.525
I (IN/HR)	7	Q (CFS) =	39.25

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): 36 in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.005	FT/FT
n=	0.013	
R=	0.75	
A=	7.065	

PIPE CAPACITY = 47.221 cfs

PIPE CAPACITY > REQUIRED Q? YES

P:\STRUCTURAL\2016\16-05053-DELCORA\7.0 CALCS & ENGINEERING\Report\Storm Separation Report\Computation Files\Computation Source files\DRAINAGE AREA TO ROUTE B TOP

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE B BOTTOM

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.36	hr
Tc(min)=	22	MIN
I(@ tc)=	**4.9**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		3089000	SF
		70.9	AC
APPROX IMPERV(SF)	50%	1544500	SF
APPOX LAWN(SF)	50%	1544500	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q				
Cover Type	C	Area (SF)	Area (AC)	
Impervious	0.6	1544500	35.457	
Lawn (B)	0.35	1544500	35.457	
Total Area			**70.9**	
Rational 'C'			0.475	
I (IN/HR)	**4.9**	Q (CFS) =	**165.05**	cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **48** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=		FEET
DELTA ELEV=		FEET
S=	0.013	FT/FT
n=	0.011	
R=	1	
A=	12.56	

PIPE CAPACITY = [illegible] cfs | PIPE CAPACITY > REQUIRED Q? | YES

STORM DRAINAGE AREA AND PIPE COMPUTATION - 100 YR STORM
SYSTEM - ROUTE B BOTTOM

OVERLAND FLOW Tc COMPUTATION

Tc(hr)=	0.36	hr
Tc(min)=	22	MIN
I(@ tc)=	**4.9**	in/hr (From PADOT Region 4)

DRAINAGE AREA COMPUTATION

TOTAL AREA(SF)		3089000	SF
		70.9	AC
APPROX IMPERV(SF)	60%	1853400	SF
APPOX LAWN(SF)	40%	1235600	SF

DRAINAGE AREA PEAK RUNOFF COMPUTATION @ MH 329

68X43 CS - DRAINAGE AREA/ PEAK Q			
Cover Type	C	Area (SF)	Area (AC)
Impervious	0.6	1853400	42.548
Lawn (B)	0.35	1235600	28.365
Total Area			**70.9**
Rational 'C'			0.500
I (IN/HR)	**4.9**	Q (CFS) =	**173.74**

cfs 100 YR @ MH 329

PROPOSED STORM DIVERSION PIPE DESIGN COMPUTATION

HDPE PIPE SIZE (PROPOSED): **48** in diameter

Q= 1.49/n * A * R^0.67 * S^0.5

L=	0	FEET
DELTA ELEV=	0	FEET
S=	0.013	FT/FT
n=	0.011	
R=	1	
A=	12.56	

PIPE CAPACITY = **193.98** cfs

PIPE CAPACITY > REQUIRED Q?	YES

APPENDIX R

Draft FCA Report

- DELCORA Draft Financial Capability Assessment Report (Final) dated May 2016 (Revised April 2017)
- USEPA Letter Providing Comments on the Draft Financial Capability Assessment Report dated August 25, 2017
- DELCORA Letter to USEPA Responding to Comments Provided in USEPA Letter dated August 25, 2017

Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Draft Financial Capability Assessment Report
(Final)

May 2016
(Revised April 2017)

GREELEY AND HANSEN

REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Identification of Sensitive Areas and Pollutants of Concern Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

DELCORA MANAGEMENT		
Executive Director	Signature	5/9/16 Date
DELCORA ENGINEERING		
Director of Engineering	Signature	5/9/16 Date
DELCORA OPERATIONS AND MAINTENANCE		
Director of Operation and Maintenance	Signature	5/9/16 Date

REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES
1	11/17/16	Greeley and Hansen/ DELCORA	• Updated Table of Content and List of Appendices. • Page ES-4: Updated Table ES-2 to address USEPA comments. • Page ES-5: Updated Table ES-3. • Page ES-6: Updated Tables ES-4 and ES-5. • Page 1-4: Updated Section 1.1, model area description to address USEPA description. • Page 1-4: Updated Section 1.1.1 conveyance system description to address USEPA description. • Page 1-5: Updated Table 1-1 to include Service Area. • Page 4-6: Updated Table 4-2 to address USEPA comments. • Page 4-7: Updated Section 4.4.2. • Page 4-8: Updated Table 4-3 to address USEPA comments. • Page 5-4: Updated Section 5.2, Line 402: Debt of Overlapping Entities. • Page 5-5: Updated Section 5.2. • Page 5-6: Updated Table 5-4. • Page 5-8: Updated Table 5-6. • Page 5-9: Updated Table 5-7. • Page 5-11: Updated Table 5-9. • Page 5-12: Updated Table 5-10. • Page 7-1: Updated Section 7 References • Appendix 1, Page 1: Revised table to address USEPA comments. • Appendix 1, Page 4, Revised tables. • Added Appendices 6 through 13
2	4/21/17	Greeley and Hansen/ DELCORA	• Updated Table of Contents and List of Appendices. • Page ES-2: Updated Figure ES-1. • Page ES-5: Updated Table ES-3 (Worksheet 1). • Page ES-6: Updated Table ES-4 (Worksheet 2). • Page ES-7: Updated Table ES-5 (Worksheet 10). • Page 1-4: Updated DELCORA's share of PWD LTCP cost (paragraph 1). • Page 1-4: Corrected spelling of Muckinipates (last paragraph). • Page 4-2: Revised last paragraph of Section 4.1.2. • Page 4-4 Updated Figure 4-1. • Page 4-5: Added Section 4.3 (description of basis for storm water costs). • Page 4-6: Updated text for Cost per Household. • Page 4-6: Updated Table 4-2 (Worksheet 1) to include estimate of storm water costs. • Page 4-8: Updated Table 4-3 (Worksheet 2) to include estimate of storm water costs. • Page 5-8: Corrected spelling error.

			• Page 5-9: Corrected spelling error. • Appendix 1, Pages 1 and 2: Updated Table 1 and Table 2 (Worksheet 1) to include storm water costs. • Appendix 1, Pages 3 and 4: Updated Table 3 and Table 4 (Worksheet 2) to include storm water costs. • Appendix 1, Page 12: Updated Table 12, added Table 13. • Appendix 8: Inserted Delaware County CAFR. • Appendix 13: Revised Figure A13-1 and text. • Appendix 14: Added new Appendix 14 in response to EPA concerns.

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Executive Summary

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal authority originally organized under the Pennsylvania Municipal Authorities Act of 1945 (P.L. 382), as amended and supplemented, pursuant to action taken by the Delaware County Council on October 20, 1971. Under County of Delaware Ordinance 2002-1, the term of existence of DELCORA was extended to January 15, 2052.

DELCORA prepared and submitted their original Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the PADEP in 1999. This LTCP was subsequently approved by the PADEP, and DELCORA had started to implement the CSO control elements selected in the LTCP. In 2009, the United States Environmental Protection Agency (USEPA) informed DELCORA that the original LTCP was not in compliance with the requirements of the USEPA's CSO Policy. As such, DELCORA prepared and submitted a revised LTCP in February 2012. Subsequent to the receipt of the revised LTCP, DELCORA and the USEPA had corresponded various times including requests for additional information from the USEPA in accordance with Section 308 of the Clean Water Act. A Consent Decree was ultimately executed between DELCORA, the Pennsylvania Department of Environmental Protection (PADEP) and USEPA, and was approved by the Federal District Court on November 10, 2015. The Consent Decree requires a revised LTCP to be prepared based on an agreed upon schedule, which will include interim deliverables and milestones.

Purpose

DELCORA is developing a Long Term Control Plan (LTCP) Update for the Combined Sewer System (CSS) as required by the Consent Decree. The Consent Decree requires the preparation of a Draft Financial Capabilities Assessment (FCA) including information on sewer rate setting, median household income (MHI) and number of households in the LTCP Model Area which must be submitted within nine (9) months of the Date of Lodging of the Consent Decree.

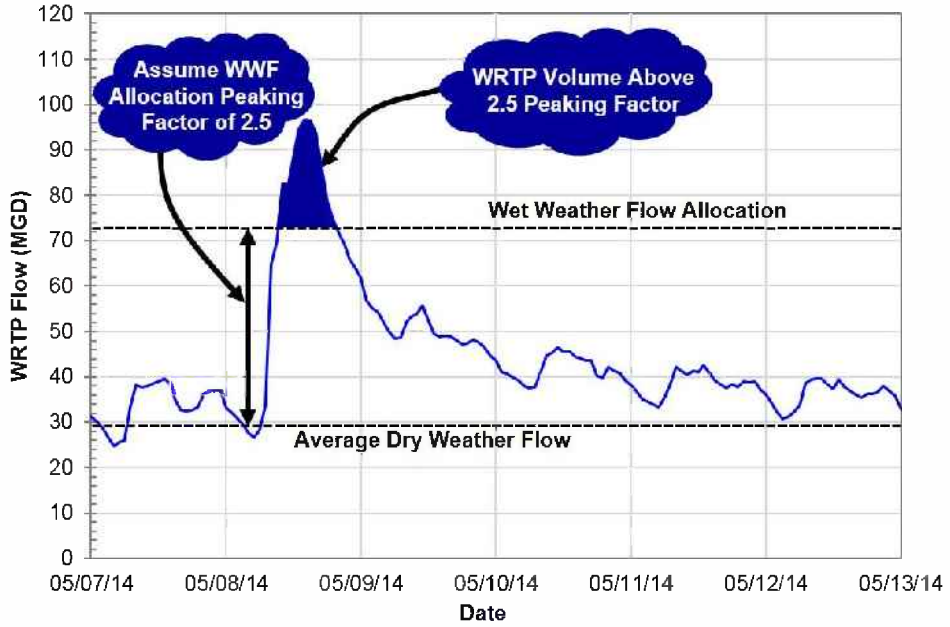
The Draft FCA has been prepared in advance of the completion of the revised LTCP. Therefore, final CSO control alternatives and their associated capital improvement costs have not been determined. The Draft FCA is based on an analysis of the affordability for the affected residential communities as measured by the Residential Index. The Final FCA, which is to be submitted after evaluation of CSO controls, will include planning level estimated costs for the identified alternatives that can then be contrasted with the results of the estimated affordability analysis.

CSO LTCP Cost Allocation to Separate Sewer System

DELCORA's system serves a variety of customers from numerous municipalities in Delaware County, PA. The majority of the sewer systems within the Model Area have separated sanitary sewers, with the exception of a portion of Chester City, which is served by combined sewers. DELCORA has service agreements with the authorities, major industries, and a few municipalities. There are service agreements that indicate that the discharger will not share in any CSO related costs, because there was no direct discharge to the combined sewer system. However, most agreements indicate that authority, industry, or municipality shall not discharge excess wet weather flow to the DELCORA WRTP. Thus, for the purpose of the Draft FCA, the allocation of CSO LTCP costs to the separate sewer system is based on

separate sewer system's share of the total Wet Weather Flow (WWF) volume. The separate sewer system's share is based on WRTP's WWF volume above a peaking factor 2.5. Figure ES-1 shows an example WRTP's WWF volume from a single storm event in May 2014.

Figure ES-1: Basis for Estimating Wet Weather Flow from Separate Sewer Areas



To estimate the total wet weather volumes shown in Table ES-1, the WRTP's WWF volumes from all storms above a peaking factor of 2.5 within the year were totaled and added to the annual CSO volume discharged.

Table ES-1: CSO Volume as Percent of Total Wet Weather Volume

Year	WRTP WWF Volume above 2.5 Peak Factor (MG)	CSO Volume (MG)	Total Wet Weather Volume (MG)	Percent CSO
2009	24.2	785	809.2	97%
2010	39.3	696	735.3	95%
2011	30.0	1144	1174.0	97%
2012	6.6	538	544.6	99%
2013	13.5	744	757.5	98%
Average	22.7	781.4	804.1	97%

Table ES-1 indicates that the separate sewer system has about a 3% to 5% share of the total wet weather volume. Further hydraulic evaluations are required to better understand the separate sewer system flows and refine the separate sewer system share of the CSO LTCP costs. Therefore for this Draft FCA, it is assumed 15 percent of CSO LTCP costs would be allocated to the separate sewer system and 85 percent of the CSO LTCP costs would allocated to combined sewer system in Chester City. For the final FCA, the updated hydrologic and hydraulic (H&H) model will be used to improve the estimate of CSO attributable to Chester City and to the remainder of the Model Area.

Financial Health of Chester City

The City of Chester is a financially distressed municipality as defined by the 1987 Financially Distressed Municipalities Act 47 (Act 47). After several years of budget deficits, Chester City Council adopted the 1996 Recovery Plan, which presented nearly 200 actions steps toward fiscal recovery. Chester City continued to have budget deficits. Subsequent recovery plans have been submitted in 2006 and 2013. While opening the Harrah's Racetrack and Casino in January 2007 has improved the financial conditions in Chester City, the budget problem has not been resolved. The City remains in the Act 47 program until financial health improves.

Financial indicator

In accordance with EPA's 1997 Guidance for Financial Capability, Table ES-2 shows the factors used to develop the financial indicator. The average score for the financial indicator was calculated by dividing the sum of the scores by the number of entries. The overall financial capability for the Model Area corresponds to a "Strong" rating. However, due to financial distressed conditions and consistent with the 2013 Recovery Plan, Chester City's overall financial capability is "Weak". EPA's 1997 Guidance for Financial Capability indicates that Chester City would have a "high burden" if the residential annual sewer bill is between 1.0 percent and 2.0 percent of Median Household Income (MHI). For the purpose of this Draft FCA, Chester City's affordability is based on 85 percent share of the CSO LTCP and a Chester City annual sewer bill at 1.6 percent of MHI.

Table ES-2: Worksheet 9 - Summary of Financial Capability Indicators

Indicator	Chester City			Model Area			Line Number
	Actual Value	Financial Indicator	Score	Actual Value	Financial Indicator	Score	
A. Bond Rating (Line 303)	A (Suspended 1/6/2014)	Mid-Range	2	AA	Strong	3	901
B. Overall Net Debt as a Percent of Full Market Property Value (Line 405)	13.4%	Weak	1	4.0%	Mid-Range	2	902
C. Unemployment Rate (Line 501)	8.6%	Weak	1	4.8%	Mid-Range	2	903
D. Household Income (Line 601)	28,350	Weak	1	71,601	Strong	3	904
E. Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	1.2%	Strong	3	0.4%	Strong	3	905
F. Property Tax Revenue Collection Rate (Line 803)	81.7%	Weak	1	97.5%	Mid-range	2	906
G. Permittee Indicators Score			1.5			2.5	907
H. Financial Indicator			Weak			Strong	

Residential indicator

The CSO LTCP will be designed and constructed as required to meet the Consent Decree deadline of August 2035 to the limit of Chester City's financial capability. Funding for the CSO LTCP is assumed to be through revenue bonds. As defined by Financial Indictor in Table ES-2 above and the Financial Capability Matrix in EPA's 1997 Guidance for Financial Capability (see Table 2-1 below), Chester City's financial capability is considered a "high burden" when the annual sewer bill is 1.25% of MHI. The Chester City annual sewer bill at 1.25% of MHI corresponds to approximately a cost of $25,500,000 for Chester City's share of CSO LTCP improvements. Therefore, assuming that 15% of the CSO LTCP costs are allocated to the separate system, the total cost of the CSO LTCP improvements would be approximately $30,000,000. The Cost per Household for Chester City and the DELCORA Model Area are shown in Table ES-3.

Table ES-3: Worksheet 1 - Cost per Household

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
A. DELCORA's Cost					
1. Current WWT and CSO Costs in millions					
a. Annual O&M Expenses (Excluding Depreciation)	$ 3.2	$ 16.7	$ 3.2	$ 16.7	100
b. Annual Debt Service (Principle plus Interest)	$ 0.1	$ 4.5	$ 0.1	$ 4.5	101
c. Current WWT and CSO Costs (Line 100 + Line 101)	$ 3.4	$ 21.3	$ 3.4	$ 21.3	102
2. Projected WWT and CSO Costs in millions (Year 2035 Dollars)					
a. Additional Annual O&M Expenses	$ 3.1	$ 18.2	$ 0.3	$ 3.8	103
b. Additional Annual Debt Service (Principle plus Interest)	$ 2.2	$ 3.5	$ 1.2	$ 2.1	104
c. Projected Additional WWT and CSO Costs (Line 103 + Line 104)	$ 5.3	$ 21.7	$ 1.5	$ 5.9	105
3. Total Current and Projected WWT and CSO Costs in millions (Line 102 + Line 105)	$ 8.7	$ 43.0	$ 4.9	$ 27.2	106a
B. Other Local Collection System Costs (Year 2035 Dollars)	--	$ 24.3	--	$ 15.6	106b
C. Total Current & Projected WWT & CSO Costs (Year 2035 Dollars)	$ 8.7	$ 67.2	$ 4.9	$ 42.7	106c
D. Annual Volume in 1,000 gallons	828,789	8,409,265	828,789	8,409,265	
E. Cost per 1,000 gallons	$ 10.4	$ 8.0	$ 5.9	$ 5.1	
F. Annual Residential Flow Per Household in 1,000 gallons	55	55	55	55	107
G. Equivalent Households	15,069	152,896	15,069	152,896	108
H. WWT and CSO Cost Per Household in dollars	$ 575	$ 440	$ 323	$ 279	109a
I Projected SW Costs Per Household	$ 79	$ 79	$ 44	$ 44	109b
J Total WWT, CSO and SW Cost Per Household	$ 653	$ 519	$ 366	$ 323	109c

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

The Median Household Income for Chester City and the DELCORA Model Area are shown in Table ES-4. Based on EPA's 1997 Guidance for Financial Capability, the Chester City residential indicator benchmark rating is "Mid-Range".

Table ES-4: Worksheet 2 - Median Household Income

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
A. Median Household Income (MHI)					
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 27,249	$ 68,821	$ 27,249	$ 68,821	201
2. Year of MHI Estimate: 2013	2013	2013	2013	2013	
3. FCA Analysis Year: 2035	2035	2035	2015	2015	
4. MHI Inflation Rate: 2%					
5. MHI Adjustment Factor	1.55	1.55	1.04	1.04	
6. Adjusted MHI (Line 201 x Line 202)	$ 42,126	$ 106,396	$ 28,350	$ 71,601	203
B. Annual WWT and CSO Control Cost Per Household (CPH) - (Line 109)	$ 575	$ 440	$ 323	$ 279	204
C. Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	1.6%	0.5%	1.3%	0.5%	205
D. Benchmark	Mid-Range	Low	Mid-Range	Low	

Financial Capability Matrix Score

Table ES-5 shows the Overall Financial Capability Matrix for Chester City and DELCORA Model Area. In accordance with EPA's 1997 Guidance for Financial Capability, Chester City will have a "high burden" if the CSO LTCP costs are $30,000,000 with an 85 percent Chester City share. The methodology presented herein will be followed for the final FCA and will be submitted with the LTCP Update. The assumed proportion of the CSO program cost for Chester City will be refined during the LTCP Update of the H&H model which will then be used to calculate the fraction of wet weather flow during CSO events attributable to each municipality.

Table ES-5: Worksheet 10 - Overall Financial Capability Matrix

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
1. Residential Indicator Score (Line 205)					
a. Actual Value	1.6%	0.5%	1.3%	0.5%	1001
b. Financial Impact	Mid-Range	Low	Mid-Range	Low	
2. Financial Capability Indictors Score (Line 907)					
a. Actual Value	1.5	2.5	1.5	2.5	1002
b. Financial Indicator	Weak	Strong	Weak	Strong	
3. Financial Capability Matrix Category	High Burden	Low Burden	High Burden	Low Burden	1003

Section 1 Introduction

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal authority originally organized under the Pennsylvania Municipal Authorities Act of 1945 (P.L. 382), as amended and supplemented, pursuant to action taken by the Delaware County Council on October 20, 1971. Under County of Delaware Ordinance 2002-1, the term of existence of DELCORA was extended to January 15, 2052.

DELCORA prepared and submitted their original Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the PADEP in 1999. This LTCP was subsequently approved by the PADEP, and DELCORA had started to implement the CSO control elements selected in the LTCP. In 2009, the United States Environmental Protection Agency (USEPA) informed DELCORA that the original LTCP was not in compliance with the requirements of the USEPA's CSO Policy. As such, DELCORA prepared and submitted a revised LTCP in February 2012. Subsequent to the receipt of the revised LTCP, DELCORA and the USEPA had corresponded various times including requests for additional information from the USEPA in accordance with Section 308 of the Clean Water Act. A Consent Decree was ultimately executed between DELCORA, the Pennsylvania Department of Environmental Protection (PADEP) and USEPA, and was approved by the Federal District Court on November 10, 2015. The Consent Decree requires a revised LTCP to be prepared based on an agreed upon schedule, which will include interim deliverables and milestones that must be met.

DELCORA is in the process of revising its Long Term Control Plan (LTCP) Update for the Combined Sewer System (CSS) as part of the 2015 Consent Decree. As part of this comprehensive effort, a Draft Financial Capabilities Assessment (FCA), including information on sewer rate setting, median household income (MHI) and number of households in the LTCP Model Area, must be submitted within nine (9) months of the Date of Lodging. The Consent Decree defines the Model Area as being those areas that are hydraulically connected to the DELCORA Western Regional Treatment Plant (WRTP), as further defined herein. This Draft FCA has been prepared in accordance with the USEPA guidance document entitled Guidance for Financial Capability Assessment and Schedule Development (USEPA, 1997).

1.1 Description of the DELCORA Service Area

DELCORA is responsible for the collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains, and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 1-1. The total service area served by DELCORA is approximately 82,977 acres, as shown on Figure 1-2, which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

Figure 1-1: DELCORA's Conveyance System

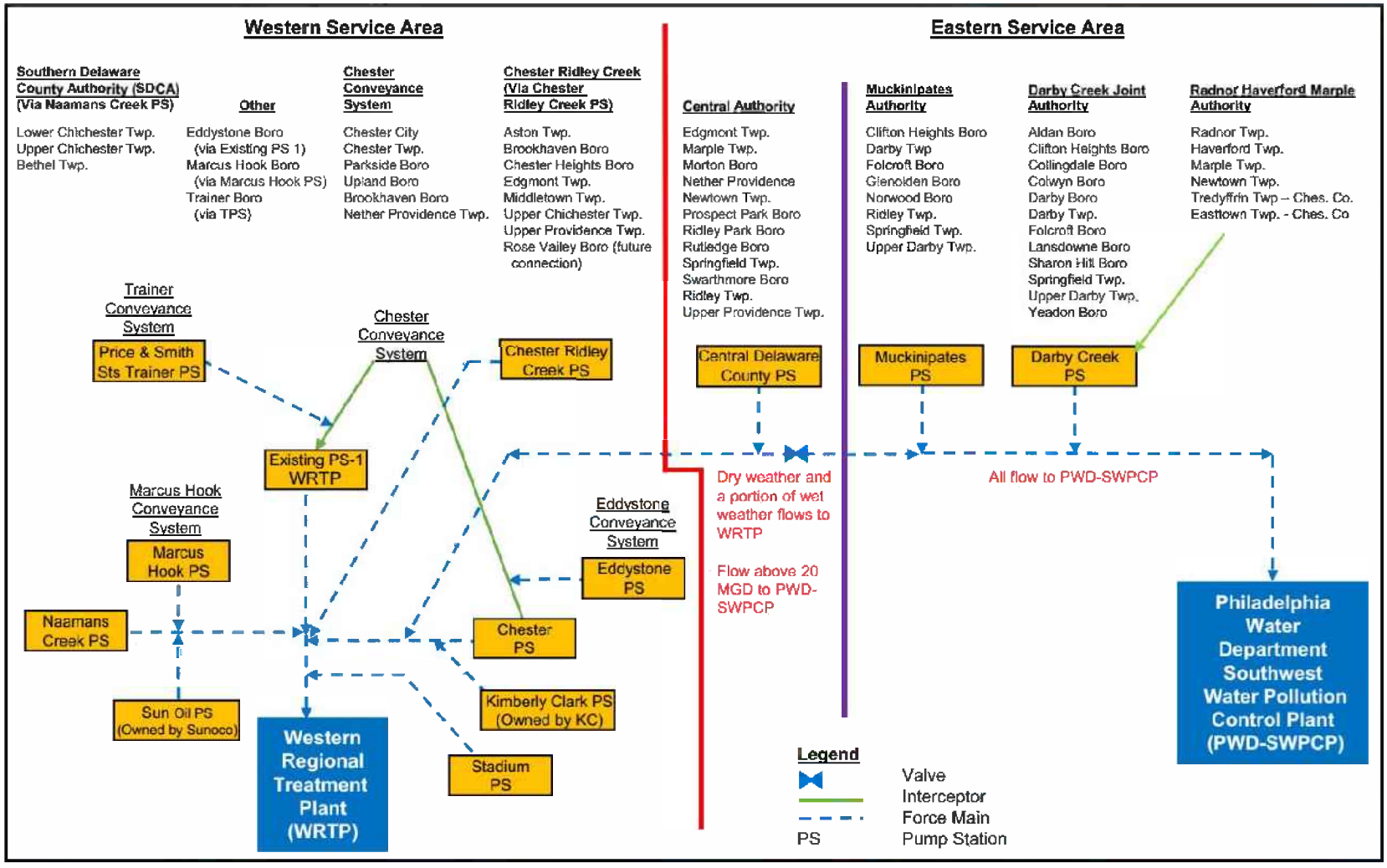
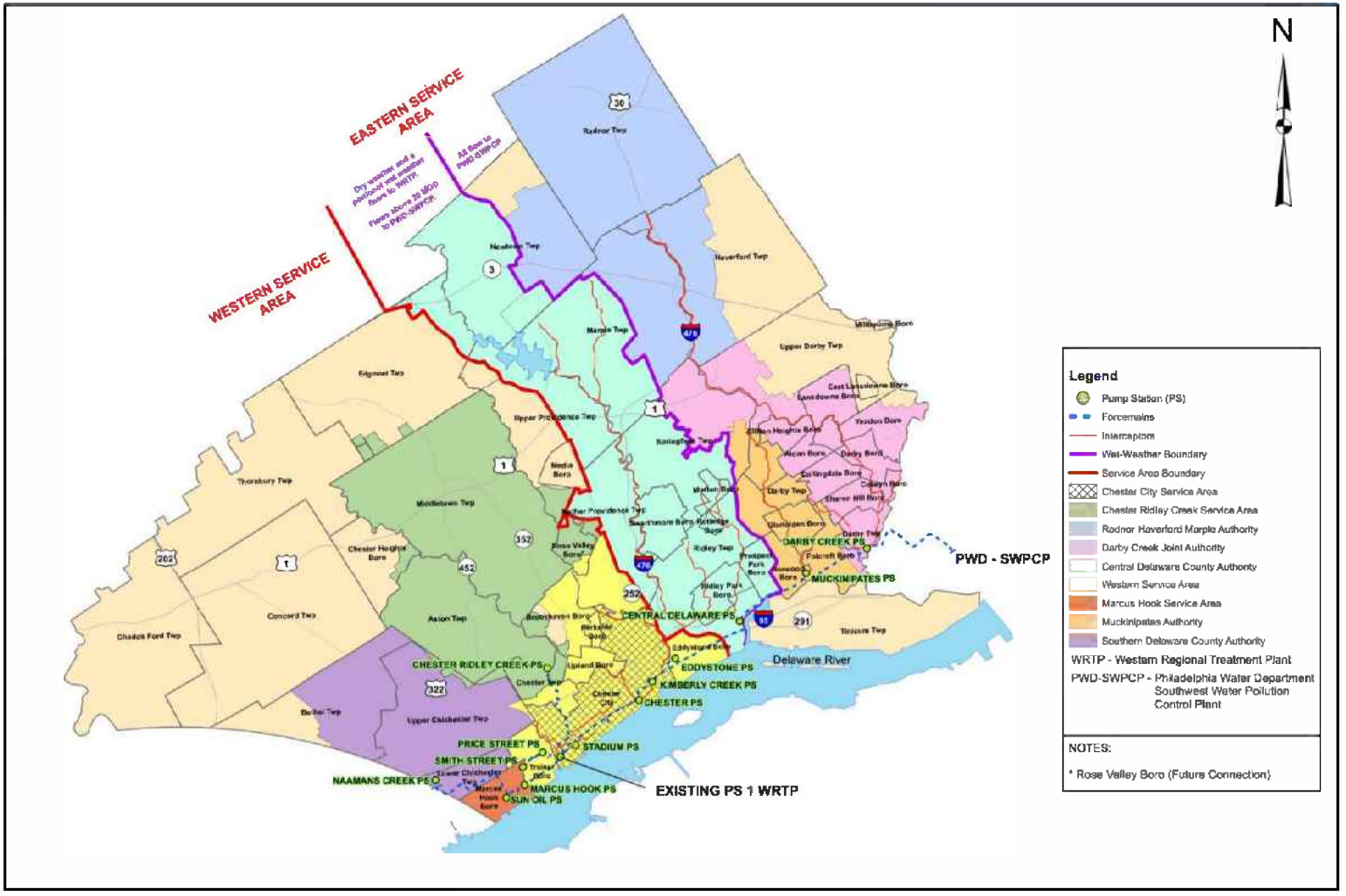


Figure 1-2: DELCORA's Service Area



Historically, DELCORA has characterized its service areas as "Eastern" and "Western". The Western service area discharges to DELCORA's WRTP. The Eastern service area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWD-SWPCP). Being hydraulically connected to the PWD-SWPCP, the Eastern Service Area will pay $427 million for a portion of the Philadelphia 25 year LTCP. In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are to be directed to the PWD-SWPCP. As such, dry weather flow and a portion of the wet weather flow from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

Under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0027103, issued and administered by the PADEP, DELCORA is authorized to discharge from the WRTP (Outfall 001), four storm water outfalls at the WRTP (028-031) and from 26 combined sewer overflow (CSO) outfalls (002-026, 032, 033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek. There are a total of 26 combined sewer overflow (CSO) outfalls listed with 25 discharge points (Outfalls 009 and 010 both discharge at Outfall 009) in DELCORA's existing NPDES Permit.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic (H&H) is located within Chester City and consists of a drainage area of approximately 1,150 acres. It comprises approximately half of Chester City's serviced area. To support this service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows. The location of Chester City's service area is illustrated in Figure 1-2.

1.1.1 Model Area

As described in the Consent Decree, this Draft FCA will evaluate the Model Area comprising those areas hydraulically connected to the WRTP. Paragraph 14.b of the Consent Decree describes the Model Area as follows:

> *… all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area").*

As shown in the schematic of DELCORA's conveyance system (see Figure 1-1), the conveyance system is divided into the Western Service Area and the Eastern Service Area. The Western Service Area discharges to DELCORA's WRTP and is therefore included in the Model Area. The Eastern Service Area is served by three pumps stations: the Central Delaware Pump Station, the Muckinipates Pump Station and the Darby Creek Pump Station. Up to 20 MGD (which includes both dry and wet weather flows) from the Central Delaware Pump Station can be pumped to, and thus is hydraulically connected to, DELCORA's WRTP. Therefore, municipalities connected to the Central Delaware Pump Station are considered part of the Model Area. Sewage from the Muckinipates Pump Station and the Darby Creek Pump Station flows to the PWD-SWPCP rather than to the WRTP. Therefore, municipalities connected

to these pump stations are not hydraulically connected to the WRTP and do not directly or indirectly influence CSOs or flow to the WRTP, and, therefore, are not considered part of the Model Area. In summary, the Model Area includes the municipalities in the Western Service Area plus those municipalities in the Eastern Service Area that are connected to the Central Delaware Pump Station, as described in Table 1-1.

Table 1-1: Model Area

Municipality ID No.	Municipality	Service Area
1	Aston Township	Western
2	Bethel Township	Western
3	Brookhaven Borough	Western
4	Chester City	Western
5	Chester Township	Western
6	Eddystone Borough	Western
7	Edgmont Township	Eastern
8	Lower Chichester Township	Western
9	Marcus Hook Borough	Western
10	Marple	Eastern
11	Middletown Township	Western
12	Morton	Eastern
13	Nether Providence	Eastern and Western
14	Newtown Township	Eastern
15	Parkside Borough	Western
16	Prospect Park	Eastern
17	Ridley Park Borough	Eastern
18	Ridley Township	Eastern
19	Rose Valley Borough	Western
20	Rutledge	Eastern
21	Springfield	Eastern
22	Swarthmore	Eastern
23	Trainer Borough	Western
24	Upland Borough	Western
25	Upper Chichester Township	Western
26	Upper Providence Township	Eastern and Western

Section 2 Consent Decree Requirements and EPA Guidance

2.1 Consent Decree Requirements

The Consent Decree requires DELCORA to submit

> *…a draft Financial Capability Assessment (FCA)in accordance with CSO Control Policy Paragraph II.C.8 and "Combined Sewer Overflows- Guidance for Financial Capability Assessment and Schedule Development," EPA 832-B-97-004, February 1997 ("1997 FCA Guidance"), as such guidance has been interpreted by EPA, including but not limited to information on sewer rate setting and median household income and number of households in the entire Model Area (as defined in Paragraph 14.b above), as well as information on all other financial resources available to DELCORA.*

However, the Consent Decree also recognizes that the draft FCA is not final. Since the draft FCA is being prepared in advance of the revised LTCP, the Consent Decree also includes requirements for a final FCA:

> *Concurrent with the submission of the LTCP, DELCORA shall submit to Plaintiffs for review and approval in accordance with the requirements of Section VI (Review and Approval of Submittals) a proposed final FCA, including an implementation schedule for the proposed CSO controls in accordance with CSO Control Policy Paragraph II.C.8 and the 1997 FCA Guidance.*

2.2 EPA Guidance

Per the EPA's CSO Control Policy (USEPA, 1994), "*EPA recognizes that financial considerations are a major factor affecting the implementation of CSO controls. For that reason, this Policy allows consideration of a permittee's financial capability in connection with the long-term CSO control planning effort, WQS review, and negotiation of enforceable schedules.*" Subsequent to the 1994 CSO Control Policy, EPA developed guidance for financial capability assessment based on a two-phase process described in their Guidance for Financial Capability Assessment and Schedule Development (USEPA, 1997).

2.2.1 Two-phase Assessment

The EPA's 1997 FCA guidance document uses a two-phased approach in the assessment of the financial capability of a municipality. The first phase develops a "Residential Indicator" that determines the financial impact of the current and proposed CSO controls on residential users. The residential indicator is the cost per household (CPH) of current and proposed wastewater treatment and CSO controls divided by Median Household Income (MHI). EPA has established the following financial impact benchmarks for the residential indicator:

Financial Impact	Residential Indicator (CPH as % MHI)
Low	Less Than 1.0 Percent of MHI
Mid-Range	1.0 – 2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI

The second phase in this assessment is used to determine a "Financial Capability Indicator", which shows the overall financial health of the Permittee. The financial capability indicator uses the following six indicators:

- Bond Ratings
- Overall Net Debt as a Percent of Full Market Property Value
- Unemployment Rate
- Median Household Income
- Property Tax Revenues as a Percent of Full Market Property Value
- Property Tax Collection Rate

A numerical score is assigned to each of the above indicators. The overall score is used to develop the overall financial capability indicator. The benchmarks for the overall financial capability indicator established by EPA are as follows:

Financial Impact Financial Capability Indicator	Overall Score
Weak	Below 1.5
Mid-Range	Between 1.5 and 2.5
Strong	Above 2.5

The residential and financial capability indictors are combined to assess the overall burden associated with funding CSO controls. The financial capability matrix, developed by EPA and shown in Table 2-1, is used to determine the overall level of burden on the Permittee and its residents.

Table 2-1: Financial Capability Matrix

Financial Capability Indicator	Residential Indicator (Cost Per Household as a % of MHI)		
	Low (1.0% and Below)	Mid-Range (Between 1.0% and 2.0%)	High (2.0% and Above)
Weak (1.5 and Below)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (2.5 and Above)	Low Burden	Low Burden	Medium Burden

2.2.2 EPA FCA Framework (2014)

Subsequent to the 1997 FCA guidance document, EPA released the 2014 Financial Capability Assessment Framework (USEPA, 2014) to clarify the "*…flexibilities built into the existing guidance that local governments or authorities can use in assessing their financial capability, and the relationship between that assessment and consideration of schedules for permit and consent decree implementation.*" In addition to the standard worksheets of the two-phase approach described above, EPA's guidance also allows permittees "*to submit any additional documentation that would create a more accurate and complete picture of their capability.*" The 2014 FCA Framework provides further explanation of this flexibility and of the type of information that may be used to illustrate the financial burdens of a locality.

As described in the 2014 FCA Framework, "*EPA will consider all CWA costs presented in the analysis described in the FCA Guidance"* such as "*…stormwater and wastewater; ongoing asset management or system rehabilitation programs; existing, CWA related capital improvement programs; collection systems and treatment facilities; and other CWA obligations required by state or other regulators. Where the costs of multiple CWA obligations are included in an FCA, each of those costs should be enumerated separately, so as to provide an understanding of how each contributes to the overall analysis."* Additional details of the 2014 FCA framework can be found in Appendix 2.

Section 3 Assumptions

3.1 Schedule and Planning Period

Based on the requirements of the Consent Decree, LTCP CSO control measures must be operational no later than August 2035 (20 years after the Date of Lodging). In alignment with this requirement, the Draft FCA Report assumes a planning period through the year 2035.

3.2 Funding Sources

Funding for the LTCP is assumed to be through revenue bonds. The inception dates described above define the years when a bond is issued and payments must start.

3.3 Interest Rate

The FCA is based on an assumed borrowing period of 20 years with a bond interest rate of 4 percent per year.

3.4 Inflation

3.4.1 Operation and Maintenance Costs

Based on the urban Consumer Price Index (CPI-U) produced by the Bureau of Labor Statistics, the long-term inflation rate (1913 to 2013) has been approximately three percent. For the period 1979-2013, the average annual change in the CPI-U has been 3.65 percent, although more recently (1999-2013) the average annual change in CPI-U has been roughly 2.4 percent. Operation and maintenance costs were assumed to increase at 3 percent per year.

3.4.2 Median Household Income

Compared to the CPI-U, MHIs generally have not kept pace with inflation. When evaluating the affordability of the LTCP program, the impact of wage stagnation should be considered since the buying power of the residential users will be diminished over time, resulting in an increase in the Residential Indicator. Comparing changes in the CPI-U to changes in the MHI shows that the MHI increased at slower rate than the CPI-U (see Table 3-1). For Delaware County, the annualized rise in MHI was 1.7 percentage points lower than the rise in CPI-U for the period 1979-2013 while for the same period, Chester City's MHI rose at 1.05 percentage points less than the CPI-U. For the period 1999-2013, the annualized rise in MHIs with respect to CPI-U was 0.67 percentage points lower for Delaware County and 2.0 percentage points lower for Chester City, respectively.

Table 3-1: Comparison of Rates of Change for CPI-U versus MHI

Time Period	Annualized Rate of Change in CPI-U	Delaware County		Chester City	
		Annualized Rate of Change in Delaware Co. MHI	Difference Between CPI-U and MHI Rates of Change	Annualized Rate of Change in Chester City MHI	Difference Between CPI-U and MHI Rates of Change
1979-2013	3.65%	1.93%	1.72%	2.60%	1.05%
1999-2013	2.44%	1.77%	0.67%	0.44%	2.00%

Overall, Delaware County MHI rose at 0.67-1.72 percentage points slower than the CPI-U, depending on the time period analyzed. Similarly, Chester City's MHI rose at 1.05- 2.00 percentage points lower than the CPI-U. In this Draft FCA, it is assumed that MHI will not keep pace with inflation. Using the long-term average inflation of 3 percent and assuming the MHI lags behind inflation by one percentage point, the assumed inflation rate for MHI will be 2 percent. Additional information regarding historical CPI-U and MHI can be found in Appendices 3 and 4.

3.5 Future Regulatory Requirements

The financial capability assessment is based on currently known regulatory requirements and currently known capital improvement projects. **No allowance has been made for potential costs that may be necessitated by future regulatory requirements that have not yet been enacted. It should be recognized that any such future regulatory requirements create a risk to the permittee's ability to fund future mandates alongside of LTCP requirements**.

Section 4 Financial Capabilities Assessment – Phase 1

This subsection calculates the cost per household and MHI, analyzes the distribution of household income, and develops the residential indicator. Per EPA guidance (EPA, 1997), the Phase 1 analysis includes two worksheets:

- Worksheet 1 – Cost per Household
- Worksheet 2 – Residential indicator

The structure of the worksheets is most suitable for permittees that are municipalities with sole responsibility for wastewater and sewer costs within its service area. DELCORA, however, differs from this situation in that it is a regional authority rather than a municipality. The service area encompasses multiple municipalities and also includes other authorities that act as intermediaries between DELCORA and residents of the municipalities. Each of these entities (DELCORA, intermediary authorities and municipalities) may impose costs on residential consumers. In general, residential billing can be divided into the following categories:

- Residents billed directly by DELCORA, with DELCORA being the sole source of wastewater and sewer costs;
- Residents billed directly by DELCORA, with both DELCORA and the local municipality being sources of wastewater and sewer costs;
- Residents billed by their local municipality, with both DELCORA and the local municipality being sources of wastewater and sewer costs. In this situation, the municipality passes along DELCORA's costs to the resident as part of the local municipality's bill; and
- Residents billed by their local municipality, with DELCORA and the local municipality being sources of wastewater and sewer costs and with an additional Authority located between DELCORA and the municipality also being a source of wastewater and sewer costs. In this situation, the municipality passes along DELCORA's and the intermediary Authority's costs to the resident as part of the local municipality's bill.

4.1 Cost per Household (Worksheet 1)

4.1.1 Current Costs

Current costs are comprised of existing operation and maintenance (O&M) expenses and debt service (principle and interest), while projected wastewater treatment and CSO costs were developed based on assumptions for future O&M and debt service for anticipated capital improvement projects. Costs for DELCORA's operation are based on 2015 rates (see Appendix 5 for description of rate policies). Within areas where DELCORA owns the collection system sewers and bills customers for collection and conveyance, costs are determined by multiplying the 2015 rates by the customer usage.

Determination of wastewater and storm water costs within the Model Area is complicated by the fact that DELCORA is not the only entity responsible for wastewater, sanitary sewer, combined sewer and storm sewer related costs. In some portions of the Model Area, there are additional costs due to other wastewater authorities and municipalities. In general, cost structures can be divided into the following categories:

- Areas where DELCORA is responsible for wastewater, sanitary and combined sewer costs;
- Areas where DELCORA is responsible for wastewater and some sewer costs, with municipalities responsible for additional sewer and storm water costs; and
- Areas where DELCORA is responsible for wastewater and some sewer costs; municipalities responsible for additional sewer and storm water costs; and another authority is responsible for additional sewer costs.

Determining costs at the municipality level is challenging due to the varying methods that each municipality uses for charging users. In some cases, municipality financial reports contain line item entries for wastewater revenues and for storm water revenues. However, some municipalities do not report these individual line items. Some state that costs are subsidized by other budgetary categories. It is possible that such costs are lumped together into line items other than wastewater and storm water and therefore not readily apparent. Given the number of entities imposing charges on the residential consumers and the absence of reported costs in some of the entities' financial reports, an alternative method of estimating current costs will be used.

In areas where DELCORA does not own the local collection sewers, it was assumed that DELCORA's unit costs for collection within the western service area can be used as a surrogate for the collection costs incurred by these municipalities. The unit cost was multiplied by each respective municipality's usage (i.e., flow) to estimate their wastewater collection costs. Current storm water costs have not been included in this analysis due to inconsistent reporting of these costs. However, for the final FCA to be submitted with the revised LTCP, the municipality storm water costs will be further evaluated to determine how they are accounted for and appropriate costs will be added to the final FCA.

4.1.2 Projected Costs

Projected costs are not limited to the costs for the LTCP Program. DELCORA, other Authorities served by DELCORA, and the local municipalities served by DELCORA all have projected costs related to their wastewater, sewer and storm water systems for items such as required improvements, replacement costs, and upgrades due to future regulatory requirements that are not related to the LTCP program. For each of these entities, costs for such projected capital improvement projects may result in additional burdens to the residents in the Model Area and, therefore, must be accounted for in the FCA. Such projected costs would include debt service for future projects as well as additional operation and maintenance (O&M) for any new infrastructure created by future projects. Debt service and O&M for projected costs will be based on the following assumptions:

- Projected Annual O&M: 1.5 percent of Capital Cost
- Project Debt Service: 20 year bond at 4 percent interest.

4.1.2.1 Projected Cost for DELCORA

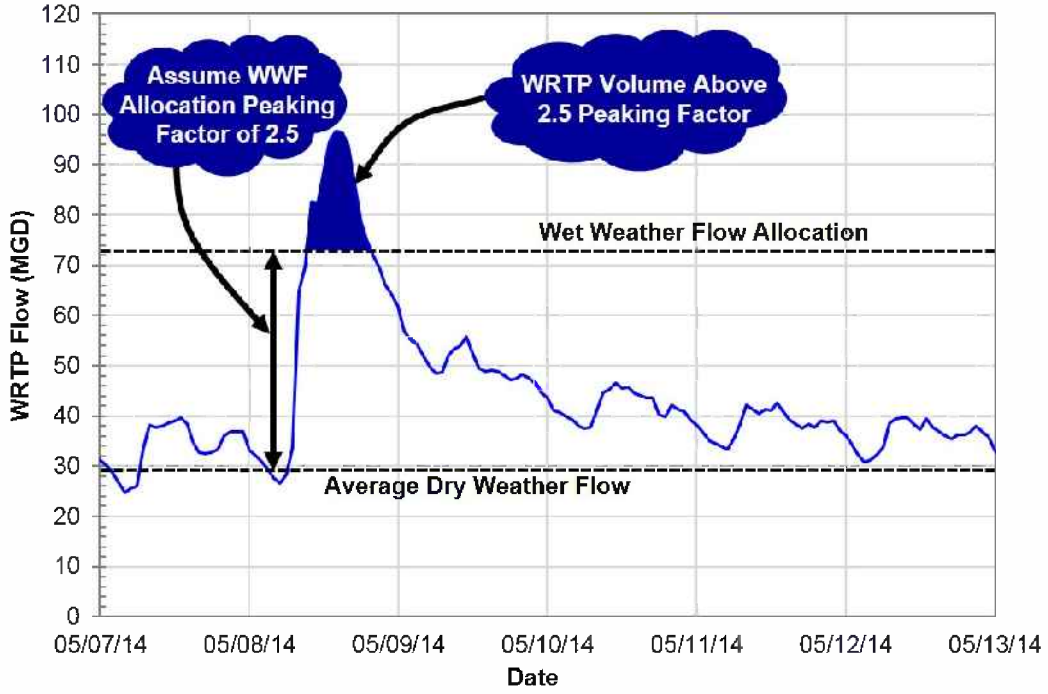
LTCP Costs

Because this Draft FCA is being prepared prior to the completion of the revised LTCP, final LTCP project alternatives have not yet been identified nor have cost estimates for such projects been completed. The approach taken for this Draft FCA is based on an evaluation of affordability as described in Executive Summary. In order to complete EPA's FCA methodology to calculate the residential indicators we need to establish a hypothetical LTCP cost. As derived in the Executive Summary above, LTCP cost estimate of $30,000,000 has been assumed. Associated operation and maintenance costs are based on the assumptions described in Section 3.

DELCORA's prior LTCP allocated all of the costs associated with the CSO projects to Chester City, which is the only customer with a combined sewer system. Per the Consent Decree, this Draft FCA will evaluate the Model Area comprising those areas hydraulically connected to the WRTP (see Section 1 for description of Model Area). Accordingly, allocation of costs for CSO abatement has been revised to distribute costs not to Chester City alone but rather to the Model Area customers in proportion to their contribution to CSO volume as well as excess volume generated from separate sewer communities within the Model Area during wet weather.

DELCORA's system serves a variety of customers from numerous municipalities in Delaware County, PA. The majority of the sewer systems within the Model Area have separated sanitary sewers, with the exception of a portion of Chester City, which is served by combined sewers. DELCORA has service agreements with the authorities, major industries, and a few municipalities. There are service agreements that indicate that the discharger will not share in any CSO related costs, because there was no direct discharge to the combined sewer system. However, most agreements indicate that authority, industry, or municipality shall not discharge excess wet weather flow to the DELCORA WRTP. Thus, for the purpose of the Draft FCA, the allocation of CSO LTCP costs to the separate sewer system is based on separate sewer system's share of the total Wet Weather Flow (WWF) volume. The separate sewer system's share is based on WRTP's WWF volume above a peaking factor 2.5. Figure 4-1 shows an example WRTP's WWF volume from a single storm event in May 2014.

Figure 4-1: Basis for Estimating Wet Weather Flow from Separate Sewer Areas



To estimate the total wet weather volumes shown in Table 4-1, the WRTP's WWF volumes from all storms above a peaking factor of 2.5 within the year were totaled and added to the annual CSO volume discharged.

Table 4-4-1: CSO Volume as Percent of Total Wet Weather Volume

Year	WRTP WWF Volume above 2.5 Peak Factor (MG)	CSO Volume (MG)	Total Wet Weather Volume (MG)	Percent CSO
2009	24.2	785	809.2	97%
2010	39.3	696	735.3	95%
2011	30.0	1144	1174.0	97%
2012	6.6	538	544.6	99%
2013	13.5	744	757.5	98%
Average	22.7	781.4	804.1	97%

Table 4-1 indicates that the separate sewer system has about a 3% to 5% share of the total wet weather volume. Further hydraulic evaluations are required to better understand the separate sewer system flows and refine the separate sewer system share of the CSO LTCP costs. Therefore for this Draft FCA, it is assumed 15 percent of CSO LTCP costs would be allocated to the separate sewer system and 85 percent of the CSO LTCP costs would allocated to combined sewer system in Chester City. For the final FCA, the updated hydrologic and hydraulic (H&H) model will be used to improve the estimate of CSO attributable to Chester City and to the remainder of the Model Area.

DELCORA Capital Improvement Costs

Projected costs for DELCORA's capital improvement programs were developed based on DELCORA's Capital Improvement Plan (CIP) which covers a 20-year planning period. Projected costs for DELCORA's CIP projects are shared by DELCORA customers based on the respective service agreements. Costs for some projects are allocated to specific customers when the project solely addresses the needs of those specific customers. Costs were also evaluated to determine the fraction of costs allocated to residential customers within any larger customer grouping.

4.2 Residential Share of Costs

To estimate the residential cost per household, an average annual water usage rate of 55,000 gallons/ household was used. This value is based on the residential water consumption for the Delaware County municipalities served by the Chester Water Authority (CWA) for the period 2010-2015. This usage multiplied by the number of households was used to estimate the residential share of the total usage for each entity.

4.3 Projected Municipal Separate Storm Sewer System (MS4) Storm Water Costs

Municipalities in DELCORA's service area will be subject to increased storm water (SW) costs as they implement MS4 requirements. No data is currently available from these municipalities. As a placeholder cost based on Richmond, VA annual SW cost of $45 per household (2016 dollars) will be used. Also, it will be assumed that costs will increase at an inflation rate of 3 percent per year. As Pennsylvania's communities develop their MS4 programs, data specific to the municipalities in DELCORA's service area may become available. For the final FCA to be submitted as part of the LTCP Update, SW costs will be re-evaluated and updated.

4.4 Cost per Household

Dividing the residential share of the WWT, CSO control and SW costs by the number of households approximates the annual cost per household as presented in Table 4-2.

Table 4-2: Worksheet 1 - Cost per Household

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
A. DELCORA's Cost					
1. Current WWT and CSO Costs in millions					
a. Annual O&M Expenses (Excluding Depreciation)	$ 3.2	$ 16.7	$ 3.2	$ 16.7	100
b. Annual Debt Service (Principle plus Interest)	$ 0.1	$ 4.5	$ 0.1	$ 4.5	101
c. Current WWT and CSO Costs (Line 100 + Line 101)	$ 3.4	$ 21.3	$ 3.4	$ 21.3	102
2. Projected WWT and CSO Costs in millions (Year 2035 Dollars)					
a. Additional Annual O&M Expenses	$ 3.1	$ 18.2	$ 0.3	$ 3.8	103
b. Additional Annual Debt Service (Principle plus Interest)	$ 2.2	$ 3.5	$ 1.2	$ 2.1	104
c. Projected Additional WWT and CSO Costs (Line 103 + Line 104)	$ 5.3	$ 21.7	$ 1.5	$ 5.9	105
3. Total Current and Projected WWT and CSO Costs in millions (Line 102 + Line 105)	$ 8.7	$ 43.0	$ 4.9	$ 27.2	106a
B. Other Local Collection System Costs (Year 2035 Dollars)	--	$ 24.3	--	$ 15.6	106b
C. Total Current & Projected WWT & CSO Costs (Year 2035 Dollars)	$ 8.7	$ 67.2	$ 4.9	$ 42.7	106c
D. Annual Volume in 1,000 gallons	828,789	8,409,265	828,789	8,409,265	
E. Cost per 1,000 gallons	$ 10.4	$ 8.0	$ 5.9	$ 5.1	
F. Annual Residential Flow Per Household in 1,000 gallons	55	55	55	55	107
G. Equivalent Households	15,069	152,896	15,069	152,896	108
H. WWT and CSO Cost Per Household in dollars	$ 575	$ 440	$ 323	$ 279	109a
I Projected SW Costs Per Household	$ 79	$ 79	$ 44	$ 44	109b
J Total WWT, CSO and SW Cost Per Household	$ 653	$ 519	$ 366	$ 323	109c

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

4.5 Development of the Residential Indicator (Worksheet 2)

Per USEPA guidance, the Residential Indicator (RI) is developed by dividing the cost per household (CPH) (from Table 4-3) by the median household income (MHI). The RI is intended as a means to judge

the residential economic burden resulting from payments for wastewater, sewer and storm water treatment and services.

4.5.1 Household Income Distribution

Household Income Distribution

Although the benchmark criteria for the residential indicator established by USEPA is based on MHI, the MHI is not representative of the distribution of income for the DELCORA Model Area. According to the U.S. Census Bureau's American Community Survey, 10 percent of the population in the Model Area have annual incomes that are below the poverty level while 33 percent of the population in the City of Chester have annual incomes that are below the poverty level. For the Model Area, this percentage is approximately two-thirds of the national poverty rate of 15.5 percent and approximately three-quarters of the Pennsylvania rate of 13.3 percent. For Chester City, this percentage is significantly higher at more than double compared to the Pennsylvania and the national value. Thus, the Model Area MHI alone may not be the most representative income bracket for determining the financial impact of increased CSO controls on the residential user in the poorer areas served by DELCORA. Therefore, the residential indicator has been developed for Chester City as well as the Model Area.

4.5.2 Median Household Income

The MHI for the City of Chester was estimated to be approximately $27,249 in 2013 dollars by the U.S. Census Bureau's American Community Survey (ACS). This was adjusted to Year 2035 using two percent inflation as described in Section 3 above, resulting in an adjusted MHI of $42,126.

The MHI for the DELCORA Model Area was estimated to be approximately $68,821 in 2013 using data from the ACS. The Model Area MHI is based on a weighted average of individual municipality MHIs using the number of households as the weighting factor. This weighted MHI was adjusted to Year 2035 using two percent inflation as described in Section 3 above, resulting in an adjusted MHI of $106,396.

4.5.3 Residential Indicators

The Median Household Income for Chester City and the DELCORA Model Area are shown in Table 4-3. Based on EPA's 1997 Guidance for Financial Capability, the Chester City residential indicator benchmark rating is "Mid-Range".

Table 4-3: Worksheet 2 - Median Household Income

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
A. Median Household Income (MHI)					
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 27,249	$ 68,821	$ 27,249	$ 68,821	201
2. Year of MHI Estimate: 2013	2013	2013	2013	2013	
3. FCA Analysis Year: 2035	2035	2035	2015	2015	
4. MHI Inflation Rate: 2%					
5. MHI Adjustment Factor	1.55	1.55	1.04	1.04	
6. Adjusted MHI (Line 201 x Line 202)	$ 42,126	$ 106,396	$ 28,350	$ 71,601	203
B. Annual WWT, CSO Control and SW Cost Per Household (CPH) - (Line 109)	$ 653	$ 519	$ 366	$ 323	204
C. Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	1.6%	0.5%	1.3%	0.5%	205
D. Benchmark	Mid-Range	Low	Mid-Range	Low	

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

Section 5 Financial Capabilities Assessment – Phase 2

The Phase 2 financial capability indicator was determined by scoring selected indicators that reflect the debt burden, socioeconomic conditions and financial operations. The current debt burden was assessed, as well as the ability to issue new debt to finance CSO controls, by evaluating the bond rating and the overall net debt as a percentage of full market property value. Socioeconomic conditions were evaluated by determining the unemployment rate and MHI. The financial operations were evaluated by assessing the property tax collection rate efficiency and the property tax revenues as a percentage of full market property value. Each of these factors are assigned a rating of "Weak", "Mid-Range" or "Strong" based on national benchmarks identified in the USEPA guidance document.

The scoring system used to develop the financial capability indicator assigns a numerical score to the national benchmarks as follows:

National Benchmark Rating	Score
Weak	1
Mid-Range	2
Strong	3

5.1 Worksheet 3 – Bond Rating

Per USEPA guidance, Worksheet 3 focuses on the bond rating of the permittee (DELCORA). However, the guidance is written as if the permittee is a municipality with taxing authority. DELCORA is an authority established to serve a community comprised of numerous municipalities in Delaware County, PA. As an authority, funding can be raised through revenue bonds, but not general obligation bonds. DELCORA does not have taxing authority nor does it have authority to require the municipalities in its service area to obtain general obligation bonds or to establish taxes for the payment of costs related to DELCORA's LTCP. Therefore, Table 5-1 summarizes Worksheet 3 based on municipalities' general obligation bond rating.

Table 5-1: Worksheet 3 - Bond Rating

Description	DELCORA	Chester City	Model Area	Line No.
A. Most Recent General Obligation Bond Rating				
1. Date		2012		
2. Rating agency		S&P	S&P	
3. Most recent rating		A (Suspended 1/6/2014)	AA	301
B. Most Recent Revenue Sewer Bond				
1. Date	2015			
2. Rating agency (Moody's or S&P)	Moody's			
3. Most recent rating	Aa3			302
C. Summary bond rating	Aa3	A (Suspended 1/6/2014)	AA	303
D. Benchmark				
1. Numerical Financial Indicator	3	2	3	
2. Financial Indicator	Strong	Mid-Range	Strong	

The City of Chester's "A" bond rating was withdrawn by S&P in 2014 due to lack of providing an audit for 2011. Therefore, it is expected that S&P will reduce the bond rating, which will place Chester City in the "Mid-Range" benchmark category. Of the 27 service area municipalities, ten have received bond ratings in the past five years. Table 5-2 below shows the bond ratings for those municipalities which have a bond rating in the past five years. Nine out of ten have a "strong" rating while the other has a "mid-range" rating. The composite rating based on a household weighted average is "strong".

Table 5-2: Summary of General Obligation Bond Ratings

Municipality	General Obligation Bond	Date	Rating Agency	Most Recent Rating	Category
Aston Township		10/1/2013	S&P	AA	3
Bethel Township		2014	Kroll	A+	3
Brookhaven Borough		Jan-14	S&P	AA-	3
City of Chester			S&P	Rating withdrawn 2014	
Eddystone Borough*		6/11/2014	S&P	BBB+	2
Marple		4/9/15	S&P	AA	3
Ridley Township			S&P	A+	3
Swarthmore			S&P	AA	3
Upland Borough	Series 2012 GO Notes	10/29/14	Kroll	A-	3
Upper Chichester Township			S&P	AA-	3
Upper Providence Township			S&P	AA-	3
Weighted Composite Rating					3

5.2 Worksheet 4 - Net Debt as Percent of Full Market Property Value

Worksheet 4 focuses on the debt repaid through property tax with respect to property value within the Model Area and is intended as a measure of a local government's ability to issue additional debt. Although this metric is not directly applicable to DELCORA as the permittee, since DELCORA is not a municipality with taxing power, Worksheet 4 has been prepared based on the methodology described below.

Line 401: Direct Net Debt

The City of Chester's Direct Debt was obtained from their 2012 Independent Audit, which was published in late 2014 (City of Chester, 2014). The other municipality general obligation debt was obtained from Municipal Annual Audit and Financial Reports (MAAFR) available on the State of Pennsylvania web site (PA MunStats, 2015). The most recent year available for most municipalities in the Model Area was for 2013, although there were some cases where 2013 reports were not available.

Where a municipality was only partly enclosed within the Model Area, the data was pro-rated based on the fraction of land area within the Model Area. This assumes that the number of households is evenly distributed within the municipality.

Line 402: Debt of Overlapping Entities

Overlapping entities with the authority to issue general obligation debt funded through property taxes were also included in the analysis of Worksheet 4. In some cases, the overlapping entity's geographic boundaries are not contiguous with a specific municipality. For example, a school district may serve more than one municipality within the Model Area. In these situations, the overlapping entity's debt assigned to a particular municipality was allocated based on the fraction of fair market value within each entity. Also, in cases where a portion of the overlapping entity falls outside of the Model Area, the overlapping entities debt was further pro-rated based on land area within the Model Area.

The overlapping entities identified include Delaware County and local school districts. Debt for Delaware County was obtained from their Comprehensive Annual Financial Report (year ended Dec. 31, 2013). Debt for school districts was based on end of fiscal year 2013-2014 information obtained from Pennsylvania state web site (PA Portal, 2015). Chester-Upland School District debt is based on information found in the 2011 bond statement for Chester Upland School District project (Chester Upland School District, 2011). A list of school districts overlapping with the Model Area is presented in the Table 5-3 below.

Table 5-3: Overlapping Entities – School Districts

Municipality	School District
Aston Township	Penn Delco
Bethel Township	Garnet Valley
Brookhaven Borough	Penn Delco
Chester City	Chester-Upland
Chester Township	Chester Upland
Eddystone Borough*	Ridley
Edgmont Township	Rose Tree Media
Lower Chichester Township	Chi Chester
Marcus Hook Borough	Chi Chester
Marple	Marple Newtown
Middletown Township	Rose Tree Media
Morton	Springfield
Nether Providence Township (partial)	Wallingford - Swarthmore
Newtown Township	Marple Newtown
Parkside Borough	Penn Delco
Prospect Park	Interboro
Ridley Park Borough	Ridley
Ridley Township	Ridley
Rose Valley Borough	Wallingford - Swarthmore
Rutledge	Wallingford Swarthmore
Springfield	Springfield
Swarthmore	Wallingford Swarthmore
Trainer Borough	Chi Chester
Upland Borough	Chester-Upland
Upper Chichester Township	Chi Chester
Upper Providence Township	Rose Tree Media

The results for worksheet 4 are presented in Table 5-4. Chester City has a rating of 1, which is considered "Weak". Viewed as a composite, the Model Area also would have an EPA rating of 2 which is considered mid-range. However, the Model Area is not a municipality and would not be able to incur debt. Individual municipalities within the Model Area would be capable of incurring debt through bonds, but the municipalities are not the permittee.

Table 5-4: Worksheet 4 – Overall Net Debt as a Percent of Full Market Property Value

	Description	Chester City	Model Area	Line No.
A	Direct Net Debt (G.O. Bonds Excluding Double-Barreled Bonds) within service area	$ 22,948,627	$ 83,347,338	401
B.	Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$ 46,181,397	$ 527,927,412	402
C.	Overall Net Debt (Line 401 + Line 402)	$ 69,130,024	$ 611,274,750	403
D.	Market Value of Property within Service Area	$ 516,553,848	$ 15,181,969,459	404
E.	Overall Net Debt as a Percentage of Full Market Property Value (Line 403/Line 404*100)	13.4%	4.0%	
F.	Benchmark			
	1. Financial Indicator	Weak	Mid-Range	
	2. Numerical Financial Indicator	**1**	**2**	

5.3 Worksheet 5 – Unemployment Rate

The Bureau of Labor Statistics does not report unemployment for municipalities with populations smaller than 25,000. Because only two of the municipalities in the Model Area are above this size limit, an estimate of the Model Area unemployment could not be developed. Instead, the Delaware County unemployment rate will be used as a surrogate for the Model Area. As shown in Table 5-5, the Delaware County unemployment rate is 0.3 percentage point above than the national unemployment rate, resulting in a mid-range rating. The Chester City's unemployment is 3.5 percentage points higher than the national unemployment. As such, Chester City's rating is considered weak.

Table 5-5: Worksheet 5 - Unemployment Rate

Description	Chester City	Model Area	Line No.
A. Unemployment Rate - Municipality Source: Homefacts, Bureau of Labor and Statistics	8.6%	--	501
B. Unemployment Rate - Delaware County Source: Bureau of Labor and Statistics	4.8%	4.8%	502
C. Average national unemployment rate Source: Bureau of Labor and Statistics	5.1%	5.1%	503
D. Benchmark			
1. Municipality Rate minus National Rate	3.5%	-0.3%	
2. Financial Indicator	Weak	Mid-range	
3. Numerical Financial Indicator	1	2	

5.4 Worksheet 6 – Median Household Income

Worksheet 6 compares the national MHI to the local MHI as a measure of the local community's earning capacity. Communities with an MHI more than 25 percent below the national MHI are rated as weak, communities with 25 percent of the MHI are rated as mid-range and communities more than 25 percent above the national MHI are rated as strong. As shown in Table 5-6, the Model Area is rated as strong with respect to the national MHI. Despite the model area as a whole being strong, this does not accurately portray the financial impact for each municipality. The Model Area has municipalities with a wide range of earning capacity. Chester City, the largest municipality in the Model Area, is rated as weak and falls significantly below the national MHI at almost half of the national value.

Table 5-6: Worksheet 6 - Median Household Income

Description	Chester City	Model Area	Line No.
A. Locality			
1. Municipality Median Household Income Source: US Census	$ 27,249	$ 68,821	
2. MHI Adjustment Factor			
a. Year of MHI Estimate	2013	2013	
b. FCA Analysis Year	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	
3. Adjusted MHI	$ 28,350	$ 71,601	601
B. National			
1. National Median Household Income Source: US Census	$ 53,046	$ 53,046	602
2. MHI Adjustment Factor			
a. Year of MHI Estimate	2013	2013	
b. FCA Analysis Year	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	603
3. Adjusted MHI	$ 55,189	$ 55,189	604
C. Benchmark			
1. Percent difference in MHI for U.S. and Municipality	-49%	30%	
2. Financial Indicator	Weak	Strong	
3. Numerical Financial Indicator	1	3	

5.5 Worksheet 7 – Property Tax Revenues as percent of Full Market Value

Worksheet 7 (see Table 5-7) provides a measure of the property tax burden and gives an indication of the ability of the community to support additional debt. While it is recognized that DELCORA does not have the ability to impose taxes to fund the CSO LTCP program, the analysis for Worksheet 7 has been prepared in accordance with EPA's guidance document (USEPA, 1997). The Model Area and Chester City receive a strong rating for this indicator. It should be noted that while Chester City has strong rating, this indicator does not reflect the true ability of Chester City to increase revenue from property taxes. For the purpose of the Draft FCA, Chester City will be shown as strong. However, it is recommended that Chester City be considered weak and studied further in final FCA. The Chester City property tax information is based on the 2012 Independent Audit, which was published in December of 2014 (City of Chester, 2014). For the remaining municipalities, property tax revenues were obtained from the MAAFRs (PA MunStats, 2015).

Table 5-7: Worksheet 7 – Property Tax Revenues as percent of Full Market Value

Description	Chester City	Model Area	Line No.
A. Full Market Property Value (Line 404)	$ 516,553,848	$ 19,803,029,357	701
B. Property Tax Revenue	$ 6,283,197	$ 70,889,731	702
C. Property Tax Revenue as a Percent of Full Market Property Value (702 / 701 x100%)	1.22%	0.36%	703
D. Benchmark			
1. Financial Indicator	Strong	Strong	
2. Numerical Financial Indicator	3	3	

5.6 Worksheet 8 – Property Tax Revenue Collection Rate

Worksheet 8 provides a measure of the property tax collection rate and the efficiency of the tax collection system. It also provides an indication of the acceptability of tax levels to residents. As shown in Table 5-8 the Model Area is rated as strong.

The City of Chester City is empowered by Pennsylvania to perform its own property assessments which results in assessed values that differ from Delaware County's assessment of the property in the City of Chester. Property taxes levied by the City of Chester are based on their own assessed values. The Chester City property tax information is based on the 2012 Independent Audit, which was published in December of 2014 (City of Chester, 2014). Assessments for other municipalities was obtained from the Pennsylvania State Tax Equalization Board web site (PA STEB/TED, 2015).

As shown in Table 5-8, the City of Chester's tax revenue collection rate is rated as weak. The 2013 Recovery Plan (City of Chester, 2013) also indicated that the reported collection rate of about 82 percent was consistent for the years 2005-2010. Therefore, the 2013 Recovery Plan support's Chester City "weak" rating.

Table 5-8: Worksheet 8 – Property Tax Revenue Collection Rate

Description	Chester City	Model Area	Line No.
A. Property Tax Revenues Collected (Line 702)	$ 6,283,197	$ 57,211,528	801
B. Levied Property Tax	$ 7,694,586	$ 58,699,061	802
C. Property Tax Revenue Collection Rate (Line 801/ Line 802 x 100)	81.7%	97.5%	803
D. Benchmark			
1. Financial Indicator	Weak	Mid-range	
2. Numerical Financial Indicator	1	2	

5.7 Worksheet 9 - Summary of Financial Capability Indicators

The average score for the financial indicator was calculated by dividing the sum of the scores by the number of entries. Table 5-9 summarizes the factors used to develop the financial capability indicator. The overall financial capability for the Model Area corresponds to a "Strong" rating. However, due to financial distressed conditions, Chester City's overall financial capability is "Weak".

Table 5-9: Worksheet 9 - Summary of Financial Capability Indicators

Indicator	Chester City			Model Area			Line Number
	Actual Value	Financial Indicator	Score	Actual Value	Financial Indicator	Score	
A. Bond Rating (Line 303)	A (Suspended 1/6/2014)	Mid-Range	2	AA	Strong	3	901
B. Overall Net Debt as a Percent of Full Market Property Value (Line 405)	13.4%	Weak	1	4.0%	Mid-Range	2	902
C. Unemployment Rate (Line 501)	8.6%	Weak	1	4.8%	Mid-Range	2	903
D. Household Income (Line 601)	28,350	Weak	1	71,601	Strong	3	904
E. Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	1.2%	Strong	3	0.4%	Strong	3	905
F. Property Tax Revenue Collection Rate (Line 803)	81.7%	Weak	1	97.5%	Mid-range	2	906
G. Permittee Indicators Score			1.5			2.5	907
H. Financial Indicator			Weak			Strong	

5.8 Worksheet 10 - Overall Financial Capability Matrix

The financial capability assessment combines the results from both the residential and financial capability indicators to determine the overall burden imposed on the residents. The financial capability matrix score is shown in Table 5-10 for the Model Area.

Table 5-10: Worksheet 10 - Overall Financial Capability Matrix

Description	2035 Basis		2015 Basis		Line No.
	Chester City	Model Area	Chester City	Model Area	
1. Residential Indicator Score (Line 205)					
a. Actual Value	1.4%	0.4%	1.1%	0.4%	1001
b. Financial Impact	Mid-Range	Low	Mid-Range	Low	
2. Financial Capability Indictors Score (Line 907)					
a. Actual Value	1.5	2.5	1.5	2.5	1002
b. Financial Indicator	Weak	Strong	Weak	Strong	
3. Financial Capability Matrix Category	High Burden	Low Burden	High Burden	Low Burden	1003

As shown in Table 5-10, the composite Model Area will have a "low" burden, while Chester City residents will have an overall "High Burden".

Section 6 Conclusions

As this Draft FCA is being prepared prior to the start of the LTCP Update, final LTCP project alternatives have not yet been identified nor have cost estimates for such projects been completed. With that in mind and in accordance with EPA's 1997 Guidance for Financial Capability, Chester City will have a "high burden" if the CSO LTCP costs are $30,000,000 with an 85 percent Chester City share. The methodology presented herein will be followed for the final FCA and will be submitted with the LTCP Update. It is recommended that the assumed proportional of the CSO program cost for Chester City be refined during the LTCP Update of the H&H model which will then be used to calculate the fraction of wet weather flow during CSO events attributable to each municipality.

Section 7 References

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Appendix 1: FCA Worksheets for Municipalities in Model Area

Appendix 1, Table 1: Cost per Household – Worksheet 1 (2035 Dollar Basis)

Description	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Southern	Eddystone Borough	Lower Chichester Township	Southwest	Central Delaware County Authority	Model Area	Line Number
A. DELCORA's Cost															
1. Current WWT and CSO Costs in millions															
a. Annual O&M Expenses (Excluding Depreciation)	$ 3.2	$ 0.2	$ 0.5	$ 0.2	$ 0.1	$ 0.2	$ 0.5	$ 0.6	$ 1.3	$ 0.2	$ 0.3	$ 2.4	$ 7.0	$ 16.7	100
b. Annual Debt Service (Principle plus Interest)	$ 0.1	$ 0.0	$ 0.0	$ 0.0	$ 0.2	$ 0.1	$ 0.5	$ 0.6	$ 0.4	$ 0.1	$ 0.1	$ 1.9	$ 0.5	$ 4.5	101
c. Current WWT and CSO Costs (Line 100 + Line 101)	$ 3.4	$ 0.2	$ 0.6	$ 0.2	$ 0.3	$ 0.3	$ 1.0	$ 1.2	$ 1.7	$ 0.3	$ 0.3	$ 4.3	$ 7.5	$ 21.3	102
2. Projected WWT and CSO Costs in millions (Year 2035 Dollars)															
a. Additional Annual O&M Expenses	$ 3.1	$ 0.1	$ 0.4	$ 0.1	$ 0.1	$ 0.2	$ 0.4	$ 0.5	$ 1.0	$ 0.2	$ 0.2	$ 1.9	$ 9.9	$ 18.2	103
b. Additional Annual Debt Service (Principle plus Interest)	$ 2.2	$ 0.0	$ 0.0	$ 0.0	$ 0.1	$ 0.0	-$ 0.3	-$ 0.4	$ 0.1	$ 0.0	$ 0.0	-$ 0.1	$ 1.8	$ 3.5	104
c. Projected Additional WWT and CSO Costs (Line 103 + Line 104)	$ 5.3	$ 0.2	$ 0.5	$ 0.1	$ 0.2	$ 0.2	$ 0.1	$ 0.1	$ 1.1	$ 0.2	$ 0.2	$ 1.9	$ 11.8	$ 21.7	105
3. Total Current and Projected WWT and CSO Costs in millions (Line 102 + Line 105)	$ 8.7	$ 0.3	$ 1.0	$ 0.3	$ 0.5	$ 0.5	$ 1.1	$ 1.3	$ 2.7	$ 0.5	$ 0.6	$ 6.2	$ 19.2	$ 43.0	106a
B. Other Local Collection System Costs (Year 2035 Dollars)	--	--	--	--	--	--	$ 1.1	$ 1.2	$ 2.7	$ 0.5	$ 0.5	$ 5.6	$ 12.7	$ 24.3	106b
C. Total Current and Projected WWT and CSO Costs (Year 2035 Dollars)	$ 8.7	$ 0.3	$ 1.0	$ 0.3	$ 0.5	$ 0.5	$ 2.2	$ 2.5	$ 5.4	$ 1.0	$ 1.1	$ 11.8	$ 31.9	$ 67.2	106c
D. Annual Volume in 1,000 gallons	828,789	43,409	133,793	41,196	37,605	54,980	316,951	367,693	795,568	145,250	163,501	1,679,000	3,801,530	8,409,265	
E. Cost per 1,000 gallons	$ 10.4	$ 7.8	$ 7.8	$ 7.8	$ 13.2	$ 9.5	$ 6.8	$ 6.8	$ 6.8	$ 6.8	$ 6.8	$ 7.0	$ 8.4	$ 8.0	
F. Annual Residential Flow Per Household in 1,000 gallons	55	55	55	55	55	55	55	55	55	55	55	55	55	55	107
G. Equivalent Households	15,069	789	2,433	749	684	1,000	5,763	6,685	14,465	2,641	2,973	30,527	69,119	152,896	108
H. WWT and CSO Cost Per Household Year (2035 dollars)	$ 575	$ 428	$ 428	$ 428	$ 725	$ 522	$ 374	$ 374	$ 374	$ 374	$ 374	$ 386	$ 462	$ 440	109a
I Projected SW Costs per Household (Year 2035 Dollars)	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	$ 79	109b
J. Combined WWT, CSO and SW Cost Per Household (Year 2035 Dollars)	$ 653	$ 507	$ 507	$ 507	$ 804	$ 601	$ 453	$ 453	$ 453	$ 453	$ 453	$ 465	$ 541	$ 519	109c

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

Appendix 1, Table 2: Cost Per Household – Worksheet 1 (2015 Dollar Basis)

Description	Chester City	Parkside Borough	Upland Borough	Chester Township	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Southern	Eddystone Borough	Lower Chichester Township	Southwest	Central Delaware County Authority	Model Area	Line Number
A. DELCORA's Cost															
1. Current WWT and CSO Costs in millions															
a. Annual O&M Expenses (Excluding Depreciation)	$ 3.2	$ 0.2	$ 0.5	$ 0.2	$ 0.1	$ 0.2	$ 0.5	$ 0.6	$ 1.3	$ 0.2	$ 0.3	$ 2.4	$ 7.0	$ 16.7	100
b. Annual Debt Service (Principle plus Interest)	$ 0.1	$ 0.0	$ 0.0	$ 0.0	$ 0.2	$ 0.1	$ 0.5	$ 0.6	$ 0.4	$ 0.1	$ 0.1	$ 1.9	$ 0.5	$ 4.5	101
c. Current WWT and CSO Costs (Line + Line)	$ 3.4	$ 0.2	$ 0.6	$ 0.2	$ 0.3	$ 0.3	$ 1.0	$ 1.2	$ 1.7	$ 0.3	$ 0.3	$ 4.3	$ 7.5	$ 21.3	102
2. Projected WWT and CSO Costs in millions (Year 2015 Dollars)															
a. Additional Annual O&M Expenses	$ 0.3	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 3.5	$ 3.8	103
b. Additional Annual Debt Service (Principle plus Interest)	$ 1.2	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	-$ 0.2	-$ 0.2	$ 0.0	$ 0.0	$ 0.0	-$ 0.2	$ 1.4	$ 2.1	104
c. Projected Additional WWT and CSO Costs (Line 103 + Line 104)	$ 1.5	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0	-$ 0.2	-$ 0.2	$ 0.0	$ 0.0	$ 0.0	-$ 0.2	$ 4.9	$ 5.9	105
3. Total Current and Projected WWT and CSO Costs in millions (Line + Line)	$ 4.9	$ 0.2	$ 0.6	$ 0.2	$ 0.3	$ 0.3	$ 0.8	$ 1.0	$ 1.7	$ 0.3	$ 0.4	$ 4.2	$ 12.3	$ 27.2	106a
B. Other Local Collection System Costs (Year 2015 Dollars)	–	–	–	–	–	–	$ 0.6	$ 0.7	$ 1.5	$ 0.3	$ 0.3	$ 3.1	$ 7.0	$ 15.6	106b
C. Total Current and Projected WWT and CSO Costs (Year 2015 Dollars)	$ 4.9	$ 0.2	$ 0.6	$ 0.2	$ 0.3	$ 0.3	$ 1.4	$ 1.7	$ 3.2	$ 0.6	$ 0.7	$ 7.3	$ 19.3	$ 42.7	106c
D. Annual Volume in 1,000 gallons	828,789	43,409	133,793	41,196	37,605	54,980	316,951	367,693	795,568	145,250	163,501	1,679,000	3,801,530	8,409,265	
E. Cost per 1,000 gallons	$ 5.9	$ 4.4	$ 4.4	$ 4.4	$ 8.4	$ 6.4	$ 4.5	$ 4.5	$ 4.0	$ 4.0	$ 4.0	$ 4.3	$ 5.1	$ 5.1	
F. Annual Residential Flow Per Household in 1,000 gallons	55	55	55	55	55	55	55	55	55	55	55	55	55	55	107
G. Equivalent Households	15,069	789	2,433	749	684	1,000	5,763	6,685	14,465	2,641	2,973	30,527	69,119	152,896	108
H. WWT and CSO Cost Per Household Year (2015 dollars)	$ 323	$ 244	$ 244	$ 244	$ 464	$ 350	$ 249	$ 249	$ 220	$ 220	$ 220	$ 238	$ 280	$ 279	109a
I Projected SW Costs per Household (Year 2015 Dollars)	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	$ 44	109b
J. Combined WWT, CSO and SW Cost Per Household (Year 2015 dollars	$ 366	$ 288	$ 288	$ 288	$ 508	$ 393	$ 292	$ 292	$ 264	$ 264	$ 264	$ 282	$ 324	$ 323	109c

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

Appendix 1, Table 3: Median Household Income – Worksheet 2 (2035 Dollar Basis)

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Median Household Income (MHI)																		
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 27,249	$ 51,103	$ 31,597	$ 44,353	$ 40,863	$ 39,167	$ 63,808	$ 98,608	$ 120,869	$ 68,294	$ 41,832	$ 53,460	$ 77,966	$ 63,808	$ 44,353	$ 85,593	$ 104,399	201
2. Year of MHI Estimate: 2013																		
3. FCA Analysis Year: 2035																		
4. MHI Inflation Rate: 2%																		
5. MHI Adjustment Factor	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	
6. Adjusted MHI (Line 201 x Line 202)	$ 42,126	$ 79,004	$ 48,848	$ 68,569	$ 63,173	$ 60,551	$ 98,646	$ 152,446	$ 186,861	$ 105,581	$ 64,671	$ 82,648	$ 120,534	$ 98,646	$ 68,569	$ 132,325	$ 161,399	203
B. Annual WWT, CSO and SW Control Cost Per Household (CPH) - (Line 109c)	$ 653	$ 507	$ 507	$ 507	$ 804	$ 601	$ 453	$ 453	$ 453	$ 453	$ 453	$ 453	$ 465	$ 465	$ 465	$ 465	$ 465	204a
C. Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	1.6%	0.6%	1.0%	0.7%	1.3%	1.0%	0.5%	0.3%	0.2%	0.4%	0.7%	0.5%	0.4%	0.5%	0.7%	0.4%	0.3%	205
D. Financial Impact	Mid-Range	Low	Mid-Range	Low	Mid-Range	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Median Household Income (MHI)														
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 114,355	$ 74,503	$ 59,022	$ 98,608	$ 93,565	$ 67,143	$ 57,516	$ 62,500	$ 71,923	$ 92,468	$ 117,604	$ 104,399	$ 68,821	201
2. Year of MHI Estimate: 2013														
3. FCA Analysis Year: 2035														
4. MHI Inflation Rate: 2%														
5. MHI Adjustment Factor	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	
6. Adjusted MHI (Line 201 x Line 202)	$ 176,791	$ 115,180	$ 91,247	$ 152,446	$ 144,650	$ 103,802	$ 88,919	$ 96,624	$ 111,191	$ 142,954	$ 181,813	$ 161,399	$ 106,396	203
B. Annual WWT, CSO and SW Control Cost Per Household (CPH) - (Line 109c)	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 541	$ 519	204a
C. Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	0.3%	0.5%	0.6%	0.4%	0.4%	0.5%	0.6%	0.6%	0.5%	0.4%	0.3%	0.3%	0.5%	205
D. Financial Impact	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

Appendix 1, Table 4: Median Household Income – Worksheet 2 (2015 Dollar Basis)

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Median Household Income (MHI)																		
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 27,249	$ 51,103	$ 31,597	$ 44,353	$ 40,863	$ 39,167	$ 63,808	$ 98,608	$ 120,869	$ 68,294	$ 41,832	$ 53,460	$ 77,966	$ 63,808	$ 44,353	$ 85,593	$ 104,399	201
2. Year of MHI Estimate: 2013																		
3. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
4. MHI Inflation Rate: 2%																		
5. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	
6. Adjusted MHI (Line 201 x Line 202)	$ 28,350	$ 53,168	$ 32,874	$ 46,145	$ 42,514	$ 40,749	$ 66,386	$ 102,592	$ 125,752	$ 71,053	$ 43,522	$ 55,620	$ 81,116	$ 66,386	$ 46,145	$ 89,051	$ 108,617	203
B. Annual WWT, CSO and SW Control Cost Per Household (CPH) - (Line 109c)	$ 366	$ 288	$ 288	$ 288	$ 508	$ 393	$ 292	$ 292	$ 264	$ 264	$ 264	$ 264	$ 282	$ 282	$ 282	$ 282	$ 282	204a
C. Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	1.3%	0.5%	0.9%	0.6%	1.2%	1.0%	0.4%	0.3%	0.2%	0.4%	0.6%	0.5%	0.3%	0.4%	0.6%	0.3%	0.3%	205
D. Financial Impact	Mid-Range	Low	Low	Low	Mid-Range	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
Median Household Income (MHI)														
1. MHI Based on 5-yr ACS, in 2013 dollars	$ 114,355	$ 74,503	$ 59,022	$ 98,608	$ 93,565	$ 67,143	$ 57,516	$ 62,500	$ 71,923	$ 92,468	$ 117,604	$ 104,399	$ 68,821	201
2. Year of MHI Estimate: 2013														
3. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
4. MHI Inflation Rate: 2%														
5. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	
6. Adjusted MHI (Line 201 x Line 202)	$ 118,975	$ 77,513	$ 61,406	$ 102,592	$ 97,345	$ 69,856	$ 59,840	$ 65,025	$ 74,829	$ 96,204	$ 122,355	$ 108,617	$ 71,601	203
Annual WWT, CSO and SW Control Cost Per Household (CPH) - (Line 109c)	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 324	$ 323	204a
Residential Indicator (CPH as % of MHI) - (Line 204/ Line 203 x 100)	0.3%	0.4%	0.5%	0.3%	0.3%	0.5%	0.5%	0.5%	0.4%	0.3%	0.3%	0.3%	0.5%	205
Financial Impact	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	

WWT - Wastewater Treatment
CSO - Combined Sewer Overflow
SW - Stormwater

Appendix 1, Table 5: Bond Rating – Worksheet 3

Description	DELCORA	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
										Southern									
		Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Most Recent General Obligation Bond Rating																			
1. Date		2012		10/29/2014				Jan-14		2,014		6/11/2014		10/1/2013					
2. Rating agency		S&P		Kroll				S&P		Kroll	S&P	S&P		S&P	S&P			S&P	
3. Most recent rating		A (Suspended 1/6/2014)	-	A-	-	-	-	AA-	-	A+	AA-	BBB+	-	AA	AA	-	-	AA-	301
B. Most Recent Revenue (Water/Sewer or Sewer) Bond																			
1. Date	2015																		
2. Rating agency (Moody's or S&P)	Moody's																		
3. Bond insurance (y/n) (Revenue bonds only)																			
4. Most recent rating	Aa3																		302
C. Summary bond rating	Aa3	A (Suspended 1/6/2014)																	303
D. Benchmark																			
1. Numerical Financial Indicator	3	2		3				3		3	3	2		3	3			3	
2. Financial Indicator	Strong	Mid-Range		Strong				Strong		Strong	Strong	Mid-Range		Strong	Strong			Strong	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Most Recent General Obligation Bond Rating														
1. Date														
2. Rating agency		S&P						S&P			S&P	S&P	S&P	
3. Most recent rating	-	AA	-	-	-	-	-	A+	-	-	AA	AA-	AA	301
B. Most Recent Revenue (Water/Sewer or Sewer) Bond														
1. Date														
2. Rating agency (Moody's or S&P)														
3. Bond insurance (y/n) (Revenue bonds only)														
4. Most recent rating														302
C. Summary bond rating														303
D. Benchmark													AA	
1. Numerical Financial Indicator		3						3			3	3	3	
2. Financial Indicator		Strong						Strong			Strong	Strong	Strong	

Appendix 1, Table 6: Overall Net Debt as a Percent of Full Market Property Value - Worksheet 4

	Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
										Southern									
		Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A	Direct Net Debt (G.O. Bonds Excluding Double-Barreled Bonds) within service area	$ 22,948,627	$ 498,976	$ 1,776,953	$ 0	$ 0	$ 1,776,603	$ 2,307,739	$ 1,561,757	$ 649,254	$ 4,874,480	$ 3,369,224	$ 0	$ 4,853,000	$ 646,656	$ 0	$ 10,650,000	$ 245,159	401
B.	Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$ 46,181,397	$ 6,388,154	$ 7,823,695	$ 7,497,564	$ 3,525,289	$ 6,164,971	$ 15,909,080	$ 19,722,217	$ 22,706,941	$ 49,666,084	$ 6,292,411	$ 5,259,349	$ 56,613,508	$ 4,810,249	$ 11,654,157	$ 33,420,942	$ 2,427,820	402
C.	Overall Net Debt (Line 401 + Line 402)	$ 69,130,024	$ 6,887,130	$ 9,600,648	$ 7,497,564	$ 3,525,289	$ 7,941,574	$ 18,216,818	$ 21,283,975	$ 23,356,195	$ 54,540,564	$ 9,661,635	$ 5,259,349	$ 61,466,508	$ 5,456,906	$ 11,654,157	$ 44,070,942	$ 2,672,978	403
D.	Market Value of Property within Service Area	$ 516,553,848	$ 140,432,669	$ 86,916,839	$ 82,419,118	$ 80,303,015	$ 140,432,669	$ 347,127,371	$ 406,831,393	$ 615,592,712	$ 1,131,350,161	$ 226,703,647	$ 119,803,390	$ 1,244,551,376	$ 97,269,279	$ 128,911,954	$ 1,546,015,387	$ 81,659,615	404
E.	Overall Net Debt as a Percentage of Full Market Property Value (Line 403/Line 404*100)	13.4%	4.9%	11.0%	9.1%	4.4%	5.7%	5.2%	5.2%	3.8%	4.8%	4.3%	4.4%	4.9%	5.6%	9.0%	2.9%	3.3%	
F.	Benchmark																		
	1. Financial Indicator	Weak	Mid-Range	Weak	Weak	Mid-Range	Weak	Weak	Weak	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Weak	Weak	Mid-Range	Mid-Range	
	2. Numerical Financial Indicator	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	

	Description	Central Delaware County Authority												Model Area	Line Number
		Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A	Direct Net Debt (G.O. Bonds Excluding Double-Barreled Bonds) within service area	$ 0	$ 2,789,733	$ 673,250	$ 3,036,697	$ 1,363,458	$ 44,183	$ 1,196,806	$ 10,961,760	$ 161,482	$ 2,468,340	$ 2,637,000	$ 1,856,202	$ 83,347,338	401
B.	Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$ 2,112,371	$ 28,596,246	$ 3,119,755	$ 37,631,416	$ 22,604,026	$ 8,885,890	$ 11,257,040	$ 39,899,577	$ 2,459,330	$ 25,959,609	$ 25,637,840	$ 13,700,483	$ 527,927,412	402
C.	Overall Net Debt (Line 401 + Line 402)	$ 2,112,371	$ 31,385,979	$ 3,793,005	$ 40,668,113	$ 23,967,484	$ 8,930,073	$ 12,453,846	$ 50,861,337	$ 2,620,812	$ 28,427,949	$ 28,274,840	$ 15,556,685	$ 611,274,750	403
D.	Market Value of Property within Service Area	$ 80,946,490	$ 1,347,335,866	$ 155,311,247	$ 791,047,234	$ 1,058,481,188	$ 295,032,728	$ 405,569,802	$ 1,430,596,670	$ 52,079,034	$ 1,259,726,502	$ 542,909,677	$ 618,279,943	$ 15,181,969,459	404
E.	Overall Net Debt as a Percentage of Full Market Property Value (Line 403/Line 404*100)	2.6%	2.3%	2.4%	5.1%	2.3%	3.0%	3.1%	3.6%	5.0%	2.3%	5.2%	2.5%	4.0%	
F.	Benchmark														
	1. Financial Indicator	Mid-Range	Mid-Range	Mid-Range	Weak	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Weak	Mid-Range	Weak	Mid-Range	Mid-Range	
	2. Numerical Financial Indicator	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	

Appendix 1, Table 7: Unemployment Rate - Worksheet 5

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Unemployment Rate - Municipality	8.6%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	501
Source: Homefacts,Bureau of Labor and Statistics																		
B. Unemployment Rate - Delaware County	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	502
Source: Bureau of Labor and Statistics																		
C. Average national unemployment rate	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	503
Source: Bureau of Labor and Statistics																		
D. Benchmark																		
1. Municipality Rate minus National Rate	3.5%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	
2. Financial Indicator	Weak	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	
3. Numerical Financial Indicator	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Unemployment Rate - Municipality	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.5%	4.8%	4.8%	4.8%	4.8%	–	501
Source: Homefacts,Bureau of Labor and Statistics														
B. Unemployment Rate - Delaware County	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	502
Source: Bureau of Labor and Statistics														
C. Average national unemployment rate	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	503
Source: Bureau of Labor and Statistics														
D. Benchmark														
1. Municipality Rate minus National Rate	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.6%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	
2. Financial Indicator	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	
3. Numerical Financial Indicator	2	2	2	2	2	2	2	2	2	2	2	2	2	

Appendix 1, Table 8: Median Household Income Comparison - Worksheet 6

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Locality																		
1. Municipality Median Household Income	$ 27,249	$ 51,103	$ 31,597	$ 44,353	$ 40,863	$ 39,167	$ 63,808	$ 98,608	$ 120,869	$ 68,294	$ 41,832	$ 53,460	$ 77,966	$ 63,808	$ 44,353	$ 85,593	$ 104,399	
Source: US Census																		
2. MHI Adjustment Factor																		
a. Year of MHI Estimate	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	
b. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	
3. Adjusted MHI	$ 28,350	$ 53,168	$ 32,874	$ 46,145	$ 42,514	$ 40,749	$ 66,386	$ 102,592	$ 125,752	$ 71,053	$ 43,522	$ 55,620	$ 81,116	$ 66,386	$ 46,145	$ 89,051	$ 108,617	601
B. National																		
1. National Median Household Income	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	602
Source: US Census																		
2. MHI Adjustment Factor																		
a. Year of MHI Estimate	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	
b. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	603
3. Adjusted MHI	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	604
C. Benchmark																		
1. Percent difference in MHI for U.S. and Municipality	-49%	-4%	-40%	-16%	-23%	-26%	20%	86%	128%	29%	-21%	1%	47%	20%	-16%	61%	97%	
2. Financial Indicator	Weak	Mid-Range	Weak	Mid-Range	Mid-Range	Weak	Mid-Range	Strong	Strong	Strong	Mid-Range	Mid-Range	Strong	Mid-Range	Mid-Range	Strong	Strong	
3. Numerical Financial Indicator	1	2	1	2	2	1	2	3	3	3	2	2	3	2	2	3	3	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Locality														
1. Municipality Median Household Income	$ 114,355	$ 74,503	$ 59,022	$ 98,608	$ 93,565	$ 67,143	$ 57,516	$ 62,500	$ 71,923	$ 92,468	$ 117,604	$ 104,399	$ 68,821	
Source: US Census														
2. MHI Adjustment Factor														
a. Year of MHI Estimate	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	
b. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	
3. Adjusted MHI	$ 118,975	$ 77,513	$ 61,406	$ 102,592	$ 97,345	$ 69,856	$ 59,840	$ 65,025	$ 74,829	$ 96,204	$ 122,355	$ 108,617	$ 71,601	601
B. National														
1. National Median Household Income	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	$ 53,046	602
Source: US Census														
2. MHI Adjustment Factor														
a. Year of MHI Estimate	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	2013	
b. FCA Analysis Year	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	
c. MHI Inflation Rate	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	
d. MHI Adjustment Factor	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	603
3. Adjusted MHI	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	$ 55,189	604
C. Benchmark														
1. Percent difference in MHI for U.S. and Municipality	116%	40%	11%	86%	76%	27%	8%	18%	36%	74%	122%	97%	30%	
2. Financial Indicator	Strong	Strong	Mid-Range	Strong	Strong	Strong	Mid-Range	Mid-Range	Strong	Strong	Strong	Strong	Strong	
3. Numerical Financial Indicator	3	3	2	3	3	3	2	2	3	3	3	3	3	

Appendix 1, Table 9: Property Tax Revenues as a Percent of Full Market Property Value - Worksheet 7

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Full Market Property Value (Line 404)	$ 516,553,848	$ 91,130,712	$ 86,916,839	$ 211,331,072	$ 80,303,015	$ 140,432,669	$ 541,287,028	$ 1,242,612,683	$ 851,442,202	$ 1,131,350,161	$ 226,703,647	$ 119,803,390	$ 1,244,551,376	$ 541,287,028	$ 211,331,072	$ 1,546,015,387	$ 1,166,565,930	701
B. Property Tax Revenue	$ 6,283,197	$ 641,259	$ 149,028	$ 1,591,862	$ 1,181,121	$ 1,400,678	$ 1,664,327	$ 4,072,907	$ 1,313,687	$ 4,481,438	$ 1,045,996		$ 3,678,340	$ 1,664,327	$ 1,591,862	$ 1,798,790	$ 3,180,481	702
C. Property Tax Revenue as a Percent of Full Market Property Value (702 / 701 x100%)	1.22%	0.70%	0.17%	0.75%	1.47%	1.00%	0.31%	0.33%	0.15%	0.40%	0.46%	0.00%	0.30%	0.31%	0.75%	0.12%	0.27%	703
D. Benchmark																		
1. Financial Indicator	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	
2. Numerical Financial Indicator	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Full Market Property Value (Line 404)	$ 674,554,080	$ 2,405,956,904	$ 155,311,247	$ 1,242,612,683	$ 2,116,962,376	$ 295,032,728	$ 405,569,802	$ 1,744,630,085	$ 52,079,034	$ 2,332,826,856	$ 542,909,677	$ 1,166,565,930	$ 19,803,029,357	701
B. Property Tax Revenue	$ 412,812	$ 7,321,267	$ 939,219	$ 4,072,907	$ 4,277,085	$ 1,840,540	$ 2,311,315	$ 10,454,725	$ 169,482	$ 8,679,467	$ 2,000,708	$ 4,492,831	$ 70,889,731	702
C. Property Tax Revenue as a Percent of Full Market Property Value (702 / 701 x100%)	0.06%	0.30%	0.60%	0.33%	0.20%	0.62%	0.57%	0.60%	0.33%	0.37%	0.37%	0.39%	0.36%	703
D. Benchmark														
1. Financial Indicator	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	
2. Numerical Financial Indicator	3	3	3	3	3	3	3	3	3	3	3	3	3	

Notes:
N.D. indicates no data.
Full Market Property Values are not corrected for portions of municipalities that do not fall within DELCORA's service area.
Full Market Property Value for Lower Chichester Township was $119,803,390. However, Lower Chichester Township was not included because property tax revenue data was not available.

Appendix 1, Table 10: Property Tax Revenue Collection Rate - Worksheet 8

Description	Retail Customers						Wholesale Customers		Western				Southwest					Line Number
									Southern									
	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township	
A. Property Tax Revenues Collected (Line 702	$ 6,283,197	$ 641,259	$ 149,028	$ 1,591,862	$ 1,181,121	$ 1,400,678	$ 1,664,327	$ 4,072,907	$ 1,313,687	$ 4,481,438	$ 1,045,996		$ 3,678,340	$ 1,664,327	$ 1,591,862	$ 1,798,790	$ 3,180,481	801
B. Levied Property Tax	$ 7,694,586	$ 645,042	$ 145,396	$ 1,477,322	$ 1,217,681	$ 1,433,237	$ 1,710,187	$ 4,088,365	$ 1,311,918	$ 4,413,476	$ 1,082,355		$ 3,676,201	$ 1,710,187	$ 1,477,322	$ 1,813,749	$ 3,221,019	802
C. Property Tax Revenue Collection Rate (Line 801/ Line 802 x 100)	81.7%	99.4%	102.5%	107.8%	97.0%	97.7%	97.3%	99.6%	100.1%	101.5%	96.6%		100.1%	97.3%	107.8%	99.2%	98.7%	803
D. Benchmark																		
1. Financial Indicator	Weak	Strong	Strong	Strong	Mid-range	Mid-range	Mid-range	Strong	Strong	Strong	Mid-range		Strong	Mid-range	Strong	Strong	Strong	
2. Numerical Financial Indicator	1	3	3	3	2	2	2	3	3	3	2		3	2	3	3	3	

Description	Central Delaware County Authority												Model Area	Line Number
	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)		
A. Property Tax Revenues Collected (Line 702	$ 412,812	$ 7,321,267	$ 939,219	$ 4,072,907	$ 4,277,085	$ 1,840,540	$ 2,311,315	$ 10,454,725	$ 169,482	$ 8,679,467	$ 2,000,708	$ 3,180,481	$ 57,211,528	801
B. Levied Property Tax	$ 417,145	$ 7,376,891	$ 960,233	$ 4,088,365	$ 3,831,186	$ 1,893,697	$ 2,357,063	$ 10,544,585	$ 177,270	$ 8,732,416	$ 2,026,604	$ 3,221,019	$ 58,699,061	802
C. Property Tax Revenue Collection Rate (Line 801/ Line 802 x 100)	99.0%	99.2%	97.8%	99.6%	111.6%	97.2%	98.1%	99.1%	95.6%	99.4%	98.7%	98.7%	97.5%	803
D. Benchmark														
1. Financial Indicator	Strong	Strong	Mid-range	Strong	Strong	Mid-range	Strong	Strong	Mid-range	Strong	Strong	Strong	Mid-range	
2. Numerical Financial Indicator	3	3	2	3	3	2	3	3	2	3	3	3	2	

Note:
Data not available for Lower Chichester Township

Appendix 1, Table 11: Summary of Financial Capability Indicators - Worksheet 9

Indicator	Chester City			Model Area			Line Number
	Actual Value	Financial Indicator	Score[1]	Actual Value	Financial Indicator	Score[1]	
A. Bond Rating (Line 303)	A (Suspended 1/6/2014)	Mid-Range	2	AA	Strong	3	901
B. Overall Net Debt as a Percent of Full Market Property Value (Line 405)	13.4%	Weak	1	4.0%	Mid-Range	2	902
C. Unemployment Rate (Line 501)	8.6%	Weak	1	4.8%	Mid-Range	2	903
D. Household Income (Line 601)	28,350	Weak	1	71,601	Strong	3	904
E. Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	1.2%	Strong	3	0.4%	Strong	3	905
F. Property Tax Revenue Collection Rate (Line 803)	81.7%	Weak	1	97.5%	Mid-range	2	906
G. Permittee Indicators Score (Sum of Column B / Number of Entries)			1.5			2.5	907
H. Financial Indicator[2]			Weak			Strong	

Note:
1. Scoring Benchmarks
   - Weak: 1
   - Mid-Range: 2
   - Strong: 3
2. Financial Indicator Benchmarks
   - Weak 1.5 and Below
   - Mid-Range: Between 1.5 and 2.5
   - Strong: 2.5 and Above

Appendix 1, Table 12: Financial Capability Matrix Score - Worksheet 10 (2035 Dollar Basis)

Description	Chester City	Model Area	Line Number
1. Residential Indicator Score (Line 205)			
a. Actual Value	1.6%	0.5%	1001
b. Financial Impact	Mid-Range	Low	
2. Permittee Financial Capability Indictors Score (Line 907)			
a. Actual Value	1.5	2.5	1002
b. Financial Indicator	Weak	Strong	
3. Financial Capability Matrix Category	High Burden	Low Burden	1003

Appendix 1, Table 13: Financial Capability Matrix Score - Worksheet 10 (2015 Dollar Basis)

Description	Chester City	Model Area	Line Number
1. Residential Indicator Score (Line 205)			
a. Actual Value	1.3%	0.5%	1001
b. Financial Impact	Mid-Range	Low	
2. Permittee Financial Capability Indictors Score (Line 907)			
a. Actual Value	1.5	2.5	1002
b. Financial Indicator	Weak	Strong	
3. Financial Capability Matrix Category	High Burden	Low Burden	1003

Appendix 2: EPA FCA Framework 2014

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 2 4 2014

MEMORANDUM

SUBJECT: Financial Capability Assessment Framework for Municipal Clean Water Act Requirements

FROM: Ken Kopocis
Deputy Assistant Administrator
Office of Water (OW)

Cynthia Giles
Assistant Administrator
Office of Enforcement and Compliance Assurance (OECA)

TO: Regional Administrators
Regional Water Division Directors
Regional Enforcement Division Directors

In May of 2012, we distributed the Integrated Municipal Stormwater and Wastewater Planning Approach Framework (Integrated Planning Framework). Since that time, we have made solid progress in promoting integrated approaches to meet Clean Water Act (CWA) obligations. Thanks to the hard work of regional and headquarters staff, and the active engagement of cities, many of our enforcement settlements now embody integrated planning principles in the structure and schedule for injunctive relief or explicitly include integrated planning as part of the settlement. We have also seen an increasing number of municipalities and local authorities moving towards developing integrated plans to support the development of their NPDES permits. We have been working with EPA Regions and States to assist in that process.

As the implementation of the Integrated Planning Framework has progressed and evolved, we have been actively engaged with stakeholders on ways to build on our efforts. Those discussions found a natural focus on issues related to the financial capability of permittees working toward our shared goals of clean water. One consistent theme that emerged was the benefit of more clearly articulating the flexibility available under the existing guidance. EPA continues to be guided by the 1997 "Combined Sewer Overflows – Guidance for Financial Capability Assessment

and Schedule Development" (FCA Guidance) that provides an aid for assessing financial capability as part of negotiating schedules for implementing CWA requirements for municipalities and local authorities. The FCA Guidance also encourages permittees "to submit any additional documentation that would create a more accurate and complete picture of their financial capability" that may "affect the conclusion" of the analysis described in the guidance.

As part of EPA's commitment to implementing CWA objectives in a sustainable manner, we have developed the attached "Financial Capability Assessment Framework" (FCA Framework). The FCA Framework has been greatly informed by the comments and experiences of a variety of stakeholders and financial experts. The FCA Framework identifies the key elements EPA uses in working with permittees to evaluate how their financial capability should influence schedules. In addition, the FCA Framework provides examples of additional information that may help some communities provide a "more accurate and complete picture" of their financial capability as is envisioned in the FCA guidance. We will be posting the FCA Framework to our website as an important next step in the pursuit of integrated planning approaches and in our ongoing work with municipalities and local authorities to achieve our shared goals of protecting our nation's waters. While this memorandum releases the FCA Framework, we know that we will continue to learn and refine our understanding of the issues surrounding financial capability assessments as we use it moving forward. We will continue to look for ways to improve the Framework as we gain new insights and additional information.

We look forward to continue working with the Regions on these important issues and encourage you to contact Deborah Nagle, Director, Water Permits Division (nagle.deborah@epa.gov) and Mark Pollins, Director, Water Enforcement Division (pollins.mark@epa.gov) with any questions you might have.

Attachment

cc: Regional Permit and Enforcement Liaisons

FINANCIAL CAPABILITY ASSESSMENT FRAMEWORK

November 24, 2014

Purpose

The Environmental Protection Agency (EPA) is committed to working with state and local government partners to assist local municipalities and local authorities to meet Clean Water Act (CWA) obligations in a manner that recognizes the unique financial challenges that local jurisdictions face. This financial capability assessment framework is intended to provide additional examples and greater clarity on the flexibilities built into existing guidance that local governments or authorities can use in assessing their financial capability, and the relationship between that assessment and consideration of schedules for permit and consent decree implementation. This framework builds on the progress already made in the May 2012 "Integrated Municipal Stormwater and Wastewater Planning Approach Framework," and the experience gained from talking with communities about their financial capability in actual, on the ground circumstances. Integrated Planning has been helping in identifying a permittee's relative priorities for projects based on the relative importance of adverse impacts on human health and water quality and the municipality's financial capability.

Background

Local governments and authorities want to provide clean water for their communities, and they play an essential role in providing wastewater and stormwater infrastructure and services for their citizens, businesses and institutions. These municipal functions have been an important part of implementing the CWA to protect public health and improve water quality in streams, lakes, bays, and other waters nationwide. However, significant water quality challenges remain. Public officials remain strong supporters of the CWA goals and objectives by directing the public investments that are necessary to comply with the Act and to provide clean water for their citizens. Many local governments face complex water quality issues that are heightened by the need to address population growth or decline, increases in impervious surfaces, source water supply needs, and aging infrastructure. In recent years, many local governments and authorities have increased investments in their wastewater and stormwater infrastructure through capital projects to rehabilitate existing systems, improve operation and maintenance, and address additional regulatory requirements. As programs are implemented to improve water quality and attain CWA objectives, many state and local government partners find themselves facing difficult economic challenges with limited resources and financial capability. We recognize these challenging conditions and are working with states and local governments to develop and implement new approaches that will achieve water quality goals at lower costs and in a manner that addresses the most pressing problems first.

Long-term approaches to meeting CWA objectives should be sustainable and within a local government or authority's financial capability. The financial capability of these entities and other relevant factors are important to consider when developing appropriate schedules for infrastructure projects in permits or enforcement actions to help protect human health and the environment. EPA's financial capability assessment guidance, "Combined Sewer Overflows:

Guidance for Financial Capability Assessment and Schedule Development" (FCA Guidance) (EPA 832-B-97-004) provides a reference point to aid all parties in negotiating reasonable and effective schedules for implementing CWA requirements, and the flexibility to take into account local considerations that may not be fully captured by the approach detailed in the guidance. As described in more detail in this Framework, the guidance provides for consideration of the impact on residential rate payers and the financial capability of the permittee using a suite of indicators, as well as allowing schedules to be responsive to circumstances unique to that community, while advancing the mutual goal to protect clean water. The FCA Guidance encourages permittees to provide any additional information that would be useful in understanding those unique or atypical circumstances and how they may affect CWA schedules, so that all relevant information presented by a community can be taken into account to ensure that a full understanding of financial capability guides the development of schedules.

Financial Capability Assessment

The following are key elements of EPA's approach to the evaluation of the financial capability of municipalities to inform implementation schedules, both in permits and enforcement actions. The elements are fully compatible with the FCA Guidance, integrated planning approaches, and the flexibility embodied in both.

1. **The 1997 FCA Guidance identifies a valuable assessment that provides a common basis for financial burden discussions between the permittee, EPA and state NPDES authorities. Permittees have the option of submitting additional information that would create a more accurate and complete picture of their financial conditions.** The financial capability assessment described in the 1997 FCA Guidance identifies information that provides a basis for a general comparison of financial conditions between communities across the country and provides a consistent assessment of basic financial indicators as part of the overall analysis. Additional information that the community provides on its unique financial circumstances will be considered so that schedules take local considerations into account. Where appropriate, this information can result in schedules that are different than the schedules suggested by the baseline analysis suggested in the 1997 FCA Guidance.

2. **Financial capability is on a continuum.** Although the FCA Guidance approach categorizes financial burden as "high, medium, or low," this does not mean that schedules will be rigidly set according to the break points between the categories. For example, two communities whose total residential share of costs are 1.1% and 1.9% of median household income (MHI) are both categorized in the FCA Guidance as having a "medium" burden for the Residential Indicator (RI). All other things being equal, the appropriate schedules for those communities are likely to be different. Similarly, all other things being equal, two communities whose residential share of costs are 1.9% and 2.1% of MHI would be more likely to have similar overall compliance timeframes, even though one community is ranked as having a "medium" burden and the other as having a "high" burden. Finally, additional information submitted by the community may affect the length of the schedule regardless of where the community is on the "high, medium, and low" continuum.

3. **EPA will consider all CWA costs presented in the analysis described in the FCA Guidance**. EPA originally published the FCA Guidance to assist in negotiating schedules for communities with combined sewer systems, as these typically represent the most expensive CWA compliance issues. The FCA Guidance has since been recognized as equally suitable for considering other municipal CWA obligations as well, such as those related to separate sanitary sewer systems. With the release of EPA's 2012 Integrated Planning Framework, the Agency clarified that the financial capability analysis could include costs of: stormwater and wastewater; ongoing asset management or system rehabilitation programs; existing, CWA related capital improvement programs; collection systems and treatment facilities; and other CWA obligations required by state or other regulators. Where the costs of multiple CWA obligations are included in an FCA, each of those costs should be enumerated separately, so as to provide an understanding of how each contributes to the overall analysis.

4. **When presented, Safe Drinking Water Act (SDWA) obligations will be considered, primarily as additional information about a permittee's financial capability.** EPA believes that the SDWA obligations of a community can be an important consideration in establishing schedules for implementing integrated plans. EPA recognizes that both clean water and drinking water costs are often covered through charges on a single rate base. One component of a financial capability assessment includes an evaluation of the residential indicator that is based on only CWA costs as this best reflects the intended use of the metric and allows for comparisons with other communities. Drinking water costs may be reflected in other components of a financial capability assessment. For example, the financial capability indicator includes consideration of bond rating of the entity that issues debt to fund the permittee's capital project, which can be impacted by both wastewater and drinking water obligations for a permittee that provides both services. If a community has incurred general obligation debt associated with the SDWA, these obligations would be considered in the indicator "overall net debt as a percent of full market property value." In addition, as discussed below, additional information, including information regarding drinking water obligations, may be submitted for consideration in analyzing financial capability. To the extent that drinking water costs are not fully addressed by these other components, communities are encouraged to provide additional information about these costs.

5. **Communities should demonstrate how the CWA work included as costs in the financial capability assessment will be implemented, including appropriate assurances that those expenditures will be made.**

The Financial Capability Assessment Guidance and Examples of Additional Information that are Relevant to a Consideration of Financial Capability

The specific approaches laid out in the FCA Guidance provide a good foundation for the assessment of financial capability. As stated in the guidance and outlined in this Framework, communities can build on that foundation to include additional relevant information. The FCA Guidance presents a two-phased approach to assessing overall financial capability. The first phase assesses the impact on residential customers, and the first step is to calculate the portion of

the annual costs that would be borne by residential households for both current and projected Clean Water Act related expenses. The residential share of the annual costs of CWA obligations is then compared to the MHI of the service area. MHI is calculated using current census data and may be adjusted based on the current Consumer Price Index. Finally, the CWA compliance costs per household are divided by the adjusted MHI to calculate the residential indicator (RI). The FCA Guidance then identifies various ranges of RI scores as "low, mid-range or high" levels of burden. In situations where there are unique circumstances that would affect the conclusion of the first phase of the assessment, additional information documenting unique financial conditions may be submitted.

The second phase of the financial capability analysis assesses the financial strength of the permittee. Six indicators are used to evaluate the debt, socioeconomic and financial conditions that affect a permittee's financial capability to implement CWA controls necessary for compliance with the Act. These include bond ratings, overall net debt as a percent of full market property value, unemployment rate, median household income, property tax revenue collection rate, and property taxes as a percent of full market property value. In the Guidance, EPA has established benchmarks for each of the six indicators showing whether the indicator reflects a "weak", "mid-range", or "strong" financial capability. These benchmarks are used to generate an overall score of a permittee's financial capability.

The residential indicator calculated in phase one and the permittee capability indicators analyzed in phase two are evaluated together in a Financial Capability Matrix to assess the level of financial burden. The level of burden is then used to inform discussions to establish an appropriate schedule for meeting CWA obligations in permits and enforcement actions. EPA uses these indicators, including the annualized costs as a percent of MHI, to help assess when costs are reaching levels that may represent a high burden on ratepayers and that longer compliance timeframes are likely to be appropriate to spread the cost over a longer period. EPA does not view or use the Financial Capability Matrix as a rigid metric that points to a given schedule length or threshold over which the costs are unaffordable.

Permittees have suggested and the FCA Guidance recognizes that the two step analysis may not provide a complete representation of financial capability. As noted above, other relevant financial or demographic information presented that illustrates the unique or atypical circumstances faced by a permittee will also be considered in evaluating financial capability. The presentation of additional information can be very valuable in analyzing financial capability, and the submission of this type of information has become fairly common practice. For example, in many consent decree negotiations, additional information has resulted in the establishment of schedules that differ from the ones suggested by the baseline analysis described in the FCA Guidance.

Some examples of information that may be relevant in negotiating schedules to be included in permits and consent decrees are given below. In order for such information to adequately illustrate that a permittee's situation is atypical, EPA encourages permittees to compare any additional information on their circumstances to national averages or to that of other permittees.

The examples given below are not intended to be a complete list, nor a list of factors that will be relevant in every community. Rather it provides an illustration of information that may prove useful in some instances.

Examples of Information Related to Residential Impacts:

1. Income distribution by quintile, geography or other breakdown, illustrating how income distribution in the service area differs from comparable data on the national level or for similar cities.

2. Where cities have adopted differential rates for low income customers, the income distribution that led to that rate structure.

3. Information about service area poverty rates and trends.

4. Projected, current and historical sewer, and stormwater fees as a percentage of household income, quintile, geography or other breakdown.

5. Information on sewer and water usage for various classes of ratepayers or by type of dwelling unit.

6. Information on the percent of households who own versus rent.

Examples of Information Related to Financial Strength:

1. Historical population trends or population projections.

2. Service area unemployment data and trends, or other labor market indicators, including unemployment on an absolute basis.

3. Rate or revenue models, including dynamic financial planning models showing the projections of impacts over the program period. All revenue sources tied to CWA obligations may be included as appropriate.

4. Rate determination studies used to develop and support recent rate increases.

5. Data and trends on late payments, disconnection notices, service terminations, uncollectable accounts, or revenue collection rates.

6. Historical increases in rates or other dedicated revenue streams.

7. State or local legal restrictions or limitations on property taxes, other revenue streams or debt levels.

8. Other costs or financial obligations, such as those that relate to drinking water or other infrastructure, that significantly affect a permittee's ability to raise revenue.

9. Circumstances that may affect a permittee's bond rating. For instance, incurring debt beyond certain thresholds may negatively impact the permittee's bond rating, thus reducing the ability to raise capital.

10. Financial plans that show the implications of incurring additional debt for a permittee's ability to secure financing, including projections of metrics such as debt ratios, debt service coverage, debt per customer, days of cash on hand, days

of working capital and other metrics used by rating agencies. Such data should be benchmarked to metrics such as rating agency medians and relative to similar entities. This will be especially relevant where the permittee does not have a bond rating.

11. Extraordinary stressors such as those from natural disasters, municipal bankruptcies, unusual capital market conditions, or other situations which impact a permittee's ability to raise revenue or acquire needed financing. When such stressors occur, they may also provide support for making changes to existing schedules.

Appendix 3: Consumer Price Index Analysis

Appendix 3: Consumer Price Index Analysis

The Consumer Price Index (CPI) as determined by the United States Bureau of Labor Statistics (BLS) can be used as a measure of inflation experienced by consumers in their day-to-day living expenses. The BLS urban CPI (CPI-U) was selected for use in the Draft FCA Report.

The CPI-U is produced monthly and provides a measure of the changes in the prices paid by urban consumers for a representative basket of goods and services. As stated by the BLS, the "CPI represents changes in prices of all goods and services purchased for consumption by urban households. User fees (such as water and sewer service) and sales and excise taxes paid by the consumer are also included. Income taxes and investment items (like stocks, bonds, and life insurance) are not included." Also, "The CPI-U includes expenditures by urban wage earners and clerical workers, professional, managerial, and technical workers, the self-employed, short-term workers, the unemployed, retirees and others not in the labor force."

Long-term inflation trends used in this report are based on CPI-U obtained from the BLS as shown in Table 1.

Appendix 3, Table 1: Historical CPI-U

Year	BLS CPI-U (January)
1913	9.8
1979	68.3
1999	164.3
2013	230.3

The annualized inflation for a given period of years was determined by assuming the inflation will be expressed as an effective annual rate that when compounded over the time period and multiplied by the initial CPI will yield the final year's CPI-U. The formula for determining the annualized inflation rate is:

$$APCC = \left[\left[\left(\frac{CPI_f}{CPI_i}\right)^{\left(\frac{1}{t}\right)}\right] - 1\right] * 100$$

where

APCC = annualized percent change in CPI-U
CPI_f = CPI-U value for final year of time period
CPI_i = CPI-U value for first initial year of time period
t = length of time period in years

Using this formula, the following percent changes in CPI-U were determined:

Appendix 3, Table 2: Change in CPI-U

Period Year	Initial CPI-U (January)	Final CPI-U (January)	Length of Time period in years	Calculated Percent Change in CPI-U as annual compound rate for indicated period
1913 - 2013	9.8	230.3	100	3.21 %
1979-2013	68.3	230.3	34	3.64 %
1999-2013	164.3	230.3	14	2.44 %

Appendix 4: Inflation of Median Household Income

Appendix 4: Inflation of Median Household Income

Long-term income inflation trends used in this report are based on median household income data obtained from the United States Census and American Community Survey as shown in Table 1.

Appendix 4, Table 1: Median Household Income

Year	Delaware County MHI	Chester City MHI
1979	33,430	11,513
1999	50,092	25,703
2013	64,041	27,249

The annualized inflation for a given period of years was determined by assuming the inflation will be expressed as an effective annual rate that when compounded over the time period and multiplied by the initial MHI will yield the final year's MHI. The formula for determining the annualized inflation rate is:

$$APCM = \left[\left[\left(\frac{MHI_f}{MHI_i}\right)^{\left(\frac{1}{t}\right)}\right] - 1\right] * 100$$

where

APCM = annualized percent change in MHI
MHI_f = MHI value for final year of time period
MHI_i = MHI value for first initial year of time period
t = length of time period in years

Using this formula, the following percent changes in MHI were determined:

Appendix 4, Table 2: Change in Delaware County MHI

Period Year	Initial MHI	Final MHI	Length of Time period in years	Calculated Percent Change in MHI as annual compound rate for indicated period
1979-2013	33,430	64,041	34	1.93%
1999-2013	50,092	64,041	14	1.77%

Appendix 4, Table 3: Change in Chester City MHI

Period Year	Initial MHI	Final MHI	Length of Time period in years	Calculated Percent Change in MHI as annual compound rate for indicated period
1979-2013	11,513	27,249	34	2.6%
1999-2013	25,703	27,249	14	0.44%

Appendix 5: Sewer Rate Setting Information

Appendix 5: Sewer Rate Setting Information

DELCORA Sewer Rate Setting Policy

DELCORA's rate setting and cost allocation is based on the following:

- All customers pay an equal rate for commonly shared costs, including Administration, common treatment, common collection, and common capital costs.
- Western customers pay their specific costs for collection and capital costs.
- Eastern customers pay their specific costs for collection, capital, and I&I costs.
- Costs for CSO abatement are allocated to the Model Area customers in proportion to their contribution to CSO volume as well as excess volume generated from separate sewer communities within the Model Area during wet weather.
- Industrial pretreatment is allocated to only the customers that incur those costs.
- Both Trainer and Marcus Hook pay their own specific debt costs
- The Southwest rate includes treatment, billing/admin, debt and debt coverage, an allocation of capital costs, as well as the operation of the pump station.

Appendix 6: Municipal Annual Audit and Financial Reports (MAAFR)

DCED-CLGS-30 (9-09)
Received by DCED: 06/02/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230064 ASTON TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

ASTON TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	3,295,230	215,093	1,052,858				13,390,715			17,953,896
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)							3,455			3,455
130.00	Due From Other Funds	12	2								14
131-139, 150-159	Other Current Assets							65,675			65,675
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		3,295,242	215,095	1,052,858				13,459,845			18,023,040
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	746									746
200-209, 231-239	All Other Current Liabilities										
230.00	Due To Other Funds	14									14

ASTON TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities							327,997			327,997
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		760						327,997			328,757
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	3,294,482	215,095	1,052,858							4,562,435
291-299	Other Equity							13,131,848			13,131,848
Total Fund and Account Group Equity		3,294,482	215,095	1,052,858				13,131,848			17,694,283
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											18,023,040

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	3,139,965	122,968		415,407				3,678,340
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	252,387							252,387
310.20	Earned Income Taxes / Wage Taxes	3,341,827							3,341,827
310.30	Business Gross Receipts Taxes	803,983							803,983
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **								
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes	5,979							5,979
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		7,544,141	122,968		415,407				8,082,516
Licenses and Permits									
320-322	All Other Licenses and Permits	59,084							59,084
321.80	Cable Television Franchise Fees	325,217							325,217
Total Licenses and Permits		384,301							384,301
Fines and Forfeits									
330-332	Fines and Forfeits	71,770							71,770
Total Fines and Forfeits		71,770							71,770

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	4,345	322	2				1,968,061	1,972,730
342.00	Rents and Royalties	104,219							104,219
Total Interest, Rents and Royalties		108,564	322	2				1,968,061	2,076,949
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	82,111							82,111
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	9,270							9,270
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		325,289						325,289
355.04	Alcoholic Beverage Licenses	4,200							4,200
355.05	General Municipal Pension System State Aid	252,483							252,483
355.07	Foreign Fire Insurance Tax Distribution		129,370						129,370
355.08	Local Share Assessment/Gaming Proceeds								

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		348,064	454,659						802,723
Local Government Units									
357.03	Highways and Streets	18,833							18,833
357.00	All Other Local Governmental Units Capital and Operating Grants	33,800							33,800
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		52,633							52,633
Charges for Service									
361.00	General Government	30,883							30,883
362.00	Public Safety	956,022							956,022
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	12,809							12,809
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	1,103,000							1,103,000
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	12,135							12,135

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		2,114,849							2,114,849
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors		5,333						5,333
388.00	Fiduciary Fund Pension Contributions							1,343,264	1,343,264
389.00	All Other Unclassified Operating Revenues	14,894						488	15,382
Total Unclassified Operating Revenues		14,894	5,333					1,343,752	1,363,979
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition		64,650						64,650
392.00	Interfund Operating Transfers			1,050	2,032				3,082
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	24,933							24,933
Total Other Financing Sources		24,933	64,650	1,050	2,032				92,665
TOTAL REVENUES		10,664,149	647,932	1,052	417,439			3,311,813	15,042,385
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	535,025							535,025
401.00	Executive (Manager or Mayor)								
402.00	Auditing Services / Financial Administration	11,600							11,600
403.00	Tax Collection	60,118							60,118
404.00	Solicitor / Legal Services	87,074							87,074
405.00	Secretary / Clerk								
406.00	Other General Government Administration	42,449							42,449
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services								
409.00	General Government Buildings and Plant	44,525							44,525
Total General Government		780,791							780,791
Public Safety									
410.00	Police	4,154,958	11,782						4,166,740
411.00	Fire	330,365	217,779						548,144
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	364,989							364,989
414.00	Planning and Zoning								
415.00	Emergency Management and Communications								

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		4,850,312	229,561						5,079,873
Health and Human Services									
420.00-425.00	Health and Human Services	25,164							25,164
Total Health and Human Services		25,164							25,164
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	949,134							949,134
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		949,134							949,134
Public Works - Highways and Streets									
430.00	General Services - Administration	779,552							779,552
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	80,042							80,042
433.00	Traffic Control Devices	48,214							48,214
434.00	Street Lighting	28,464	121,433						149,897
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains	132,763							132,763

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	23,259	210,744						234,003
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		1,092,294	332,177						1,424,471
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	227,511							227,511
452.00	Participant Recreation	236,842							236,842
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries	35,420	35,340						70,760

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation		60,400						60,400
Total Culture and Recreation		499,773	95,740						595,513
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing	1,747							1,747
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development		1,747							1,747
Debt Service									
471.00	Debt Principal (short-term and long-term)				318,000				318,000
472.00	Debt Interest (short-term and long-term)	54,000			99,439				153,439
475.00	Fiscal Agent Fees	1,050							1,050
Total Debt Service		55,050			417,439				472,489
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	1,241,324							1,241,324
484.00	Worker Compensation Insurance								

ASTON TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		1,241,324							1,241,324
Insurance									
486.00	Insurance, Casualty, and Surety								
Total Insurance									
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							1,415,016	1,415,016
489.00	All Other Unclassified Expenditures	1,382						67,434	68,816
Total Unclassified Operating Expenditures		1,382						1,482,450	1,483,832
Other Financing Uses									
491.00	Refund of Prior Year Revenues	43,991							43,991
492.00	Interfund Operating Transfers	3,082							3,082
493.00	All Other Financing Uses								
Total Other Financing Uses		47,073							47,073
TOTAL EXPENDITURES		9,544,044	657,478		417,439			1,482,450	12,101,411
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		1,120,105	-9,546	1,052				1,829,363	2,940,974

ASTON TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GOB Series 2010	Bond	2010	2023	3,655,000	3,345,000		195,000		3,150,000		3,150,000
GOB Series 2012	Bond	2012	2025	1,826,000	1,826,000		123,000		1,703,000		1,703,000
Revenue Bonds and Notes											
DELVAL Loan for Fire Truck	Bond	2010	2026	100,000	89,000		6,000		83,000		83,000
Lease Rental Debt											
2010 Truck	Captial Leases	2010	2014	136,931	58,337		28,540		29,797		29,797
2013 Ford F350 Truck	Captial Leases	2013	2017	44,392	0	44,392	3,493		40,899		40,899
Three pieces of equipment	Captial Leases	2013	2018	63,297	0	63,297	6,890		56,407		56,407
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	5,063,103
Capitalized lease obligations	
Net debt	5,063,103

ASTON TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	3,248		3,248
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police			
Recreation			
Sewer			
Solid Waste			
Streets / Highways	29,883		29,883
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	33,131		33,131

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	3,844,959

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

ASTON TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/15/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230095 BETHEL TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

BETHEL TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	1,310,260	284,005			186,143		23,496			1,803,904
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		1,310,260	284,005			186,143		23,496			1,803,904
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities							23,496			23,496
230.00	Due To Other Funds										

BETHEL TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits								23,496			23,496
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	1,310,260	284,005			186,143					1,780,408
291-299	Other Equity										
Total Fund and Account Group Equity		1,310,260	284,005			186,143					1,780,408

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	1,803,904

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,191,906	121,781						1,313,687
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	329,513							329,513
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **								
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		1,521,419	121,781						1,643,200
Licenses and Permits									
320-322	All Other Licenses and Permits	663							663
321.80	Cable Television Franchise Fees	199,493							199,493
Total Licenses and Permits		200,156							200,156
Fines and Forfeits									
330-332	Fines and Forfeits	15,167							15,167
Total Fines and Forfeits		15,167							15,167

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	1,419	383			260			2,062
342.00	Rents and Royalties	7,824							7,824
Total Interest, Rents and Royalties		9,243	383			260			9,886
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	12,004							12,004
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	2,021							2,021
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		168,707						168,707
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid								
355.07	Foreign Fire Insurance Tax Distribution	79,172							79,172
355.08	Local Share Assessment/Gaming Proceeds								

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		93,197	168,707						261,904
Local Government Units									
357.03	Highways and Streets	2,700							2,700
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		2,700							2,700
Charges for Service									
361.00	General Government	50,821							50,821
362.00	Public Safety	172,110							172,110
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)					435,019			435,019
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	14,212							14,212

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		237,143				435,019			672,162
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	1,075							1,075
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	6,344	710						7,054
Total Unclassified Operating Revenues		7,419	710						8,129
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers								
393.00	Proceeds of General Long-Term Debt		222,000						222,000
394.00	Proceeds of Short Term-Debt								

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	41,000							41,000
Total Other Financing Sources		41,000	222,000						263,000
TOTAL REVENUES		2,127,444	513,581			435,279			3,076,304
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	46,021	38						46,059
401.00	Executive (Manager or Mayor)								
402.00	Auditing Services / Financial Administration	77,042							77,042
403.00	Tax Collection	61,255							61,255
404.00	Solicitor / Legal Services	40,433							40,433
405.00	Secretary / Clerk	49,773							49,773
406.00	Other General Government Administration	42,645							42,645
407.00	IT-Networking Services-Data Processing	19,348							19,348
408.00	Engineering Services	76,052							76,052
409.00	General Government Buildings and Plant	32,504							32,504
Total General Government		445,073	38						445,111
Public Safety									
410.00	Police	499,249							499,249
411.00	Fire	171,067	434,971						606,038
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	86,021							86,021
414.00	Planning and Zoning	28,973							28,973
415.00	Emergency Management and Communications								

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		785,310	434,971						1,220,281
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal					58,129			58,129
427.00	Solid Waste Collection and Disposal (garbage)					325,401			325,401
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation						383,530			383,530
Public Works - Highways and Streets									
430.00	General Services - Administration	77,506							77,506
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal		25,289						25,289
433.00	Traffic Control Devices		6,488						6,488
434.00	Street Lighting		6,513						6,513
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains		3,300						3,300

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	189	7,608						7,797
438.00	Maintenance and Repairs of Roads and Bridges	989	9,271						10,260
439.00	Highway Construction and Rebuilding Projects		57,183						57,183
Total Public Works - Highways and Streets		78,684	115,652						194,336
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	34,061							34,061
455.00	Shade Trees								
456.00	Libraries		33,200						33,200

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	3,000							3,000
Total Culture and Recreation		37,061	33,200						70,261
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	162,859	58,996						221,855
472.00	Debt Interest (short-term and long-term)	11,474	8,018						19,492
475.00	Fiscal Agent Fees		6,334						6,334
Total Debt Service		174,333	73,348						247,681
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions								
484.00	Worker Compensation Insurance	30,577							30,577

BETHEL TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		30,577							30,577
Insurance									
486.00	Insurance, Casualty, and Surety	77,100							77,100
Total Insurance		77,100							77,100
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures	10,710							10,710
Total Unclassified Operating Expenditures		10,710							10,710
Other Financing Uses									
491.00	Refund of Prior Year Revenues	1,779	88			378			2,245
492.00	Interfund Operating Transfers								
493.00	All Other Financing Uses								
Total Other Financing Uses		1,779	88			378			2,245
TOTAL EXPENDITURES		1,640,627	657,297			383,908			2,681,832
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		486,817	-143,716			51,371			394,472

BETHEL TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
2012 Note	Note	2012	2018	856,000	807,000	0	131,000		676,000		676,000
2013 Note - Fire Truck	Note	2013	2025	222,000	0	222,000			222,000		222,000
Revenue Bonds and Notes											
Lease Rental Debt											
Ford F-550 Truck	Note	2011	2013	38,637	19,790		19,790		0		0
Ford Crown Victoria	Note	2011	2013	44,691	22,996		22,996		0		0
Ford Interceptor SUV	Note	2012	2014	28,355	18,302		8,863		9,439		9,439
Ford F-550 Truck	Note	2012	2014	62,407	40,381		39,206		1,175		1,175
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	908,614
Capitalized lease obligations	
Net debt	908,614

BETHEL TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire	434,701		434,701
Gas System			
General Government	12,902		12,902
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	34,429		34,429
Recreation			
Sewer			
Solid Waste			
Streets / Highways	69,320	57,183	126,503
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	551,352	57,183	608,535

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	606,684

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane, Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

BETHEL TWP, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/18/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230153 BROOKHAVEN BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

BROOKHAVEN BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	1,469,894	101,791			1,512,669		359,113			3,443,467
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds	410,623									410,623
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		1,880,517	101,791			1,512,669		359,113			3,854,090
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities							343,468			343,468
230.00	Due To Other Funds		60,685			334,293		15,645			410,623

BROOKHAVEN BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits			60,685			334,293		359,113			754,091
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	1,880,517	41,106			1,178,376					3,099,999
291-299	Other Equity										
Total Fund and Account Group Equity		1,880,517	41,106			1,178,376					3,099,999
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											3,854,090

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Taxes									
301.00	Real Estate Taxes	1,664,327							1,664,327
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	102,055							102,055
310.20	Earned Income Taxes / Wage Taxes	1,168,545							1,168,545
310.30	Business Gross Receipts Taxes	461,726							461,726
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **								
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes	15,720							15,720
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		3,412,373							3,412,373
Licenses and Permits									
320-322	All Other Licenses and Permits	8,234							8,234
321.80	Cable Television Franchise Fees	179,125							179,125
Total Licenses and Permits		187,359							187,359
Fines and Forfeits									
330-332	Fines and Forfeits	44,924							44,924
Total Fines and Forfeits		44,924							44,924

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Interest, Rents and Royalties									
341.00	Interest Earnings	3,831	328			3,333			7,492
342.00	Rents and Royalties	68,171							68,171
Total Interest, Rents and Royalties		72,002	328			3,333			75,663
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101					33,148			33,148
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	4,211							4,211
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		146,844						146,844
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	97,109							97,109
355.07	Foreign Fire Insurance Tax Distribution	58,972							58,972
355.08	Local Share Assessment/Gaming Proceeds								

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		160,292	146,844			33,148			340,284
Local Government Units									
357.03	Highways and Streets	8,910							8,910
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	11,008							11,008
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		19,918							19,918
Charges for Service									
361.00	General Government	21,164							21,164
362.00	Public Safety	93,878							93,878
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	4,604							4,604
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					1,040,475			1,040,475
364.30	Solid Waste Collection and Disposal Charge (trash)	3,400				361,985			365,385
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health	5,019							5,019
366.00	Human Services								
367.00	Culture and Recreation	39,610							39,610

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		167,675				1,402,460			1,570,135
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	13,200							13,200
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	964							964
Total Unclassified Operating Revenues		14,164							14,164
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers								
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	59,414							59,414
Total Other Financing Sources		59,414							59,414
TOTAL REVENUES		4,138,121	147,172			1,438,941			5,724,234
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	64,911							64,911
401.00	Executive (Manager or Mayor)	5,004							5,004
402.00	Auditing Services / Financial Administration	50,065							50,065
403.00	Tax Collection	59,201							59,201
404.00	Solicitor / Legal Services	55,076							55,076
405.00	Secretary / Clerk	80,490							80,490
406.00	Other General Government Administration	3,015							3,015
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	22,841	15,026						37,867
409.00	General Government Buildings and Plant	236,382							236,382
Total General Government		576,985	15,026						592,011
Public Safety									
410.00	Police	879,142							879,142
411.00	Fire	188,457							188,457
412.00	Ambulance / Rescue	12,499							12,499
413.00	UCC and Code Enforcement	86,665							86,665
414.00	Planning and Zoning	6,692							6,692
415.00	Emergency Management and Communications								

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		1,173,455							1,173,455
Health and Human Services									
420.00-425.00	Health and Human Services	21,548							21,548
Total Health and Human Services		21,548							21,548
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)					378,263			378,263
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					824,920			824,920
Total Public Works - Sanitation						1,203,183			1,203,183
Public Works - Highways and Streets									
430.00	General Services - Administration	237,335							237,335
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	2,359	24,161						26,520
433.00	Traffic Control Devices	5,054	6,632						11,686
434.00	Street Lighting		74,314						74,314
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains		2,853						2,853

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges		439						439
439.00	Highway Construction and Rebuilding Projects	118,907	40,000						158,907
Total Public Works - Highways and Streets		363,655	148,399						512,054
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	97,940							97,940
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees	17,057							17,057
456.00	Libraries								

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Culture and Recreation									
457.00	Civil and Military Celebrations	19,192							19,192
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		134,189							134,189
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	157,428				64,000			221,428
472.00	Debt Interest (short-term and long-term)	51,212				43,100			94,312
475.00	Fiscal Agent Fees								
Total Debt Service		208,640				107,100			315,740
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	59,889							59,889
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	410,913							410,913
484.00	Worker Compensation Insurance	136,214							136,214

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	476,100							476,100
Total Employer Paid Benefits and Withholding Items		1,083,116							1,083,116
Insurance									
486.00	Insurance, Casualty, and Surety	93,158							93,158
Total Insurance		93,158							93,158
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers								
493.00	All Other Financing Uses								
Total Other Financing Uses									
TOTAL EXPENDITURES		3,654,746	163,425			1,310,283			5,128,454
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		483,375	-16,253			128,658			595,780

BROOKHAVEN BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Fire Truck	Note	2008	2023	150,000	111,960		9,428		102,532		102,532
Wastewater Renue Notes	Note	2010	2030	1,620,000	1,498,000		64,000		1,434,000		1,434,000
Series 2012	Note	2012	2025	2,210,000	2,210,000		148,000		2,062,000		2,062,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	3,598,532
Capitalized lease obligations	
Net debt	3,598,532

BROOKHAVEN BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	42,835		42,835
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	4,446		4,446
Recreation	9,300		9,300
Sewer	44,245		44,245
Solid Waste			
Streets / Highways	31,482	17,430	48,912
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	132,308	17,430	149,738

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,330,159

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

BROOKHAVEN BORO, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 12/31/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2012 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230182 CHESTER CITY, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

CHESTER CITY, DELAWARE County

BALANCE SHEET

December 31, 2012

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	2,321,358	2,696,229	455,812	3,070			50,470,713			55,947,182
140-144	Tax Receivable	1,388,251									1,388,251
121-129, 145-149	Accounts Receivable (excluding taxes)	4,954,544	51,461					96,963			5,102,968
130.00	Due From Other Funds	371,680									371,680
131-139, 150-159	Other Current Assets	161,393						23,422			184,815
160-169	Fixed Assets								22,747,878		22,747,878
180-189	Other Debits									68,048,814	68,048,814
Total Assets and Other Debits		9,197,226	2,747,690	455,812	3,070			50,591,098	22,747,878	68,048,814	153,791,588
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	1,466,118									1,466,118
200-209, 231-239	All Other Current Liabilities	2,053,617	834,742	2,419							2,890,778
230.00	Due To Other Funds		283,404								283,404

CHESTER CITY, DELAWARE County

BALANCE SHEET

December 31, 2012

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities							3,884,919		65,399,406	69,284,325
240-259	Current Portion of Long-Term Debt and Other Credits									2,562,598	2,562,598
Total Liabilities and Other Credits		3,519,735	1,118,146	2,419				3,884,919		67,962,004	76,487,223
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	5,677,491	1,629,544	453,393	3,070			46,706,179	22,747,878	86,810	77,304,365
291-299	Other Equity										
Total Fund and Account Group Equity		5,677,491	1,629,544	453,393	3,070			46,706,179	22,747,878	86,810	77,304,365
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											153,791,588

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	6,805,420	163,929		608,375				7,577,724
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes								
310.20	Earned Income Taxes / Wage Taxes	8,103,760							8,103,760
310.30	Business Gross Receipts Taxes	1,269,229							1,269,229
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	228,950							228,950
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		16,407,359	163,929		608,375				17,179,663
Licenses and Permits									
320-322	All Other Licenses and Permits	674,180							674,180
321.80	Cable Television Franchise Fees	410,833							410,833
Total Licenses and Permits		1,085,013							1,085,013
Fines and Forfeits									
330-332	Fines and Forfeits	226,834							226,834
Total Fines and Forfeits		226,834							226,834

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	58	1,635	105					1,798
342.00	Rents and Royalties	6,885,714							6,885,714
Total Interest, Rents and Royalties		6,885,772	1,635	105					6,887,512
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants	313,520	352,158						665,678
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal		313,520	352,158						665,678
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	23,677							23,677
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		607,478						607,478
355.04	Alcoholic Beverage Licenses	12,500							12,500
355.05	General Municipal Pension System State Aid	1,415,941							1,415,941
355.07	Foreign Fire Insurance Tax Distribution								
355.08	Local Share Assessment/Gaming Proceeds	5,195,982	307,386						5,503,368

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		6,648,100	914,864						7,562,964
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes	579,494							579,494
Total Local Government Units		579,494							579,494
Charges for Service									
361.00	General Government	445,697							445,697
362.00	Public Safety								
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	1,152,438							1,152,438
364.60	Host Municipality Benefit Fee for Solid Waste Facility	5,320,501							5,320,501
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service		15,996						15,996
Total Charges for Service		6,918,636	15,996						6,934,632
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors							668,153	668,153
388.00	Fiduciary Fund Pension Contributions							2,265,018	2,265,018
389.00	All Other Unclassified Operating Revenues	431,843	12,787	936				41,553	487,119
Total Unclassified Operating Revenues		431,843	12,787	936				2,974,724	3,420,290
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers	1,391,423	624,029		2,474,689				4,490,141
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	2,434,426	654,745	92,606					3,181,777
Total Other Financing Sources		3,825,849	1,278,774	92,606	2,474,689				7,671,918
TOTAL REVENUES		43,322,420	2,740,143	93,647	3,083,064			2,974,724	52,213,998
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body								
401.00	Executive (Manager or Mayor)	1,249,851	257,664						1,507,515
402.00	Auditing Services / Financial Administration	508,724			179,099				687,823
403.00	Tax Collection	201,580							201,580
404.00	Solicitor / Legal Services	544,857							544,857
405.00	Secretary / Clerk	63,771							63,771
406.00	Other General Government Administration	665,801	179,032	67					844,900
407.00	IT-Networking Services-Data Processing	221,256							221,256
408.00	Engineering Services	197,868							197,868
409.00	General Government Buildings and Plant	1,735,358							1,735,358
Total General Government		5,389,066	436,696	67	179,099				6,004,928
Public Safety									
410.00	Police	13,123,944	214,096						13,338,040
411.00	Fire	8,307,845							8,307,845
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	403,910							403,910
414.00	Planning and Zoning	226,138							226,138
415.00	Emergency Management and Communications								

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety		201,492	79,884					281,376
Total Public Safety		22,061,837	415,588	79,884					22,557,309
Health and Human Services									
420.00-425.00	Health and Human Services	484,940							484,940
Total Health and Human Services		484,940							484,940
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	1,169,176							1,169,176
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		1,169,176							1,169,176
Public Works - Highways and Streets									
430.00	General Services - Administration	1,067,953							1,067,953
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	1,600							1,600
433.00	Traffic Control Devices	37,921							37,921
434.00	Street Lighting	109,779	674,357						784,136
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	129,024							129,024
439.00	Highway Construction and Rebuilding Projects			101,435					101,435
Total Public Works - Highways and Streets		1,346,277	674,357	101,435					2,122,069
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	556,621							556,621
452.00	Participant Recreation	108,818							108,818
453.00	Spectator Recreation	641,370							641,370
454.00	Parks	641,370							641,370
455.00	Shade Trees								
456.00	Libraries								

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation		291,579						291,579
Total Culture and Recreation		1,948,179	291,579						2,239,758
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development		307,232						307,232
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development			307,232						307,232
Debt Service									
471.00	Debt Principal (short-term and long-term)	553,558		382,428	1,626,000				2,561,986
472.00	Debt Interest (short-term and long-term)	11,154		134,278	1,559,416				1,704,848
475.00	Fiscal Agent Fees								
Total Debt Service		564,712		516,706	3,185,416				4,266,834
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	1,158,898							1,158,898
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	2,310,792							2,310,792
484.00	Worker Compensation Insurance	1,799,140							1,799,140

CHESTER CITY, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	2,140,404							2,140,404
Total Employer Paid Benefits and Withholding Items		7,409,234							7,409,234
Insurance									
486.00	Insurance, Casualty, and Surety	1,372,472							1,372,472
Total Insurance		1,372,472							1,372,472
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							6,684,304	6,684,304
489.00	All Other Unclassified Expenditures		37,994					147,601	185,595
Total Unclassified Operating Expenditures			37,994					6,831,905	6,869,899
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	3,066,004	1,416,344	7,793					4,490,141
493.00	All Other Financing Uses	846,762	219,670						1,066,432
Total Other Financing Uses		3,912,766	1,636,014	7,793					5,556,573
TOTAL EXPENDITURES		45,658,659	3,799,460	705,885	3,364,515			6,831,905	60,360,424
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-2,336,239	-1,059,317	-612,238	-281,451			-3,857,181	-8,146,426

CHESTER CITY

December 31, 2012

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Bond Issue 2007	Bond	2007	2010	4,000,000	2,657,055		382,428		2,274,627		2,274,627
Bond Issue 2010A	Bond	2010	2019	5,895,000	5,291,000		641,000		4,650,000		4,650,000
Bond Issue 2010B	Bond	2010	2025	2,985,000	3,768,000		236,000		3,532,000		3,532,000
Bond Issue 2011	Bond	2011	2016	3,720,000	3,720,000		744,000		2,976,000		2,976,000
Revenue Bonds and Notes											
Lease Rental Debt											
2004 Lease	Captial Leases	2004	2019	9,500,000	9,465,000		5,000		9,460,000		9,460,000
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	22,892,627
Capitalized lease obligations	
Net debt	22,892,627

CHESTER CITY, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2012

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	79,884		79,884
Recreation			
Sewer			
Solid Waste			
Streets / Highways		101,435	101,435
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	79,884	101,435	181,319

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	18,182,886

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the CHESTER CITY have audited, adjusted and settled the various funds and account groups of the CHESTER CITY for the year ended December 31, 2012. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

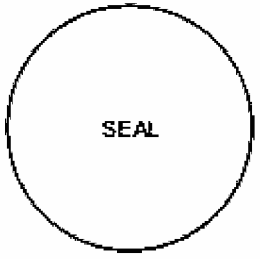
These financial statements do not include all of the disclosures required by generally accepted accounting principles.

In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of CHESTER CITY for the year ended December 31, 2012, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: Edith Blackwell Controller

Subscribed and sworn to before me this 5 day of January, 2015.



Signed: _____

Witness (Controller)/Auditor (Auditors)

CHESTER CITY, DELAWARE County

December 31, 2012

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/25/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230245 CHESTER TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

CHESTER TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	258,704	689,382	5,948		3,315		2,204,574			3,161,923
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds	20				5,806					5,826
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		258,724	689,382	5,948		9,121		2,204,574			3,167,749
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities										
230.00	Due To Other Funds	5,806	20								5,826

CHESTER TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities							60,046			60,046
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		5,806	20					60,046			65,872
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	252,918	689,362	5,948		9,121		2,144,528			3,101,877
291-299	Other Equity										
Total Fund and Account Group Equity		252,918	689,362	5,948		9,121		2,144,528			3,101,877
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											3,167,749

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,458,282	133,580						1,591,862
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	112,812							112,812
310.20	Earned Income Taxes / Wage Taxes	1,241,875							1,241,875
310.30	Business Gross Receipts Taxes	241,189							241,189
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	44,935							44,935
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		3,099,093	133,580						3,232,673
Licenses and Permits									
320-322	All Other Licenses and Permits	71,885							71,885
321.80	Cable Television Franchise Fees	71,489							71,489
Total Licenses and Permits		143,374							143,374
Fines and Forfeits									
330-332	Fines and Forfeits	28,082							28,082
Total Fines and Forfeits		28,082							28,082

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings		2					234,503	234,505
342.00	Rents and Royalties	17,270				21,655			38,925
Total Interest, Rents and Royalties		17,270	2			21,655		234,503	273,430
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants		523,041						523,041
355.01	Public Utility Realty Tax (PURTA)	3,636							3,636
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		70,867						70,867
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	92,253							92,253
355.07	Foreign Fire Insurance Tax Distribution	25,722							25,722
355.08	Local Share Assessment/Gaming Proceeds								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements	400							400
356.00	State Payments in Lieu of Taxes								
Total State		122,011	593,908						715,919
Local Government Units									
357.03	Highways and Streets	32,382							32,382
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes	44,999							44,999
Total Local Government Units		77,381							77,381
Charges for Service									
361.00	General Government	2,106							2,106
362.00	Public Safety	5,548							5,548
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	7,895							7,895
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	219,228							219,228
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		234,777							234,777
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	4,500							4,500
388.00	Fiduciary Fund Pension Contributions							146,677	146,677
389.00	All Other Unclassified Operating Revenues								
Total Unclassified Operating Revenues		4,500						146,677	151,177
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers		4,000						4,000
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	206,622							206,622
Total Other Financing Sources		206,622	4,000						210,622
TOTAL REVENUES		3,933,110	731,490			21,655		381,180	5,067,435
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	161,800							161,800
401.00	Executive (Manager or Mayor)	380,318							380,318
402.00	Auditing Services / Financial Administration	37,791						8,200	45,991
403.00	Tax Collection	82,208							82,208
404.00	Solicitor / Legal Services	90,515							90,515
405.00	Secretary / Clerk								
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	310,333							310,333
409.00	General Government Buildings and Plant	162,237							162,237
Total General Government		1,225,202						8,200	1,233,402
Public Safety									
410.00	Police	1,922,239							1,922,239
411.00	Fire		133,580						133,580
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	71,760							71,760
414.00	Planning and Zoning	3,022							3,022
415.00	Emergency Management and Communications		14						14

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety		1,107						1,107
Total Public Safety		1,997,021	134,701						2,131,722
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	176,182							176,182
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		176,182							176,182
Public Works - Highways and Streets									
430.00	General Services - Administration	416,978							416,978
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices	4,937							4,937
434.00	Street Lighting	31,754							31,754
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	1,342							1,342
438.00	Maintenance and Repairs of Roads and Bridges	33,179							33,179
439.00	Highway Construction and Rebuilding Projects		67,799						67,799
Total Public Works - Highways and Streets		488,190	67,799						555,989
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	32,633							32,633
452.00	Participant Recreation					19,201			19,201
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers	3,130							3,130
459.00	All Other Culture and Recreation								
Total Culture and Recreation		35,763				19,201			54,964
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development	207,167							207,167
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development		207,167							207,167
Debt Service									
471.00	Debt Principal (short-term and long-term)								
472.00	Debt Interest (short-term and long-term)								
475.00	Fiscal Agent Fees								
Total Debt Service									
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses	36,811							36,811
483.00	Pension / Retirement Fund Contributions	110,879							110,879
484.00	Worker Compensation Insurance								

CHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		147,690							147,690
Insurance									
486.00	Insurance, Casualty, and Surety								
Total Insurance									
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							111,764	111,764
489.00	All Other Unclassified Expenditures	2,288						4,582	6,870
Total Unclassified Operating Expenditures		2,288						116,346	118,634
Other Financing Uses									
491.00	Refund of Prior Year Revenues	93,109							93,109
492.00	Interfund Operating Transfers	4,000							4,000
493.00	All Other Financing Uses								
Total Other Financing Uses		97,109							97,109
TOTAL EXPENDITURES		4,376,612	202,500			19,201		124,546	4,722,859
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-443,502	528,990			2,454		256,634	344,576

CHESTER TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	0
Capitalized lease obligations	
Net debt	0

CHESTER TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	25,356		25,356
Recreation			
Sewer			
Solid Waste			
Streets / Highways			
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	25,356		25,356

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,647,724

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the CHESTER TWP have audited, adjusted and settled the various funds and account groups of the CHESTER TWP for the year ended December 31, 2013. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

These financial statements do not include all of the disclosures required by generally accepted accounting principles.

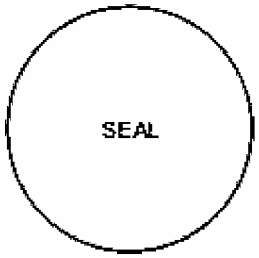
In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of CHESTER TWP for the year ended December 31, 2013, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: Dorothy Green Elected Auditor

Thelma Newcomb Elected Auditor

Subscribed and sworn to before me this 10 day of September, 2014.



Signed: _____

Witness (Controller)/Auditor (Auditors)

CHESTER TWP, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 08/20/2015

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230483 EDDYSTONE BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

EDDYSTONE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	95,384	77,290	7,543	3,855						184,072
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets	215,028									215,028
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		310,412	77,290	7,543	3,855						399,100
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	20,436									20,436
200-209, 231-239	All Other Current Liabilities	215,028									215,028
230.00	Due To Other Funds										

EDDYSTONE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		235,464									235,464
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	74,948	77,290	7,543	3,855						163,636
291-299	Other Equity										
Total Fund and Account Group Equity		74,948	77,290	7,543	3,855						163,636
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											399,100

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	997,055			48,941				1,045,996
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	15,762							15,762
310.20	Earned Income Taxes / Wage Taxes	1,249,993							1,249,993
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	110,409							110,409
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		2,373,219			48,941				2,422,160
Licenses and Permits									
320-322	All Other Licenses and Permits	17,347							17,347
321.80	Cable Television Franchise Fees	36,205							36,205
Total Licenses and Permits		53,552							53,552
Fines and Forfeits									
330-332	Fines and Forfeits	68,937							68,937
Total Fines and Forfeits		68,937							68,937

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	554	167	8	10				739
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		554	167	8	10				739
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	2,918							2,918
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		41,189						41,189
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	46,612							46,612
355.07	Foreign Fire Insurance Tax Distribution	21,509							21,509
355.08	Local Share Assessment/Gaming Proceeds								

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		71,039	41,189						112,228
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	19,377							19,377
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		19,377							19,377
Charges for Service									
361.00	General Government	2,659							2,659
362.00	Public Safety	552,820							552,820
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)		314,792						314,792
364.30	Solid Waste Collection and Disposal Charge (trash)	1,655							1,655
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		557,134	314,792						871,926
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors								
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues								
Total Unclassified Operating Revenues									
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers		84,578	397,665	179,892				662,135
393.00	Proceeds of General Long-Term Debt			450,000					450,000
394.00	Proceeds of Short Term-Debt				250,000				250,000

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources			84,578	847,665	429,892				1,362,135
TOTAL REVENUES		3,143,812	440,726	847,673	478,843				4,911,054
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	12,875							12,875
401.00	Executive (Manager or Mayor)	59,865							59,865
402.00	Auditing Services / Financial Administration	20,330							20,330
403.00	Tax Collection	9,216							9,216
404.00	Solicitor / Legal Services	60,717							60,717
405.00	Secretary / Clerk	32,011							32,011
406.00	Other General Government Administration	34,929							34,929
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services								
409.00	General Government Buildings and Plant	46,481		14,995					61,476
Total General Government		276,424		14,995					291,419
Public Safety									
410.00	Police	868,573							868,573
411.00	Fire	143,623		832,670					976,293
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	62,122							62,122
414.00	Planning and Zoning								
415.00	Emergency Management and Communications								

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		1,074,318		832,670					1,906,988
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	121,948							121,948
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection		366,410						366,410
Total Public Works - Sanitation		121,948	366,410						488,358
Public Works - Highways and Streets									
430.00	General Services - Administration	105,424							105,424
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices		16,574						16,574
434.00	Street Lighting		37,922						37,922
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges		3,599						3,599
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		105,424	58,095						163,519
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	43,319							43,319
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries								

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		43,319							43,319
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)				388,889				388,889
472.00	Debt Interest (short-term and long-term)				93,769				93,769
475.00	Fiscal Agent Fees								
Total Debt Service					482,658				482,658
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	49,086							49,086
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	173,207							173,207
484.00	Worker Compensation Insurance	128,381							128,381

EDDYSTONE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	495,449							495,449
Total Employer Paid Benefits and Withholding Items		846,123							846,123
Insurance									
486.00	Insurance, Casualty, and Surety	68,500							68,500
Total Insurance		68,500							68,500
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures	3,292	4,287						7,579
Total Unclassified Operating Expenditures		3,292	4,287						7,579
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	662,135							662,135
493.00	All Other Financing Uses								
Total Other Financing Uses		662,135							662,135
TOTAL EXPENDITURES		3,201,483	428,792	847,665	482,658				4,960,598
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-57,671	11,934	8	-3,815				-49,544

EDDYSTONE BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Citizens Bank	Note	1999	2014	425,000	58,113		18,889		39,224		39,224
Firehouse Construction Note 2011 Series	Note	2011	2025	3,000,000	3,000,000		120,000		2,880,000		2,880,000
Firehouse Construction Note 2013 Series	Note	2013	2031	450,000	0	450,000			450,000		450,000
Revenue Bonds and Notes											
Tax Anticipation Note	Note	2013	2013	250,000	0	250,000	250,000		0		0
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	3,369,224
Capitalized lease obligations	
Net debt	3,369,224

EDDYSTONE BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire		832,670	832,670
Gas System			
General Government		14,995	14,995
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police			
Recreation			
Sewer			
Solid Waste			
Streets / Highways			
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES		847,665	847,665

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,157,793

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: John Hanna Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

EDDYSTONE BORO, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/18/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230515 EDGMONT TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

EDGMONT TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	775,144	19,793	1,079,795				354,510			2,229,242
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		775,144	19,793	1,079,795				354,510			2,229,242
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings		436								436
200-209, 231-239	All Other Current Liabilities	164						215,673			215,837
230.00	Due To Other Funds										

EDGMONT TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		164	436					215,673			216,273
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	774,980	19,357	1,079,795				138,837			2,012,969
291-299	Other Equity										
Total Fund and Account Group Equity		774,980	19,357	1,079,795				138,837			2,012,969
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											2,229,242

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	304,472	108,340						412,812
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	12,625							12,625
310.10	Real Estate Transfer Taxes	167,017							167,017
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	71,750							71,750
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		555,864	108,340						664,204
Licenses and Permits									
320-322	All Other Licenses and Permits	7,600							7,600
321.80	Cable Television Franchise Fees	104,363							104,363
Total Licenses and Permits		111,963							111,963
Fines and Forfeits									
330-332	Fines and Forfeits	4,373							4,373
Total Fines and Forfeits		4,373							4,373

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	3,572	142	2,442				27,656	33,812
342.00	Rents and Royalties	115,526							115,526
Total Interest, Rents and Royalties		119,098	142	2,442				27,656	149,338
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	19,080							19,080
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	702							702
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		86,575						86,575
355.04	Alcoholic Beverage Licenses	1,400							1,400
355.05	General Municipal Pension System State Aid	10,485							10,485
355.07	Foreign Fire Insurance Tax Distribution	52,623							52,623
355.08	Local Share Assessment/Gaming Proceeds								

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
356.00	State Payments in Lieu of Taxes	2,869							2,869
355.00	All Other State Shared Revenues and Entitlements								
Total State		87,159	86,575						173,734
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants	2,768							2,768
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	4,277							4,277
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		7,045							7,045
Charges for Service									
361.00	General Government	97,756							97,756
362.00	Public Safety	133,518							133,518
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)								
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	5,666							5,666

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service	8,817							8,817
Total Charges for Service		245,757							245,757
Unclassified Operating Revenues									
383.00	Special Assessments		18,922						18,922
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	745		47,625					48,370
388.00	Fiduciary Fund Pension Contributions							11,854	11,854
389.00	All Other Unclassified Operating Revenues	4,859							4,859
Total Unclassified Operating Revenues		5,604	18,922	47,625				11,854	84,005
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	6,870							6,870
392.00	Interfund Operating Transfers			466,048					466,048
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources		6,870		466,048					472,918
TOTAL REVENUES		1,143,733	213,979	516,115				39,510	1,913,337
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	7,940							7,940
401.00	Executive (Manager or Mayor)	120,320		1,700					122,020
402.00	Auditing Services / Financial Administration	58,805							58,805
403.00	Tax Collection	8,624							8,624
404.00	Solicitor / Legal Services	89,377		5,768					95,145
405.00	Secretary / Clerk	72,760							72,760
406.00	Other General Government Administration	350							350
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	57,500		19,479					76,979
409.00	General Government Buildings and Plant	49,002		2,893					51,895
Total General Government		464,678		29,840					494,518
Public Safety									
410.00	Police								
411.00	Fire	71,248	108,777						180,025
412.00	Ambulance / Rescue		15,412						15,412
413.00	UCC and Code Enforcement	82,730							82,730
414.00	Planning and Zoning	26,881							26,881
415.00	Emergency Management and Communications	1,636							1,636

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		182,495	124,189						306,684
Health and Human Services									
420.00-425.00	Health and Human Services	1,850							1,850
Total Health and Human Services		1,850							1,850
Public Works - Sanitation									
426.00	Recycling Collection and Disposal	9,236							9,236
427.00	Solid Waste Collection and Disposal (garbage)								
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection			212,715					212,715
Total Public Works - Sanitation		9,236		212,715					221,951
Public Works - Highways and Streets									
430.00	General Services - Administration								
431.00	Cleaning of Streets and Gutters	3,283							3,283
432.00	Winter Maintenance – Snow Removal	45,718							45,718
433.00	Traffic Control Devices	17,294							17,294
434.00	Street Lighting								
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains	17,257							17,257

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	40,926							40,926
439.00	Highway Construction and Rebuilding Projects	2,769	99,541						102,310
Total Public Works - Highways and Streets		127,247	99,541						226,788
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation	5,710							5,710
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries	7,500							7,500

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	3,550							3,550
Total Culture and Recreation		16,760							16,760
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)								
472.00	Debt Interest (short-term and long-term)								
475.00	Fiscal Agent Fees								
Total Debt Service									
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	11,854							11,854
484.00	Worker Compensation Insurance	11,616							11,616

EDGMONT TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	86,280							86,280
Total Employer Paid Benefits and Withholding Items		109,750							109,750
Insurance									
486.00	Insurance, Casualty, and Surety	13,362							13,362
Total Insurance		13,362							13,362
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							134	134
489.00	All Other Unclassified Expenditures	1,177							1,177
Total Unclassified Operating Expenditures		1,177						134	1,311
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	193,948		272,100					466,048
493.00	All Other Financing Uses								
Total Other Financing Uses		193,948		272,100					466,048
TOTAL EXPENDITURES		1,120,503	223,730	514,655				134	1,859,022
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		23,230	-9,751	1,460				39,376	54,315

EDGMONT TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	0
Capitalized lease obligations	
Net debt	0

EDGMONT TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	1,144	1,750	2,894
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police			
Recreation			
Sewer		212,715	212,715
Solid Waste			
Streets / Highways		99,541	99,541
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	1,144	314,006	315,150

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	278,752

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the EDGMONT TWP have audited, adjusted and settled the various funds and account groups of the EDGMONT TWP for the year ended December 31, 2013. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

These financial statements do not include all of the disclosures required by generally accepted accounting principles.

In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of EDGMONT TWP for the year ended December 31, 2013, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: Merves Amon & Barsz LLC Appointed Auditor/CPA

Subscribed and sworn to before me this 10 day of September, 2014.

SEAL

Signed: _____

Witness (Controller)/Auditor (Auditors)

EDGMONT TWP, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/29/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230693 MARCUS HOOK BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

MARCUS HOOK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	2,570,407	6,475	73,372	204,760						2,855,014
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		2,570,407	6,475	73,372	204,760						2,855,014
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	2,378									2,378
200-209, 231-239	All Other Current Liabilities	12,603									12,603
230.00	Due To Other Funds										

MARCUS HOOK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		14,981									14,981
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	2,555,426	6,475	73,372	204,760						2,840,033
291-299	Other Equity										
Total Fund and Account Group Equity		2,555,426	6,475	73,372	204,760						2,840,033
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											2,855,014

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,304,639	19,644		76,395				1,400,678
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	197,249							197,249
310.20	Earned Income Taxes / Wage Taxes	863,282							863,282
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	60,619							60,619
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		2,425,789	19,644		76,395				2,521,828
Licenses and Permits									
320-322	All Other Licenses and Permits	10,832							10,832
321.80	Cable Television Franchise Fees	43,382							43,382
Total Licenses and Permits		54,214							54,214
Fines and Forfeits									
330-332	Fines and Forfeits	35,073							35,073
Total Fines and Forfeits		35,073							35,073

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	2,758	8	104	121				2,991
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		2,758	8	104	121				2,991
Federal									
351.03	Highways and Streets								
351.09	Community Development	8,691							8,691
351.00	All Other Federal Capital and Operating Grants	741							741
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal		9,432							9,432
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	2,701							2,701
354.00	All Other State Capital and Operating Grants	38,685							38,685
355.01	Public Utility Realty Tax (PURTA)	2,679							2,679
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		42,109						42,109
355.04	Alcoholic Beverage Licenses	1,200							1,200
355.05	General Municipal Pension System State Aid	62,450							62,450
355.07	Foreign Fire Insurance Tax Distribution	16,423							16,423
355.08	Local Share Assessment/Gaming Proceeds								

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		124,138	42,109						166,247
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants	10,179							10,179
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services			4,450	33,467				37,917
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		10,179		4,450	33,467				48,096
Charges for Service									
361.00	General Government	3,208							3,208
362.00	Public Safety	511,626							511,626
363.20	Parking	13,979							13,979
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)	6,297							6,297
364.30	Solid Waste Collection and Disposal Charge (trash)	7,312							7,312
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services	1,061							1,061
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	66,820							66,820

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		610,303							610,303
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	302,500							302,500
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	36,062							36,062
Total Unclassified Operating Revenues		338,562							338,562
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition			15,881					15,881
392.00	Interfund Operating Transfers	350,000		69,644					419,644
393.00	Proceeds of General Long-Term Debt			350,000					350,000
394.00	Proceeds of Short Term-Debt								

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures			12,090					12,090
Total Other Financing Sources		350,000		447,615					797,615
TOTAL REVENUES		3,960,448	61,761	452,169	109,983				4,584,361
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	48,704							48,704
401.00	Executive (Manager or Mayor)	66,977							66,977
402.00	Auditing Services / Financial Administration	49,054							49,054
403.00	Tax Collection	10,499							10,499
404.00	Solicitor / Legal Services	19,441							19,441
405.00	Secretary / Clerk	40,498							40,498
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing	3,718							3,718
408.00	Engineering Services	12,889							12,889
409.00	General Government Buildings and Plant	31,283							31,283
Total General Government		283,063							283,063
Public Safety									
410.00	Police	658,940		33,809					692,749
411.00	Fire	91,360		2,563					93,923
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	71,695							71,695
414.00	Planning and Zoning	9,411							9,411
415.00	Emergency Management and Communications								

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		831,406		36,372					867,778
Health and Human Services									
420.00-425.00	Health and Human Services	1,367							1,367
Total Health and Human Services		1,367							1,367
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	106,224							106,224
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection	1,455							1,455
Total Public Works - Sanitation		107,679							107,679
Public Works - Highways and Streets									
430.00	General Services - Administration	188,557							188,557
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	234	4,934						5,168
433.00	Traffic Control Devices	24,586	4,442						29,028
434.00	Street Lighting	40,467	6,254						46,721
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains	27,633							27,633

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges		2,250						2,250
439.00	Highway Construction and Rebuilding Projects		20,474						20,474
Total Public Works - Highways and Streets		281,477	38,354						319,831
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation	92,640							92,640
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees	9,715							9,715
456.00	Libraries	66,736							66,736

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		169,091							169,091
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development			19,518					19,518
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development				19,518					19,518
Debt Service									
471.00	Debt Principal (short-term and long-term)				78,975				78,975
472.00	Debt Interest (short-term and long-term)			2,915	37,331				40,246
475.00	Fiscal Agent Fees			1,785					1,785
Total Debt Service				4,700	116,306				121,006
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	56,936							56,936
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	291,440							291,440
484.00	Worker Compensation Insurance	53,552							53,552

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	455,282							455,282
Total Employer Paid Benefits and Withholding Items		857,210							857,210
Insurance									
486.00	Insurance, Casualty, and Surety	90,994							90,994
Total Insurance		90,994							90,994
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues	1,344							1,344
492.00	Interfund Operating Transfers	50,000	19,644	350,000					419,644
493.00	All Other Financing Uses								
Total Other Financing Uses		51,344	19,644	350,000					420,988
TOTAL EXPENDITURES		2,673,631	57,998	410,590	116,306				3,258,525
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		1,286,817	3,763	41,579	-6,323				1,325,836

MARCUS HOOK BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GON	Note	2003	2027	1,900,000	1,383,000		69,000		1,314,000		1,314,000
VLAP(PA)	Note	2004	2024	200,000	122,578		9,975		112,603		112,603
DVRFA	Note	2013	2023	350,000	0	350,000			350,000		350,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	1,776,603
Capitalized lease obligations	
Net debt	1,776,603

MARCUS HOOK BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	32,693		32,693
Recreation			
Sewer		6,150	6,150
Solid Waste			
Streets / Highways	12,982	30,149	43,131
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	45,675	36,299	81,974

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	954,709

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane, Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

MARCUS HOOK BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/24/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230724 MARPLE TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

MARPLE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	3,505,661	137,424	344,033		1,746,180		17,366,801			23,100,099
140-144	Tax Receivable	297,546									297,546
121-129, 145-149	Accounts Receivable (excluding taxes)	281,117				701,938		492,769			1,475,824
130.00	Due From Other Funds	20,849				14,423		13,036			48,308
131-139, 150-159	Other Current Assets	185,712				41,003		124,649			351,364
160-169	Fixed Assets					3,235,443			23,606,627		26,842,070
180-189	Other Debits					35,830				5,185,252	5,221,082
Total Assets and Other Debits		4,290,885	137,424	344,033		5,774,817		17,997,255	23,606,627	5,185,252	57,336,293
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	173,495				41,351					214,846
200-209, 231-239	All Other Current Liabilities	805,681		2,784		255,714		26,083			1,090,262
230.00	Due To Other Funds	11,766				34,832		1,710			48,308

MARPLE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	837,235				315,464				4,184,985	5,337,684
240-259	Current Portion of Long-Term Debt and Other Credits					115,622				1,000,267	1,115,889
Total Liabilities and Other Credits		1,828,177		2,784		762,983		27,793		5,185,252	7,806,989
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets								23,606,627		23,606,627
270-289	Fund Balance / Retained Earnings on 12/31	2,462,708	137,424	341,249		5,011,834					7,953,215
291-299	Other Equity							17,969,462			17,969,462
Total Fund and Account Group Equity		2,462,708	137,424	341,249		5,011,834		17,969,462	23,606,627		49,529,304
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											57,336,293

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	7,321,267							7,321,267
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	605,058							605,058
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes	1,643,826							1,643,826
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	523,433							523,433
310.60	Amusement / Admission Taxes	34,493							34,493
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		10,128,077							10,128,077
Licenses and Permits									
320-322	All Other Licenses and Permits	800,225							800,225
321.80	Cable Television Franchise Fees	516,635							516,635
Total Licenses and Permits		1,316,860							1,316,860
Fines and Forfeits									
330-332	Fines and Forfeits	78,157							78,157
Total Fines and Forfeits		78,157							78,157

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	5,351	105	23		1,797		2,511,362	2,518,638
342.00	Rents and Royalties	140,538							140,538
Total Interest, Rents and Royalties		145,889	105	23		1,797		2,511,362	2,659,176
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	44,340							44,340
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	12,555							12,555
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		477,266						477,266
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	473,892							473,892
355.07	Foreign Fire Insurance Tax Distribution	219,651							219,651
355.08	Local Share Assessment/Gaming Proceeds								

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		750,438	477,266						1,227,704
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	26,025							26,025
362.00	Public Safety	250,646							250,646
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	24,720		243,055					267,775
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)	49,250				3,036,711			3,085,961
364.30	Solid Waste Collection and Disposal Charge (trash)	51,122				1,651,089			1,702,211
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation					1,622,950			1,622,950

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service					18,308			18,308
Total Charges for Service		401,763		243,055		6,329,058			6,973,876
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors								
388.00	Fiduciary Fund Pension Contributions							1,399,157	1,399,157
389.00	All Other Unclassified Operating Revenues	21,455						11,281	32,736
Total Unclassified Operating Revenues		21,455						1,410,438	1,431,893
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	5,980							5,980
392.00	Interfund Operating Transfers	665,000							665,000
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	40,300							40,300
Total Other Financing Sources		711,280							711,280
TOTAL REVENUES		13,553,919	477,371	243,078		6,330,855		3,921,800	24,527,023
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	44,931							44,931
401.00	Executive (Manager or Mayor)	480,960							480,960
402.00	Auditing Services / Financial Administration	526,805							526,805
403.00	Tax Collection	39,830							39,830
404.00	Solicitor / Legal Services	81,033							81,033
405.00	Secretary / Clerk								
406.00	Other General Government Administration	615		4					619
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	83,190							83,190
409.00	General Government Buildings and Plant	144,680							144,680
Total General Government		1,402,044		4					1,402,048
Public Safety									
410.00	Police	5,069,523							5,069,523
411.00	Fire	458,736							458,736
412.00	Ambulance / Rescue	96,241							96,241
413.00	UCC and Code Enforcement	374,267							374,267
414.00	Planning and Zoning	9,616							9,616
415.00	Emergency Management and Communications	6,912							6,912

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		6,015,295							6,015,295
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)					1,490,248			1,490,248
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					3,012,317			3,012,317
Total Public Works - Sanitation						4,502,565			4,502,565
Public Works - Highways and Streets									
430.00	General Services - Administration	1,870,948							1,870,948
431.00	Cleaning of Streets and Gutters	11,622							11,622
432.00	Winter Maintenance – Snow Removal	80,497							80,497
433.00	Traffic Control Devices	38,791							38,791
434.00	Street Lighting	283,051							283,051
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	12,833		22,312					35,145
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		2,297,742		22,312					2,320,054
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	6,309							6,309
452.00	Participant Recreation					1,327,522			1,327,522
453.00	Spectator Recreation								
454.00	Parks	634,699		85,018					719,717
455.00	Shade Trees								
456.00	Libraries	638,542							638,542

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	74,156							74,156
Total Culture and Recreation		1,353,706		85,018		1,327,522			2,766,246
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	1,141,970							1,141,970
472.00	Debt Interest (short-term and long-term)	174,697				8,081			182,778
475.00	Fiscal Agent Fees								
Total Debt Service		1,316,667				8,081			1,324,748
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	1,155,641							1,155,641
484.00	Worker Compensation Insurance								

MARPLE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		1,155,641							1,155,641
Insurance									
486.00	Insurance, Casualty, and Surety	207,524							207,524
Total Insurance		207,524							207,524
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							1,593,366	1,593,366
489.00	All Other Unclassified Expenditures							171,143	171,143
Total Unclassified Operating Expenditures								1,764,509	1,764,509
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers		340,000			325,000			665,000
493.00	All Other Financing Uses								
Total Other Financing Uses			340,000			325,000			665,000
TOTAL EXPENDITURES		13,748,619	340,000	107,334		6,163,168		1,764,509	22,123,630
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-194,700	137,371	135,744		167,687		2,157,291	2,403,393

MARPLE TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Note	Note	2003	2009	1,196,000	116,000		116,000		0		0
Bond Series 2010A	Bond	2010	2019	2,955,000	1,390,000		575,000		815,000		815,000
Bond Series 2010B	Bond	2010	2019	2,630,000	2,265,000		150,000		2,115,000		2,115,000
DCED Note	Note	2010	2019	365,000	182,499		60,833		121,666		121,666
Bond Series 2011	Bond	2011	2015	2,725,000	2,330,000		400,000		1,930,000		1,930,000
Revenue Bonds and Notes											
Lease Rental Debt											
Capital Lease	Captial Leases	2011	2013	146,003	48,645		48,645		0		0
Packer Truck	Captial Leases	2013	2015	157,278	0	157,278	53,809		103,469		103,469
Roll Off Truck	Captial Leases	2013	2015	152,137	0	152,137	52,020		100,117		100,117
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	5,185,252
Capitalized lease obligations	
Net debt	5,185,252

MARPLE TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	2,000		2,000
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	96,674		96,674
Recreation	13,141	137,001	150,142
Sewer	25,568		25,568
Solid Waste	163,780		163,780
Streets / Highways	88,080	12,833	100,913
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	389,243	149,834	539,077

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	6,380,243

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

MARPLE TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 04/01/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230785 MIDDLETOWN TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

MIDDLETOWN TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	924,413	136,314	3,296,293		294,976		3,828,959			8,480,955
140-144	Tax Receivable	107,925									107,925
121-129, 145-149	Accounts Receivable (excluding taxes)	28,645		15,684		293					44,622
130.00	Due From Other Funds		112,987			5,251					118,238
131-139, 150-159	Other Current Assets					7,003					7,003
160-169	Fixed Assets								20,776,363		20,776,363
180-189	Other Debits									10,650,000	10,650,000
Total Assets and Other Debits		1,060,983	249,301	3,311,977		307,523		3,828,959	20,776,363	10,650,000	40,185,106
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities	64,875	112,987	10,000		8,317		424,527			620,706
230.00	Due To Other Funds	118,238									118,238

MIDDLETOWN TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities									9,990,000	9,990,000
240-259	Current Portion of Long-Term Debt and Other Credits									660,000	660,000
Total Liabilities and Other Credits		183,113	112,987	10,000		8,317		424,527		10,650,000	11,388,944
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets								20,776,363		20,776,363
270-289	Fund Balance / Retained Earnings on 12/31	877,870	136,314	3,301,977		299,206		3,404,432			8,019,799
291-299	Other Equity										
Total Fund and Account Group Equity		877,870	136,314	3,301,977		299,206		3,404,432	20,776,363		28,796,162
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											40,185,106

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	494,647	326,027		978,116				1,798,790
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	617,518							617,518
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes	1,209,782							1,209,782
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **								
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		2,321,947	326,027		978,116				3,626,090
Licenses and Permits									
320-322	All Other Licenses and Permits	273,868							273,868
321.80	Cable Television Franchise Fees	187,970							187,970
Total Licenses and Permits		461,838							461,838
Fines and Forfeits									
330-332	Fines and Forfeits	20,721							20,721
Total Fines and Forfeits		20,721							20,721

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	4,248	1,533	23,085		369		214,283	243,518
342.00	Rents and Royalties	88,636							88,636
Total Interest, Rents and Royalties		92,884	1,533	23,085		369		214,283	332,154
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	33,796							33,796
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	4,275							4,275
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		326,507						326,507
355.04	Alcoholic Beverage Licenses	1,550							1,550
355.05	General Municipal Pension System State Aid	69,918							69,918
355.07	Foreign Fire Insurance Tax Distribution	144,680							144,680
355.08	Local Share Assessment/Gaming Proceeds								

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		254,219	326,507						580,726
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	65,475							65,475
362.00	Public Safety								
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	220,131							220,131
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation					646,035			646,035

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		285,606				646,035			931,641
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors			2,600		209,647			212,247
388.00	Fiduciary Fund Pension Contributions							111,976	111,976
389.00	All Other Unclassified Operating Revenues	5,546	1,115	890					7,551
Total Unclassified Operating Revenues		5,546	1,115	3,490		209,647		111,976	331,774
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	6,775		37,500					44,275
392.00	Interfund Operating Transfers			1,218,230					1,218,230
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	14,105						241,378	255,483
Total Other Financing Sources		20,880		1,255,730				241,378	1,517,988
TOTAL REVENUES		3,463,641	655,182	1,282,305	978,116	856,051		567,637	7,802,932
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	112,004							112,004
401.00	Executive (Manager or Mayor)	442,211							442,211
402.00	Auditing Services / Financial Administration	299,327						23,234	322,561
403.00	Tax Collection	27,697							27,697
404.00	Solicitor / Legal Services	54,652							54,652
405.00	Secretary / Clerk								
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	114,518							114,518
409.00	General Government Buildings and Plant	70,823		35,309					106,132
Total General Government		1,121,232		35,309				23,234	1,179,775
Public Safety									
410.00	Police								
411.00	Fire	308,371	88,805						397,176
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	155,602							155,602
414.00	Planning and Zoning	13,493							13,493
415.00	Emergency Management and Communications								

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories	880							880
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)	5,600							5,600
419.00	Other Public Safety								
Total Public Safety		483,946	88,805						572,751
Health and Human Services									
420.00-425.00	Health and Human Services	36,000							36,000
Total Health and Human Services		36,000							36,000
Public Works - Sanitation									
426.00	Recycling Collection and Disposal	218,128							218,128
427.00	Solid Waste Collection and Disposal (garbage)								
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		218,128							218,128
Public Works - Highways and Streets									
430.00	General Services - Administration	659,535							659,535
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal		43,287						43,287
433.00	Traffic Control Devices	4,624	16,574						21,198
434.00	Street Lighting		7,576						7,576
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	39,245							39,245
438.00	Maintenance and Repairs of Roads and Bridges	14,331							14,331
439.00	Highway Construction and Rebuilding Projects	89,108	339,230	153,057					581,395
Total Public Works - Highways and Streets		806,843	406,667	153,057					1,366,567
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	96,413				733,537			829,950
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	7,521		54,791					62,312
455.00	Shade Trees								
456.00	Libraries	143,595	118,058						261,653

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		247,529	118,058	54,791		733,537			1,153,915
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)			645,000					645,000
472.00	Debt Interest (short-term and long-term)			374,228					374,228
475.00	Fiscal Agent Fees	1,365		3,029					4,394
Total Debt Service		1,365		1,022,257					1,023,622
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses	8,428							8,428
483.00	Pension / Retirement Fund Contributions	131,973							131,973
484.00	Worker Compensation Insurance	15,966							15,966

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		156,367							156,367
Insurance									
486.00	Insurance, Casualty, and Surety	99,939							99,939
Total Insurance		99,939							99,939
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							100,203	100,203
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures								100,203	100,203
Other Financing Uses									
491.00	Refund of Prior Year Revenues	1,002							1,002
492.00	Interfund Operating Transfers	120,950	119,164		978,116				1,218,230
493.00	All Other Financing Uses								
Total Other Financing Uses		121,952	119,164		978,116				1,219,232
TOTAL EXPENDITURES		3,293,301	732,694	1,265,414	978,116	733,537		123,437	7,126,499
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		170,340	-77,512	16,891		122,514		444,200	676,433

MIDDLETOWN TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GOB 2011	Bond	2011	2020	3,885,000	3,675,000		415,000		3,260,000		3,260,000
GOB 2010	Bond	2010	2035	0	7,620,000		230,000		7,390,000		7,390,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	10,650,000
Capitalized lease obligations	
Net debt	10,650,000

MIDDLETOWN TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	16,393	16,094	32,487
Health			
Housing			
Libraries			
Mass Transit			
Parks		9,500	9,500
Police			
Recreation			
Sewer			
Solid Waste			
Streets / Highways	6,962	575,057	582,019
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	23,355	600,651	624,006

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,282,888

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane Thornton Co Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

MIDDLETOWN TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/28/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230843 MORTON BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

MORTON BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	385,522	55,978			192,654		1,784,290			2,418,444
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds					219,712					219,712
131-139, 150-159	Other Current Assets							6,083			6,083
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		385,522	55,978			412,366		1,790,373			2,644,239
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	3,617									3,617
200-209, 231-239	All Other Current Liabilities	2,410									2,410
230.00	Due To Other Funds	219,712									219,712

MORTON BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		225,739									225,739
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31										
291-299	Other Equity	159,783	55,978			412,366		1,790,373			2,418,500
Total Fund and Account Group Equity		159,783	55,978			412,366		1,790,373			2,418,500
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											2,644,239

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	939,219							939,219
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	40,446							40,446
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes	173,577							173,577
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	48,913							48,913
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes	1,640							1,640
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		1,203,795							1,203,795
Licenses and Permits									
320-322	All Other Licenses and Permits	75,129							75,129
321.80	Cable Television Franchise Fees	61,648							61,648
Total Licenses and Permits		136,777							136,777
Fines and Forfeits									
330-332	Fines and Forfeits	52,419							52,419
Total Fines and Forfeits		52,419							52,419

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	774	76			171		202,989	204,010
342.00	Rents and Royalties	55,600							55,600
Total Interest, Rents and Royalties		56,374	76			171		202,989	259,610
Federal									
351.03	Highways and Streets	572							572
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants	3,080							3,080
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal		3,652							3,652
State									
354.03	Highways and Streets								
354.09	Community Development	225							225
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	1,108							1,108
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		49,085						49,085
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	42,728							42,728
355.07	Foreign Fire Insurance Tax Distribution	18,238							18,238
355.08	Local Share Assessment/Gaming Proceeds								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements	214							214
356.00	State Payments in Lieu of Taxes								
Total State		62,513	49,085						111,598
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	10,598							10,598
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		10,598							10,598
Charges for Service									
361.00	General Government	3,555							3,555
362.00	Public Safety	13,476							13,476
363.20	Parking	14,512							14,512
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					504,215			504,215
364.30	Solid Waste Collection and Disposal Charge (trash)	147,650							147,650
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services					1,300			1,300
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		179,193				505,515			684,708
Unclassified Operating Revenues									
383.00	Special Assessments					6,205			6,205
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	3,485							3,485
388.00	Fiduciary Fund Pension Contributions							136,564	136,564
389.00	All Other Unclassified Operating Revenues	5,187							5,187
Total Unclassified Operating Revenues		8,672				6,205		136,564	151,441
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers		14,147						14,147
393.00	Proceeds of General Long-Term Debt	478,250							478,250
394.00	Proceeds of Short Term-Debt	250,000							250,000

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	1,389							1,389
Total Other Financing Sources		729,639	14,147						743,786
TOTAL REVENUES		2,443,632	63,308			511,891		339,553	3,358,384
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	14,869	1		1				14,871
401.00	Executive (Manager or Mayor)	1,875							1,875
402.00	Auditing Services / Financial Administration	16,544				7,308			23,852
403.00	Tax Collection	7,244							7,244
404.00	Solicitor / Legal Services	22,894				11,089			33,983
405.00	Secretary / Clerk	40,140							40,140
406.00	Other General Government Administration	169,393				5,193		15,303	189,889
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	41,430				8,179			49,609
409.00	General Government Buildings and Plant	82,259							82,259
Total General Government		396,648	1		1	31,769		15,303	443,722
Public Safety									
410.00	Police	825,406							825,406
411.00	Fire	81,511							81,511
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	66,182							66,182
414.00	Planning and Zoning	1,740							1,740
415.00	Emergency Management and Communications								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		974,839							974,839
Health and Human Services									
420.00-425.00	Health and Human Services	1,899							1,899
Total Health and Human Services		1,899							1,899
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	120,930							120,930
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					483,567			483,567
Total Public Works - Sanitation		120,930				483,567			604,497
Public Works - Highways and Streets									
430.00	General Services - Administration	2,237	15,949						18,186
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal		943						943
433.00	Traffic Control Devices		2,338						2,338
434.00	Street Lighting		25,846						25,846
435.00	Sidewalks and Crosswalks		578						578
436.00	Storm Sewers and Drains								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	1,800							1,800
439.00	Highway Construction and Rebuilding Projects	308,481							308,481
Total Public Works - Highways and Streets		312,518	45,654						358,172
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	6,625							6,625
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	6,585							6,585
455.00	Shade Trees								
456.00	Libraries								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations	1,500							1,500
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		14,710							14,710
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	280,723				24,788			305,511
472.00	Debt Interest (short-term and long-term)	2,516				15,430			17,946
475.00	Fiscal Agent Fees								
Total Debt Service		283,239				40,218			323,457
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	112,124							112,124
484.00	Worker Compensation Insurance								

MORTON BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		112,124							112,124
Insurance									
486.00	Insurance, Casualty, and Surety	62,614							62,614
Total Insurance		62,614							62,614
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							64,167	64,167
489.00	All Other Unclassified Expenditures	162							162
Total Unclassified Operating Expenditures		162						64,167	64,329
Other Financing Uses									
491.00	Refund of Prior Year Revenues	7,039							7,039
492.00	Interfund Operating Transfers	14,147							14,147
493.00	All Other Financing Uses								
Total Other Financing Uses		21,186							21,186
TOTAL EXPENDITURES		2,300,869	45,655		1	555,554		79,470	2,981,549
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		142,763	17,653		-1	-43,663		260,083	376,835

MORTON BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
DVRFA	Note	2007	2010	250,000	205,000		10,000		195,000		195,000
Sharon Bank	Note	2013	2013	250,000	0	250,000	250,000		0		0
PA Dept of Transportation	Note	2013	2023	478,250	0	478,250			478,250		478,250
Revenue Bonds and Notes											
Lease Rental Debt											
Copier	Note	2010	2015	10,800	7,200		2,160		5,040		5,040
Other											
Pennvest Authority	Note	2003	2023	313,182	183,933		14,788		169,145		169,145
Ford Credit - Police Car	Note	2011	2013	22,954	7,641		7,641		0		0
Ford Credit - Hwy Truck	Note	2011	2013	35,915	11,555		11,555		0		0
Ford Credit - Police Car	Note	2013	2015	23,838	0	23,838	8,451		15,387		15,387
John Deere Financial	Note	2013	2018	10,018	0	10,018	916		9,102		9,102

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	871,924
Capitalized lease obligations	
Net debt	871,924

MORTON BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	2,160		2,160
Health			
Housing			
Libraries			
Mass Transit			
Parks	916		916
Police	23,344		23,344
Recreation	710		710
Sewer			
Solid Waste			
Streets / Highways	12,946	340,742	353,688
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	40,076	340,742	380,818

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	691,225

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the MORTON BORO have audited, adjusted and settled the various funds and account groups of the MORTON BORO for the year ended December 31, 2013. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

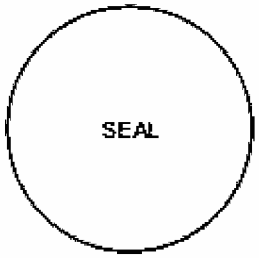
These financial statements do not include all of the disclosures required by generally accepted accounting principles.

In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of MORTON BORO for the year ended December 31, 2013, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: Ronald R Woodworth CPA Appointed Auditor/CPA

Subscribed and sworn to before me this 10 day of September, 2014.



Signed: _____

Witness (Controller)/Auditor (Auditors)

MORTON BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 05/20/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230874 NETHER PROVIDENCE TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

NETHER PROVIDENCE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	665,371	1,082,921	806,208		1,077,404		6,405,824			10,037,728
140-144	Tax Receivable	201,986									201,986
121-129, 145-149	Accounts Receivable (excluding taxes)	14,106		9,053		61,258					84,417
130.00	Due From Other Funds	562,122	19,093	293,262		23,932		8,716			907,125
131-139, 150-159	Other Current Assets	30,633									30,633
160-169	Fixed Assets										
180-189	Other Debits									4,770,181	4,770,181
Total Assets and Other Debits		1,474,218	1,102,014	1,108,523		1,162,594		6,414,540		4,770,181	16,032,070
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	104,276									104,276
200-209, 231-239	All Other Current Liabilities	267,792	11,559	15,889		703,586		59,614			1,058,440
230.00	Due To Other Funds	321,070	325,504	144,706		115,845					907,125

NETHER PROVIDENCE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities									4,408,618	4,408,618
240-259	Current Portion of Long-Term Debt and Other Credits									361,563	361,563
Total Liabilities and Other Credits		693,138	337,063	160,595		819,431		59,614		4,770,181	6,840,022
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	781,080	764,951	947,928		343,163		6,354,926			9,192,048
291-299	Other Equity										
Total Fund and Account Group Equity		781,080	764,951	947,928		343,163		6,354,926			9,192,048

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	16,032,070

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	4,072,907							4,072,907
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	37,291							37,291
310.10	Real Estate Transfer Taxes	350,849							350,849
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	107,967							107,967
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		4,569,014							4,569,014
Licenses and Permits									
320-322	All Other Licenses and Permits	7,600							7,600
321.80	Cable Television Franchise Fees	300,162							300,162
Total Licenses and Permits		307,762							307,762
Fines and Forfeits									
330-332	Fines and Forfeits	37,111	3,037						40,148
Total Fines and Forfeits		37,111	3,037						40,148

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	925	79	864		213		724,721	726,802
342.00	Rents and Royalties	13,800							13,800
Total Interest, Rents and Royalties		14,725	79	864		213		724,721	740,602
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	48,352							48,352
354.00	All Other State Capital and Operating Grants	51,256		364,633					415,889
355.01	Public Utility Realty Tax (PURTA)	5,242							5,242
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		274,016						274,016
355.04	Alcoholic Beverage Licenses	300							300
355.05	General Municipal Pension System State Aid	163,143							163,143
355.07	Foreign Fire Insurance Tax Distribution	119,241							119,241
355.08	Local Share Assessment/Gaming Proceeds								

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		387,534	274,016	364,633					1,026,183
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants	18,968							18,968
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		18,968							18,968
Charges for Service									
361.00	General Government	18,580		9,053					27,633
362.00	Public Safety	333,732							333,732
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					2,019,070			2,019,070
364.30	Solid Waste Collection and Disposal Charge (trash)	280,901							280,901
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	39,930							39,930

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		673,143		9,053		2,019,070			2,701,266
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	34,451	703,008	32,787					770,246
388.00	Fiduciary Fund Pension Contributions							776,468	776,468
389.00	All Other Unclassified Operating Revenues	46,366		1,690					48,056
Total Unclassified Operating Revenues		80,817	703,008	34,477				776,468	1,594,770
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition			8,459					8,459
392.00	Interfund Operating Transfers	185,426	1,000	216,776					403,202
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	138,143	647						138,790
Total Other Financing Sources		323,569	1,647	225,235					550,451
TOTAL REVENUES		6,412,643	981,787	634,262		2,019,283		1,501,189	11,549,164
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	17,444	604						18,048
401.00	Executive (Manager or Mayor)	551,796							551,796
402.00	Auditing Services / Financial Administration	9,700							9,700
403.00	Tax Collection	52,143							52,143
404.00	Solicitor / Legal Services	12,588							12,588
405.00	Secretary / Clerk								
406.00	Other General Government Administration	30,394							30,394
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	9,405		1,995					11,400
409.00	General Government Buildings and Plant	37,723		550,464					588,187
Total General Government		721,193	604	552,459					1,274,256
Public Safety									
410.00	Police	1,996,326	28,135	11,228					2,035,689
411.00	Fire	325,943		3,146					329,089
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	219,966							219,966
414.00	Planning and Zoning	22,702							22,702
415.00	Emergency Management and Communications								

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		2,564,937	28,135	14,374					2,607,446
Health and Human Services									
420.00-425.00	Health and Human Services	1,227							1,227
Total Health and Human Services		1,227							1,227
Public Works - Sanitation									
426.00	Recycling Collection and Disposal	232,819							232,819
427.00	Solid Waste Collection and Disposal (garbage)	5,415							5,415
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection			369,542		1,819,207			2,188,749
Total Public Works - Sanitation		238,234		369,542		1,819,207			2,426,983
Public Works - Highways and Streets									
430.00	General Services - Administration	763,010	5,485						768,495
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	22,713							22,713
433.00	Traffic Control Devices	31,743							31,743
434.00	Street Lighting	62,726							62,726
435.00	Sidewalks and Crosswalks		42,911						42,911
436.00	Storm Sewers and Drains	1,510		57					1,567

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	4,336							4,336
438.00	Maintenance and Repairs of Roads and Bridges								
439.00	Highway Construction and Rebuilding Projects	121,355		57					121,412
Total Public Works - Highways and Streets		1,007,393	48,396	114					1,055,903
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	68,739							68,739
452.00	Participant Recreation		6,319						6,319
453.00	Spectator Recreation								
454.00	Parks	7,238							7,238
455.00	Shade Trees								
456.00	Libraries	80,840							80,840

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		156,817	6,319						163,136
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing	11,247							11,247
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development		11,247							11,247
Debt Service									
471.00	Debt Principal (short-term and long-term)	489,982				18,192			508,174
472.00	Debt Interest (short-term and long-term)	152,949				6,896			159,845
475.00	Fiscal Agent Fees	605							605
Total Debt Service		643,536				25,088			668,624
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	688,644							688,644
484.00	Worker Compensation Insurance	130,178							130,178

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		818,822							818,822
Insurance									
486.00	Insurance, Casualty, and Surety	145,875							145,875
Total Insurance		145,875							145,875
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							487,055	487,055
489.00	All Other Unclassified Expenditures	1,799		1,906				24,579	28,284
Total Unclassified Operating Expenditures		1,799		1,906				511,634	515,339
Other Financing Uses									
491.00	Refund of Prior Year Revenues	746							746
492.00	Interfund Operating Transfers	147,776		5,426		250,000			403,202
493.00	All Other Financing Uses								
Total Other Financing Uses		148,522		5,426		250,000			403,948
TOTAL EXPENDITURES		6,459,602	83,454	943,821		2,094,295		511,634	10,092,806
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-46,959	898,333	-309,559		-75,012		989,555	1,456,358

NETHER PROVIDENCE TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
2011 General Onligation	Note	2011	2026	655,000	621,000		175,000		446,000		446,000
2004 General Obligation	Note	2004	2019	1,030,000	553,000		70,000		483,000		483,000
1999 Volunteer Loan Assistance	Bond	1999	2014	100,000	10,152		10,152		0		0
2000 Volunteer Loan Assistance	Bond	2000	2015	100,000	18,203		9,022		9,181		9,181
2006 General Obligation	Note	2006	2026	3,772,000	2,958,000		157,000		2,801,000		2,801,000
General Obligation	Note	2009	2023	1,310,000	1,118,000		87,000		1,031,000		1,031,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	4,770,181
Capitalized lease obligations	
Net debt	4,770,181

NETHER PROVIDENCE TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	45,278		45,278
Recreation			
Sewer		217,354	217,354
Solid Waste			
Streets / Highways			
Water			
Other: _____			
Community Development		630,547	630,547
TOTAL CAPITAL EXPENDITURES	45,278	847,901	893,179

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	2,214,869

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane,Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

NETHER PROVIDENCE TWP, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 11/03/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230905 NEWTOWN TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

NEWTOWN TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	1,507,711	123,651	1,284,415		623,987		11,200,940			14,740,704
140-144	Tax Receivable	83,460									83,460
121-129, 145-149	Accounts Receivable (excluding taxes)	366,129				246,148					612,277
130.00	Due From Other Funds	299,019	1,000			819,073		18,692			1,137,784
131-139, 150-159	Other Current Assets	349,856						41,991			391,847
160-169	Fixed Assets								12,238,640		12,238,640
180-189	Other Debits									3,012,447	3,012,447
Total Assets and Other Debits		2,606,175	124,651	1,284,415		1,689,208		11,261,623	12,238,640	3,012,447	32,217,159
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities	725,577		3,652		39,482		21,937			790,648
230.00	Due To Other Funds	46,974	39,124	9,028		1,042,658					1,137,784

NEWTOWN TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities									2,847,447	2,847,447
240-259	Current Portion of Long-Term Debt and Other Credits					44,000				165,000	209,000
Total Liabilities and Other Credits		772,551	39,124	12,680		1,126,140		21,937		3,012,447	4,984,879
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets								12,238,640		12,238,640
270-289	Fund Balance / Retained Earnings on 12/31	1,833,624	85,527	1,271,735		563,068		11,239,686			14,993,640
291-299	Other Equity										
Total Fund and Account Group Equity		1,833,624	85,527	1,271,735		563,068		11,239,686	12,238,640		27,232,280
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											32,217,159

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	4,277,085							4,277,085
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	721,174							721,174
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	481,904							481,904
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		5,480,163							5,480,163
Licenses and Permits									
320-322	All Other Licenses and Permits	29,571							29,571
321.80	Cable Television Franchise Fees	281,978							281,978
Total Licenses and Permits		311,549							311,549
Fines and Forfeits									
330-332	Fines and Forfeits	51,957							51,957
Total Fines and Forfeits		51,957							51,957

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	2,252	164	392		14,060		1,572,390	1,589,258
342.00	Rents and Royalties	3,164							3,164
Total Interest, Rents and Royalties		5,416	164	392		14,060		1,572,390	1,592,422
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes	10,000							10,000
Total Federal		10,000							10,000
State									
354.03	Highways and Streets	19,654							19,654
354.09	Community Development								
354.15	Recycling / Act 101	21,491							21,491
354.00	All Other State Capital and Operating Grants	1,398							1,398
355.01	Public Utility Realty Tax (PURTA)	6,362							6,362
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		293,120						293,120
355.04	Alcoholic Beverage Licenses	300							300
355.05	General Municipal Pension System State Aid	178,680							178,680
355.07	Foreign Fire Insurance Tax Distribution	162,079							162,079
355.08	Local Share Assessment/Gaming Proceeds								

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		389,964	293,120						683,084
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	75,980							75,980
362.00	Public Safety	1,256,256							1,256,256
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					1,483,114			1,483,114
364.30	Solid Waste Collection and Disposal Charge (trash)								
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services					18,216			18,216
365.00	Health	392,889							392,889
366.00	Human Services								
367.00	Culture and Recreation								

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		1,725,125				1,501,330			3,226,455
Unclassified Operating Revenues									
383.00	Special Assessments	27,940							27,940
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	145,848	35,565	578,720					760,133
388.00	Fiduciary Fund Pension Contributions							393,182	393,182
389.00	All Other Unclassified Operating Revenues	4,983				6,003			10,986
Total Unclassified Operating Revenues		178,771	35,565	578,720		6,003		393,182	1,192,241
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	13,686		11,751					25,437
392.00	Interfund Operating Transfers		5,001						5,001
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	30,948							30,948
Total Other Financing Sources		44,634	5,001	11,751					61,386
TOTAL REVENUES		8,197,579	333,850	590,863		1,521,393		1,965,572	12,609,257
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	117,349							117,349
401.00	Executive (Manager or Mayor)	502,946							502,946
402.00	Auditing Services / Financial Administration	3,202							3,202
403.00	Tax Collection	22,177							22,177
404.00	Solicitor / Legal Services	162,648							162,648
405.00	Secretary / Clerk								
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services								
409.00	General Government Buildings and Plant	109,896							109,896
Total General Government		918,218							918,218
Public Safety									
410.00	Police	2,602,929	16,460	29,448					2,648,837
411.00	Fire	412,229							412,229
412.00	Ambulance / Rescue	798,349	1,546						799,895
413.00	UCC and Code Enforcement	411,505							411,505
414.00	Planning and Zoning	226,451							226,451
415.00	Emergency Management and Communications								

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		4,451,463	18,006	29,448					4,498,917
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal	148,248							148,248
427.00	Solid Waste Collection and Disposal (garbage)								
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection	270,897				1,493,751			1,764,648
Total Public Works - Sanitation		419,145				1,493,751			1,912,896
Public Works - Highways and Streets									
430.00	General Services - Administration	486,342		5,900					492,242
431.00	Cleaning of Streets and Gutters	13,410							13,410
432.00	Winter Maintenance – Snow Removal	80,256							80,256
433.00	Traffic Control Devices	34,222		14,548					48,770
434.00	Street Lighting	35,037							35,037
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains	2,378							2,378

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	84,219							84,219
438.00	Maintenance and Repairs of Roads and Bridges	57,101	514,338						571,439
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		792,965	514,338	20,448					1,327,751
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	55,849							55,849
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	145,981							145,981
455.00	Shade Trees								
456.00	Libraries	195,078							195,078

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		396,908							396,908
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	170,000							170,000
472.00	Debt Interest (short-term and long-term)	78,430							78,430
475.00	Fiscal Agent Fees	1,500							1,500
Total Debt Service		249,930							249,930
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	315,565							315,565
484.00	Worker Compensation Insurance								

NEWTOWN TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		315,565							315,565
Insurance									
486.00	Insurance, Casualty, and Surety	65,066							65,066
Total Insurance		65,066							65,066
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							491,081	491,081
489.00	All Other Unclassified Expenditures							91,535	91,535
Total Unclassified Operating Expenditures								582,616	582,616
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	5,001							5,001
493.00	All Other Financing Uses								
Total Other Financing Uses		5,001							5,001
TOTAL EXPENDITURES		7,614,261	532,344	49,896		1,493,751		582,616	10,272,868
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		583,318	-198,494	540,967		27,642		1,382,956	2,336,389

NEWTOWN TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
2010A GOB	Bond	2010	2026	2,615,000	2,400,000		150,000		2,250,000		2,250,000
2010B GOB	Bond	2010	2030	500,000	460,000		20,000		440,000		440,000
NTMA Florida Park	Note	1990	2015	115,000	36,916		0		36,916		36,916
Revenue Bonds and Notes											
Lease Rental Debt											
Ford Motor Lease	Captial Leases	2012	2015	56,854	27,406		27,406		0		0
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	2,726,916
Capitalized lease obligations	
Net debt	2,726,916

NEWTOWN TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	15,986		15,986
Health			
Housing			
Libraries			
Mass Transit			
Parks	50,148		50,148
Police			
Recreation			
Sewer			
Solid Waste			
Streets / Highways	5,900		5,900
Water			
Other: Traffic Signals & Signs	15,679		15,679
Community Development			
TOTAL CAPITAL EXPENDITURES	87,713		87,713

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	2,322,317

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Rainer & Company Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

NEWTOWN TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 12/05/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2012 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230963 PARKSIDE BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

PARKSIDE BORO, DELAWARE County

BALANCE SHEET

December 31, 2012

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	38,046	84,869					35,868			158,783
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds		35,500					1,818			37,318
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		38,046	120,369					37,686			196,101
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities										
230.00	Due To Other Funds	37,318									37,318

PARKSIDE BORO, DELAWARE County

BALANCE SHEET

December 31, 2012

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities							37,686			37,686
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		37,318						37,686			75,004
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	728	120,369								121,097
291-299	Other Equity										
Total Fund and Account Group Equity		728	120,369								121,097
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											196,101

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	641,259							641,259
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	17,644							17,644
310.20	Earned Income Taxes / Wage Taxes	183,162							183,162
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	2,792							2,792
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		844,857							844,857
Licenses and Permits									
320-322	All Other Licenses and Permits	41,288							41,288
321.80	Cable Television Franchise Fees	39,831							39,831
Total Licenses and Permits		81,119							81,119
Fines and Forfeits									
330-332	Fines and Forfeits	11,570							11,570
Total Fines and Forfeits		11,570							11,570

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Interest, Rents and Royalties									
341.00	Interest Earnings	523	122						645
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		523	122						645
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants	62,052							62,052
355.01	Public Utility Realty Tax (PURTA)	1,032							1,032
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		39,009						39,009
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	21,457							21,457
355.07	Foreign Fire Insurance Tax Distribution	11,768							11,768
355.08	Local Share Assessment/Gaming Proceeds								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		96,309	39,009						135,318
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	370							370
362.00	Public Safety	5,322							5,322
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	137,948							137,948
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		143,640							143,640
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors								
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	9,156							9,156
Total Unclassified Operating Revenues		9,156							9,156
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers								
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt	100,000							100,000

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	35,568							35,568
Total Other Financing Sources		135,568							135,568
TOTAL REVENUES		1,322,742	39,131						1,361,873
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	14,063							14,063
401.00	Executive (Manager or Mayor)	2,500							2,500
402.00	Auditing Services / Financial Administration	20,004							20,004
403.00	Tax Collection	10,310							10,310
404.00	Solicitor / Legal Services	22,991							22,991
405.00	Secretary / Clerk	29,740							29,740
406.00	Other General Government Administration	27,401							27,401
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	17,261							17,261
409.00	General Government Buildings and Plant	28,781							28,781
Total General Government		173,051							173,051
Public Safety									
410.00	Police	643,781							643,781
411.00	Fire	23,653							23,653
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	23,867							23,867
414.00	Planning and Zoning								
415.00	Emergency Management and Communications								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety	3,234							3,234
Total Public Safety		694,535							694,535
Health and Human Services									
420.00-425.00	Health and Human Services	1,667							1,667
Total Health and Human Services		1,667							1,667
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	132,302							132,302
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		132,302							132,302
Public Works - Highways and Streets									
430.00	General Services - Administration	26,565							26,565
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices		1,460						1,460
434.00	Street Lighting		16,142						16,142
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	2,664							2,664
439.00	Highway Construction and Rebuilding Projects		43,454						43,454
Total Public Works - Highways and Streets		29,229	61,056						90,285
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	3,786							3,786
Total Culture and Recreation		3,786							3,786
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	145,850							145,850
472.00	Debt Interest (short-term and long-term)	25,682							25,682
475.00	Fiscal Agent Fees								
Total Debt Service		171,532							171,532
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	48,691							48,691
484.00	Worker Compensation Insurance								

PARKSIDE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2012

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		48,691							48,691
Insurance									
486.00	Insurance, Casualty, and Surety								
Total Insurance									
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers								
493.00	All Other Financing Uses								
Total Other Financing Uses									
TOTAL EXPENDITURES		1,254,793	61,056						1,315,849
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		67,949	-21,925						46,024

PARKSIDE BORO

December 31, 2012

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GON	Note	2005	2006	675,000	527,761		28,785		498,976		498,976
Revenue Bonds and Notes											
Lease Rental Debt											
Ford Motor Credit	Bond	2010	2013	28,586	17,319		8,798		8,521		8,521
Ford Motor Credit	Bond	2010	2012	25,650	10,627		8,267		2,360		2,360
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	509,857
Capitalized lease obligations	
Net debt	509,857

PARKSIDE BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2012

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government		3,957	3,957
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	26,540		26,540
Recreation			
Sewer			
Solid Waste			
Streets / Highways	43,454		43,454
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	69,994	3,957	73,951

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	422,729

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

PARKSIDE BORO, DELAWARE County
December 31, 2012

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/18/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

230993 PROSPECT PARK BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

PROSPECT PARK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	1,472,779	107,565			838,364		3,112,821			5,531,529
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds	6,511				5,052					11,563
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		1,479,290	107,565			843,416		3,112,821			5,543,092
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	859									859
200-209, 231-239	All Other Current Liabilities	30,030						72,804			102,834
230.00	Due To Other Funds	5,052	5,000					1,511			11,563

PROSPECT PARK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		35,941	5,000					74,315			115,256
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	1,443,349	102,565			843,416					2,389,330
291-299	Other Equity							3,038,506			3,038,506
Total Fund and Account Group Equity		1,443,349	102,565			843,416		3,038,506			5,427,836
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											5,543,092

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,840,540							1,840,540
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	30,576							30,576
310.10	Real Estate Transfer Taxes	86,998							86,998
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	71,978							71,978
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		2,030,092							2,030,092
Licenses and Permits									
320-322	All Other Licenses and Permits	185,084							185,084
321.80	Cable Television Franchise Fees	125,029							125,029
Total Licenses and Permits		310,113							310,113
Fines and Forfeits									
330-332	Fines and Forfeits	42,421							42,421
Total Fines and Forfeits		42,421							42,421

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	4,191				1,900		427,557	433,648
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		4,191				1,900		427,557	433,648
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development	2,996							2,996
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants	3,192							3,192
355.01	Public Utility Realty Tax (PURTA)	2,435							2,435
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		109,098						109,098
355.04	Alcoholic Beverage Licenses	800							800
355.05	General Municipal Pension System State Aid	89,340							89,340
355.07	Foreign Fire Insurance Tax Distribution	39,392							39,392
355.08	Local Share Assessment/Gaming Proceeds								

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		138,155	109,098						247,253
Local Government Units									
357.03	Highways and Streets	15,120							15,120
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	27,866							27,866
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		42,986							42,986
Charges for Service									
361.00	General Government	456							456
362.00	Public Safety	20,662							20,662
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)	130,433				889,449			1,019,882
364.30	Solid Waste Collection and Disposal Charge (trash)	378,671							378,671
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services		7,151						7,151
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		530,222	7,151			889,449			1,426,822
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors								
388.00	Fiduciary Fund Pension Contributions							219,999	219,999
389.00	All Other Unclassified Operating Revenues	1,013	46			189			1,248
Total Unclassified Operating Revenues		1,013	46			189		219,999	221,247
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers	17,956	28,511						46,467
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt	600,000							600,000

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	79,929	5,531						85,460
Total Other Financing Sources		697,885	34,042						731,927
TOTAL REVENUES		3,797,078	150,337			891,538		647,556	5,486,509
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	65,863							65,863
401.00	Executive (Manager or Mayor)	1,800							1,800
402.00	Auditing Services / Financial Administration	10,000							10,000
403.00	Tax Collection	8,814							8,814
404.00	Solicitor / Legal Services	21,724							21,724
405.00	Secretary / Clerk	83,693							83,693
406.00	Other General Government Administration	8,772							8,772
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	117,327							117,327
409.00	General Government Buildings and Plant	514,209							514,209
Total General Government		832,202							832,202
Public Safety									
410.00	Police	1,461,308							1,461,308
411.00	Fire	136,613							136,613
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement								
414.00	Planning and Zoning	83,526							83,526
415.00	Emergency Management and Communications								

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety	4,405							4,405
Total Public Safety		1,685,852							1,685,852
Health and Human Services									
420.00-425.00	Health and Human Services	5,866							5,866
Total Health and Human Services		5,866							5,866
Public Works - Sanitation									
426.00	Recycling Collection and Disposal		1,000						1,000
427.00	Solid Waste Collection and Disposal (garbage)	228,088							228,088
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection	1,610				999,994			1,001,604
Total Public Works - Sanitation		229,698	1,000			999,994			1,230,692
Public Works - Highways and Streets									
430.00	General Services - Administration	164,766	4,548						169,314
431.00	Cleaning of Streets and Gutters		11,063						11,063
432.00	Winter Maintenance – Snow Removal	1,663	9,990						11,653
433.00	Traffic Control Devices		10,312						10,312
434.00	Street Lighting	54,166							54,166
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains		1,918						1,918

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges								
439.00	Highway Construction and Rebuilding Projects	295,900	73,109						369,009
Total Public Works - Highways and Streets		516,495	110,940						627,435
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	33,237							33,237
455.00	Shade Trees								
456.00	Libraries	36,116							36,116

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	15,021							15,021
Total Culture and Recreation		84,374							84,374
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	11,700							11,700
472.00	Debt Interest (short-term and long-term)	976							976
475.00	Fiscal Agent Fees								
Total Debt Service		12,676							12,676
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	37,192							37,192
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	183,076							183,076
484.00	Worker Compensation Insurance	17,280							17,280

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	111,456							111,456
Total Employer Paid Benefits and Withholding Items		349,004							349,004
Insurance									
486.00	Insurance, Casualty, and Surety	64,245							64,245
Total Insurance		64,245							64,245
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							278,621	278,621
489.00	All Other Unclassified Expenditures							12,632	12,632
Total Unclassified Operating Expenditures								291,253	291,253
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	28,511	17,956						46,467
493.00	All Other Financing Uses								
Total Other Financing Uses		28,511	17,956						46,467
TOTAL EXPENDITURES		3,808,923	129,896			999,994		291,253	5,230,066
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-11,845	20,441			-108,456		356,303	256,443

PROSPECT PARK BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Fire Truck	Note	2004	2020	100,000	50,962		6,779		44,183		44,183
Fire Truck	Note	1998	2009	110,000	4,921		4,921		0		0
Revenue Bonds and Notes											
Lease Rental Debt											
Other											
Short term note for property purchase	Note	2013	2014	600,000	0	600,000			600,000		600,000

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	644,183
Capitalized lease obligations	
Net debt	644,183

PROSPECT PARK BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	480,620		480,620
Health			
Housing			
Libraries			
Mass Transit			
Parks	9,580		9,580
Police	24,642		24,642
Recreation			
Sewer			
Solid Waste			
Streets / Highways			
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	514,842		514,842

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,285,722

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

PROSPECT PARK BORO, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 04/01/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231053 RIDLEY PARK BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

RIDLEY PARK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	154,149	88,774	444,577							687,500
140-144	Tax Receivable	12,704	16,783		2,685	7,612					39,784
121-129, 145-149	Accounts Receivable (excluding taxes)	26,779									26,779
130.00	Due From Other Funds	1,747,094	1,507,733		62,319	767,703					4,084,849
131-139, 150-159	Other Current Assets	19,971	38,405			3,185					61,561
160-169	Fixed Assets										
180-189	Other Debits									1,547,422	1,547,422
Total Assets and Other Debits		1,960,697	1,651,695	444,577	65,004	778,500				1,547,422	6,447,895
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities	148,858	46,052			22,409					217,319
230.00	Due To Other Funds	2,325,442	1,685,814	37,418	11,630	24,545					4,084,849

RIDLEY PARK BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities									1,317,886	1,317,886
240-259	Current Portion of Long-Term Debt and Other Credits									229,536	229,536
Total Liabilities and Other Credits		2,474,300	1,731,866	37,418	11,630	46,954				1,547,422	5,849,590
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	-513,603	-80,171	407,159	53,374	731,546					598,305
291-299	Other Equity										
Total Fund and Account Group Equity		-513,603	-80,171	407,159	53,374	731,546					598,305

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	6,447,895

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	174,415	1,842,217		294,683				2,311,315
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	44,395							44,395
310.10	Real Estate Transfer Taxes	72,749							72,749
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	120,408							120,408
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes	1,500							1,500
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		413,467	1,842,217		294,683				2,550,367
Licenses and Permits									
320-322	All Other Licenses and Permits	46,564							46,564
321.80	Cable Television Franchise Fees	149,422							149,422
Total Licenses and Permits		195,986							195,986
Fines and Forfeits									
330-332	Fines and Forfeits	48,034	13,283						61,317
Total Fines and Forfeits		48,034	13,283						61,317

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Interest, Rents and Royalties									
341.00	Interest Earnings	1,552	283	616					2,451
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		1,552	283	616					2,451
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants		30,241						30,241
355.01	Public Utility Realty Tax (PURTA)	3,282							3,282
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		124,826						124,826
355.04	Alcoholic Beverage Licenses	1,000							1,000
355.05	General Municipal Pension System State Aid	93,980							93,980
355.07	Foreign Fire Insurance Tax Distribution	47,747							47,747
355.08	Local Share Assessment/Gaming Proceeds								

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements	6,151							6,151
356.00	State Payments in Lieu of Taxes								
Total State		152,160	155,067						307,227
Local Government Units									
357.03	Highways and Streets	9,518							9,518
357.00	All Other Local Governmental Units Capital and Operating Grants	2,500	27,382						29,882
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		12,018	27,382						39,400
Charges for Service									
361.00	General Government	985							985
362.00	Public Safety	41,744	44,210						85,954
363.20	Parking	89,356							89,356
363.00	All Other Charges for Highway & Street Services	5,751							5,751
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					1,151,818			1,151,818
364.30	Solid Waste Collection and Disposal Charge (trash)	511,034							511,034
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	1,021							1,021

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		649,891	44,210			1,151,818			1,845,919
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	164,320	1,490						165,810
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	7,216	10						7,226
Total Unclassified Operating Revenues		171,536	1,500						173,036
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	5,301	4,950						10,251
392.00	Interfund Operating Transfers								
393.00	Proceeds of General Long-Term Debt		78,678						78,678
394.00	Proceeds of Short Term-Debt								

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	4,094							4,094
Total Other Financing Sources		9,395	83,628						93,023
TOTAL REVENUES		1,654,039	2,167,570	616	294,683	1,151,818			5,268,726
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	10,178							10,178
401.00	Executive (Manager or Mayor)	95,911							95,911
402.00	Auditing Services / Financial Administration	27,980							27,980
403.00	Tax Collection	14,703							14,703
404.00	Solicitor / Legal Services	38,358							38,358
405.00	Secretary / Clerk	109,785							109,785
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing	4,025							4,025
408.00	Engineering Services	38,224							38,224
409.00	General Government Buildings and Plant	50,701							50,701
Total General Government		389,865							389,865
Public Safety									
410.00	Police		1,814,616						1,814,616
411.00	Fire	47,746	83,012						130,758
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement								
414.00	Planning and Zoning	116,524							116,524
415.00	Emergency Management and Communications	1,200							1,200

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		165,470	1,897,628						2,063,098
Health and Human Services									
420.00-425.00	Health and Human Services	7,812							7,812
Total Health and Human Services		7,812							7,812
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	461,898							461,898
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					1,047,550			1,047,550
Total Public Works - Sanitation		461,898				1,047,550			1,509,448
Public Works - Highways and Streets									
430.00	General Services - Administration	206,202	131,452						337,654
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal		16,230						16,230
433.00	Traffic Control Devices		21,983						21,983
434.00	Street Lighting		66,772						66,772
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges		120,361						120,361
439.00	Highway Construction and Rebuilding Projects	9,518	20,918						30,436
Total Public Works - Highways and Streets		215,720	377,716						593,436
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation		112,186						112,186
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries		128,031						128,031

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	23,405							23,405
Total Culture and Recreation		23,405	240,217						263,622
Community Development									
461.00	Conservation of Natural Resources	1,251							1,251
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development			45,126					45,126
Total Community Development		1,251		45,126					46,377
Debt Service									
471.00	Debt Principal (short-term and long-term)		44,844		204,533				249,377
472.00	Debt Interest (short-term and long-term)		3,778		67,154				70,932
475.00	Fiscal Agent Fees								
Total Debt Service			48,622		271,687				320,309
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions								
484.00	Worker Compensation Insurance	11,482							11,482

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	266,110							266,110
Total Employer Paid Benefits and Withholding Items		277,592							277,592
Insurance									
486.00	Insurance, Casualty, and Surety	71,870							71,870
Total Insurance		71,870							71,870
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers								
493.00	All Other Financing Uses								
Total Other Financing Uses									
TOTAL EXPENDITURES		1,614,883	2,564,183	45,126	271,687	1,047,550			5,543,429
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		39,156	-396,613	-44,510	22,996	104,268			-274,703

RIDLEY PARK BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Ridley Ave Sanitary Sewer	Note	1995	2015	577,722	189,316		60,472		128,844		128,844
Storm Sewer	Note	1995	2013	348,000	20,298		20,298		0		0
Police Building	Note	2007	2017	1,400,000	1,146,314		78,352		1,067,962		1,067,962
Revenue Bonds and Notes											
Lease Rental Debt											
2010 Crown Victoria - Police	Note	2010	2013	30,871	5,516		5,516		0		0
2011 Crown Victoria - Police	Note	2011	2014	29,184	15,031		9,866		5,165		5,165
2012 Dodge Charger	Note	2012	2015	31,180	28,356		9,761		18,595		18,595
John Deere Backhoe Loader	Note	2013	2016	78,678	0	78,678	19,701		58,977		58,977
Other											
LaFrance Ladder	Note	2003	2018	500,000	254,739		34,903		219,836		219,836
PEMA - LaFrance Loader	Note	2003	2018	150,000	58,551		10,508		48,043		48,043

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	1,547,422
Capitalized lease obligations	
Net debt	1,547,422

RIDLEY PARK BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	12,653	14,452	27,105
Health			
Housing			
Libraries	7,295		7,295
Mass Transit			
Parks		27,172	27,172
Police	64,779		64,779
Recreation			
Sewer			
Solid Waste			
Streets / Highways	78,678	129,879	208,557
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	163,405	171,503	334,908

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,603,631

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane, Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

RIDLEY PARK BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/24/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231084 RIDLEY TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

RIDLEY TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	5,036,474	3,232,871	15,716,289	2,702,804			19,837,866			46,526,304
140-144	Tax Receivable	522,401	52,082		76,865						651,348
121-129, 145-149	Accounts Receivable (excluding taxes)	599,638	500,910								1,100,548
130.00	Due From Other Funds	221,741	84,692	400,000	73,964			818			781,215
131-139, 150-159	Other Current Assets	23,865									23,865
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		6,404,119	3,870,555	16,116,289	2,853,633			19,838,684			49,083,280
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	290,518									290,518
200-209, 231-239	All Other Current Liabilities	159,377	24,926	28,298				2,381			214,982
230.00	Due To Other Funds	76,415	4,486	400,000				300,314			781,215

RIDLEY TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	714,890	494,578	102,550	62,605			835,140			2,209,763
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		1,241,200	523,990	530,848	62,605			1,137,835			3,496,478
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	5,162,919	3,346,565	15,585,441	2,791,028						26,885,953
291-299	Other Equity							18,700,849			18,700,849
Total Fund and Account Group Equity		5,162,919	3,346,565	15,585,441	2,791,028			18,700,849			45,586,802
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											49,083,280

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	8,389,273	834,249		1,231,203				10,454,725
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	287,985							287,985
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes	558,101							558,101
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	716,134							716,134
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		9,951,493	834,249		1,231,203				12,016,945
Licenses and Permits									
320-322	All Other Licenses and Permits	1,290,575							1,290,575
321.80	Cable Television Franchise Fees	655,299							655,299
Total Licenses and Permits		1,945,874							1,945,874
Fines and Forfeits									
330-332	Fines and Forfeits	144,813							144,813
Total Fines and Forfeits		144,813							144,813

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	15,801	6,675	23,252	3,323			2,736,515	2,785,566
342.00	Rents and Royalties	450,224							450,224
Total Interest, Rents and Royalties		466,025	6,675	23,252	3,323			2,736,515	3,235,790
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	114,134							114,134
354.00	All Other State Capital and Operating Grants	1,000							1,000
355.01	Public Utility Realty Tax (PURTA)	13,979							13,979
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		551,701						551,701
355.04	Alcoholic Beverage Licenses	8,950							8,950
355.05	General Municipal Pension System State Aid	473,891							473,891
355.07	Foreign Fire Insurance Tax Distribution	207,187							207,187
355.08	Local Share Assessment/Gaming Proceeds								

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements	900							900
356.00	State Payments in Lieu of Taxes								
Total State		820,041	551,701						1,371,742
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants	41,243							41,243
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	131,316							131,316
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		172,559							172,559
Charges for Service									
361.00	General Government	39,397							39,397
362.00	Public Safety	99,374							99,374
363.20	Parking								
363.00	All Other Charges for Highway & Street Services			661,610					661,610
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)		3,032,515						3,032,515
364.30	Solid Waste Collection and Disposal Charge (trash)	1,763,749							1,763,749
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	477,833							477,833

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		2,380,353	3,032,515	661,610					6,074,478
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors							985	985
388.00	Fiduciary Fund Pension Contributions							840,940	840,940
389.00	All Other Unclassified Operating Revenues	200	14,273					970	15,443
Total Unclassified Operating Revenues		200	14,273					842,895	857,368
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers	70,000		800,000					870,000
393.00	Proceeds of General Long-Term Debt			10,000,000					10,000,000
394.00	Proceeds of Short Term-Debt								

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	246,984							246,984
Total Other Financing Sources		316,984		10,800,000					11,116,984
TOTAL REVENUES		16,198,342	4,439,413	11,484,862	1,234,526			3,579,410	36,936,553
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	39,375							39,375
401.00	Executive (Manager or Mayor)	107,628							107,628
402.00	Auditing Services / Financial Administration	34,250							34,250
403.00	Tax Collection	96,228							96,228
404.00	Solicitor / Legal Services	48,275							48,275
405.00	Secretary / Clerk								
406.00	Other General Government Administration	778,734		244,348	392				1,023,474
407.00	IT-Networking Services-Data Processing	2,707							2,707
408.00	Engineering Services								
409.00	General Government Buildings and Plant	244,399		13,900					258,299
Total General Government		1,351,596		258,248	392				1,610,236
Public Safety									
410.00	Police	3,941,998							3,941,998
411.00	Fire	214,613	216,529						431,142
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	428,860							428,860
414.00	Planning and Zoning	45,252							45,252
415.00	Emergency Management and Communications								

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety	6,060							6,060
Total Public Safety		4,636,783	216,529						4,853,312
Health and Human Services									
420.00-425.00	Health and Human Services	10,850							10,850
Total Health and Human Services		10,850							10,850
Public Works - Sanitation									
426.00	Recycling Collection and Disposal	528,227							528,227
427.00	Solid Waste Collection and Disposal (garbage)	1,376,958							1,376,958
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection		2,934,506						2,934,506
Total Public Works - Sanitation		1,905,185	2,934,506						4,839,691
Public Works - Highways and Streets									
430.00	General Services - Administration	866,773	4,862						871,635
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	66,057							66,057
433.00	Traffic Control Devices	387,852							387,852
434.00	Street Lighting		255,906						255,906
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains	485							485

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges			328,093					328,093
439.00	Highway Construction and Rebuilding Projects	50,669	195,489	150,517					396,675
Total Public Works - Highways and Streets		1,371,836	456,257	478,610					2,306,703
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	635,583							635,583
452.00	Participant Recreation	249,323							249,323
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								
456.00	Libraries		460,000						460,000

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers	15,000							15,000
459.00	All Other Culture and Recreation	30,721							30,721
Total Culture and Recreation		930,627	460,000						1,390,627
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development							1,000	1,000
Total Community Development								1,000	1,000
Debt Service									
471.00	Debt Principal (short-term and long-term)				265,000				265,000
472.00	Debt Interest (short-term and long-term)				319,441				319,441
475.00	Fiscal Agent Fees								
Total Debt Service					584,441				584,441
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	444,690							444,690
482.00	Judgments and Losses	58,573							58,573
483.00	Pension / Retirement Fund Contributions	964,688							964,688
484.00	Worker Compensation Insurance	490,336							490,336

RIDLEY TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	2,483,593							2,483,593
Total Employer Paid Benefits and Withholding Items		4,441,880							4,441,880
Insurance									
486.00	Insurance, Casualty, and Surety	497,730							497,730
Total Insurance		497,730							497,730
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							912,641	912,641
489.00	All Other Unclassified Expenditures							36,863	36,863
Total Unclassified Operating Expenditures								949,504	949,504
Other Financing Uses									
491.00	Refund of Prior Year Revenues	125,266							125,266
492.00	Interfund Operating Transfers	800,000	70,000						870,000
493.00	All Other Financing Uses								
Total Other Financing Uses		925,266	70,000						995,266
TOTAL EXPENDITURES		16,071,753	4,137,292	736,858	584,833			950,504	22,481,240
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		126,589	302,121	10,748,004	649,693			2,628,906	14,455,313

RIDLEY TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GOB	Bond	2009	2022	3,065,000	2,400,000		205,000		2,195,000		2,195,000
GON	Note	2006	2009	1,500,000	1,233,000		60,000		1,173,000		1,173,000
GON	Note	2013	2028	10,000,000	0	10,000,000	0		10,000,000		10,000,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	13,368,000
Capitalized lease obligations	
Net debt	13,368,000

RIDLEY TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	52,351		52,351
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	57,429		57,429
Recreation	23,432		23,432
Sewer			
Solid Waste			
Streets / Highways	326,216		326,216
Water			
Other: _____			
Community Development	10,700		10,700
TOTAL CAPITAL EXPENDITURES	470,128		470,128

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	7,031,198

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

RIDLEY TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 07/17/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231143 RUTLEDGE BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

RUTLEDGE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	74,673	15,716			51,704					142,093
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		74,673	15,716			51,704					142,093
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	781	88								869
200-209, 231-239	All Other Current Liabilities	943									943
230.00	Due To Other Funds										

RUTLEDGE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	107,515									107,515
240-259	Current Portion of Long-Term Debt and Other Credits	11,704									11,704
Total Liabilities and Other Credits		120,943	88								121,031
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	-46,270	15,628			51,704					21,062
291-299	Other Equity										
Total Fund and Account Group Equity		-46,270	15,628			51,704					21,062

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	142,093

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	169,482							169,482
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	2,428							2,428
310.10	Real Estate Transfer Taxes	3,503							3,503
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **								
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		175,413							175,413
Licenses and Permits									
320-322	All Other Licenses and Permits	3,350							3,350
321.80	Cable Television Franchise Fees	15,070							15,070
Total Licenses and Permits		18,420							18,420
Fines and Forfeits									
330-332	Fines and Forfeits	4,167							4,167
Total Fines and Forfeits		4,167							4,167

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	136	5			12			153
342.00	Rents and Royalties	35,486							35,486
Total Interest, Rents and Royalties		35,622	5			12			35,639
Federal									
351.03	Highways and Streets		61,880						61,880
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal			61,880						61,880
State									
354.03	Highways and Streets		59						59
354.09	Community Development								
354.15	Recycling / Act 101	757							757
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	208							208
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		16,318						16,318
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid								
355.07	Foreign Fire Insurance Tax Distribution	5,719							5,719
355.08	Local Share Assessment/Gaming Proceeds								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		6,684	16,377						23,061
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government								
362.00	Public Safety	16,562							16,562
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					173,523			173,523
364.30	Solid Waste Collection and Disposal Charge (trash)	59,287							59,287
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		75,849				173,523			249,372
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors								
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	454							454
Total Unclassified Operating Revenues		454							454
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers								
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources									
TOTAL REVENUES		316,609	78,262			173,535			568,406
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	10,538							10,538
401.00	Executive (Manager or Mayor)								
402.00	Auditing Services / Financial Administration	420							420
403.00	Tax Collection	2,407							2,407
404.00	Solicitor / Legal Services	2,400							2,400
405.00	Secretary / Clerk	25,292							25,292
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	4,954	2,718						7,672
409.00	General Government Buildings and Plant	17,568							17,568
Total General Government		63,579	2,718						66,297
Public Safety									
410.00	Police	80,932							80,932
411.00	Fire	27,869							27,869
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	11,612							11,612
414.00	Planning and Zoning								
415.00	Emergency Management and Communications								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		120,413							120,413
Health and Human Services									
420.00-425.00	Health and Human Services	200							200
Total Health and Human Services		200							200
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	58,322							58,322
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					181,105			181,105
Total Public Works - Sanitation		58,322				181,105			239,427
Public Works - Highways and Streets									
430.00	General Services - Administration								
431.00	Cleaning of Streets and Gutters		499						499
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices		74						74
434.00	Street Lighting	681	7,354						8,035
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery		1,050						1,050
438.00	Maintenance and Repairs of Roads and Bridges	209,741	6,293						216,034
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		210,422	15,270						225,692
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation	500							500
453.00	Spectator Recreation								
454.00	Parks	2,352							2,352
455.00	Shade Trees	500							500
456.00	Libraries								

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations	500							500
458.00	Senior Citizens' Centers	300							300
459.00	All Other Culture and Recreation	29							29
Total Culture and Recreation		4,181							4,181
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	5,034							5,034
472.00	Debt Interest (short-term and long-term)	3,829							3,829
475.00	Fiscal Agent Fees								
Total Debt Service		8,863							8,863
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions								
484.00	Worker Compensation Insurance	2,386							2,386

RUTLEDGE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		2,386							2,386
Insurance									
486.00	Insurance, Casualty, and Surety	17,582							17,582
Total Insurance		17,582							17,582
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers								
493.00	All Other Financing Uses								
Total Other Financing Uses									
TOTAL EXPENDITURES		485,948	17,988			181,105			685,041
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-169,339	60,274			-7,570			-116,635

RUTLEDGE BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Loan	Note	1994	2024	80,000	47,297		5,034		42,263		42,263
General Obligation Note	Note	2013	2023	125,000	0	125,000	5,781		119,219		119,219
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	161,482
Capitalized lease obligations	
Net debt	161,482

RUTLEDGE BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police			
Recreation			
Sewer			
Solid Waste			
Streets / Highways			
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES			

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	47,257

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the RUTLEDGE BORO have audited, adjusted and settled the various funds and account groups of the RUTLEDGE BORO for the year ended December 31, 2013. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

These financial statements do not include all of the disclosures required by generally accepted accounting principles.

In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of RUTLEDGE BORO for the year ended December 31, 2013, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: Paul S. Garrity Elected Auditor

Catherine A. Myers Elected Auditor

Henry J. Borsch, III Elected Auditor

Subscribed and sworn to before me this 12 day of August, 2014.

SEAL

Signed: _____

Witness (Controller)/Auditor (Auditors)

RUTLEDGE BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/29/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231204 SPRINGFIELD TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

SPRINGFIELD TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	2,452,511	149,131	1,434,662		631,312	3,951,390	2,407,567			11,026,573
140-144	Tax Receivable	170,506									170,506
121-129, 145-149	Accounts Receivable (excluding taxes)	38,095					64,688				102,783
130.00	Due From Other Funds	3,823,258					842,300				4,665,558
131-139, 150-159	Other Current Assets					43,539					43,539
160-169	Fixed Assets					3,350,491			1,557,489		4,907,980
180-189	Other Debits					21,200				262,958	284,158
Total Assets and Other Debits		6,484,370	149,131	1,434,662		4,046,542	4,858,378	2,407,567	1,557,489	262,958	21,201,097
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	180,180									180,180
200-209, 231-239	All Other Current Liabilities	285,893				406		394,708			681,007
230.00	Due To Other Funds	3,308				3,785,740	35,750				3,824,798

SPRINGFIELD TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	7,006				3,962,145		2,012,820	720,000	241,855	6,943,826
240-259	Current Portion of Long-Term Debt and Other Credits					345,898			120,000	21,103	487,001
Total Liabilities and Other Credits		476,387				8,094,189	35,750	2,407,528	840,000	262,958	12,116,812
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	6,007,983	149,131	1,434,662		-4,047,647	4,822,628	39	717,489		9,084,285
291-299	Other Equity										
Total Fund and Account Group Equity		6,007,983	149,131	1,434,662		-4,047,647	4,822,628	39	717,489		9,084,285

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	21,201,097

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	8,679,467							8,679,467
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	751,268							751,268
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes	1,435,641							1,435,641
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	460,681							460,681
310.60	Amusement / Admission Taxes	55,057							55,057
310.70	Mechanical Device Taxes	26,350							26,350
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		11,408,464							11,408,464
Licenses and Permits									
320-322	All Other Licenses and Permits	234,039						28,178	262,217
321.80	Cable Television Franchise Fees	533,806							533,806
Total Licenses and Permits		767,845						28,178	796,023
Fines and Forfeits									
330-332	Fines and Forfeits	124,778		9,838					134,616
Total Fines and Forfeits		124,778		9,838					134,616

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	8,064	1,374	1,449		506	10,929	418	22,740
342.00	Rents and Royalties	119,959	50,400			811,822			982,181
Total Interest, Rents and Royalties		128,023	51,774	1,449		812,328	10,929	418	1,004,921
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101			142,273					142,273
354.00	All Other State Capital and Operating Grants	457,082					267,369		724,451
355.01	Public Utility Realty Tax (PURTA)	13,764							13,764
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		455,052						455,052
355.04	Alcoholic Beverage Licenses	8,350							8,350
355.05	General Municipal Pension System State Aid	539,926							539,926
355.07	Foreign Fire Insurance Tax Distribution	218,632							218,632
355.08	Local Share Assessment/Gaming Proceeds								

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		1,237,754	455,052	142,273			267,369		2,102,448
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	75,745							75,745
362.00	Public Safety	1,154,023							1,154,023
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	20,268							20,268
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)						3,027,996		3,027,996
364.30	Solid Waste Collection and Disposal Charge (trash)	1,863,997							1,863,997
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services	84,303							84,303
365.00	Health	32,703							32,703
366.00	Human Services								
367.00	Culture and Recreation		1,800			1,644,468			1,646,268

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		3,231,039	1,800			1,644,468	3,027,996		7,905,303
Unclassified Operating Revenues									
383.00	Special Assessments						3,694		3,694
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors							325,965	325,965
388.00	Fiduciary Fund Pension Contributions							155,339	155,339
389.00	All Other Unclassified Operating Revenues	7,109							7,109
Total Unclassified Operating Revenues		7,109					3,694	481,304	492,107
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition			121,303					121,303
392.00	Interfund Operating Transfers	526,443		1,850,000	34,327		120,000		2,530,770
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	240,121					330		240,451
Total Other Financing Sources		766,564		1,971,303	34,327		120,330		2,892,524
TOTAL REVENUES		17,671,576	508,626	2,124,863	34,327	2,456,796	3,430,318	509,900	26,736,406
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	146,690							146,690
401.00	Executive (Manager or Mayor)								
402.00	Auditing Services / Financial Administration	2,400						11,176	13,576
403.00	Tax Collection	76,625							76,625
404.00	Solicitor / Legal Services								
405.00	Secretary / Clerk	824,340	391	12,983					837,714
406.00	Other General Government Administration								
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	356,132							356,132
409.00	General Government Buildings and Plant	308,097		68,108					376,205
Total General Government		1,714,284	391	81,091				11,176	1,806,942
Public Safety									
410.00	Police	5,226,161		86,355					5,312,516
411.00	Fire	567,610		247,466					815,076
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	382,005							382,005
414.00	Planning and Zoning								
415.00	Emergency Management and Communications	2,383							2,383

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		6,178,159		333,821					6,511,980
Health and Human Services									
420.00-425.00	Health and Human Services	88,980		18,185					107,165
Total Health and Human Services		88,980		18,185					107,165
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	1,950,002		487,433					2,437,435
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection						2,907,704		2,907,704
Total Public Works - Sanitation		1,950,002		487,433			2,907,704		5,345,139
Public Works - Highways and Streets									
430.00	General Services - Administration	1,383,833							1,383,833
431.00	Cleaning of Streets and Gutters	56,461		387,437					443,898
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices	139,084							139,084
434.00	Street Lighting	195,762							195,762
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	479,243							479,243
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		2,254,383		387,437					2,641,820
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration								
452.00	Participant Recreation					2,704,204			2,704,204
453.00	Spectator Recreation								
454.00	Parks	398,334	91,757	4,674					494,765
455.00	Shade Trees								
456.00	Libraries	693,528							693,528

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations	500							500
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		1,092,362	91,757	4,674		2,704,204			3,892,997
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)				20,125		120,000		140,125
472.00	Debt Interest (short-term and long-term)				14,202	232,789			246,991
475.00	Fiscal Agent Fees	1,967							1,967
Total Debt Service		1,967			34,327	232,789	120,000		389,083
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	550,897							550,897
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	1,525,233							1,525,233
484.00	Worker Compensation Insurance								

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		2,076,130							2,076,130
Insurance									
486.00	Insurance, Casualty, and Surety	796,365							796,365
Total Insurance		796,365							796,365
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							470,128	470,128
489.00	All Other Unclassified Expenditures	148,286							148,286
Total Unclassified Operating Expenditures		148,286						470,128	618,414
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	2,004,327	444,345			53,500		28,598	2,530,770
493.00	All Other Financing Uses								
Total Other Financing Uses		2,004,327	444,345			53,500		28,598	2,530,770
TOTAL EXPENDITURES		18,305,245	536,493	1,312,641	34,327	2,990,493	3,027,704	509,902	26,716,805
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-633,669	-27,867	812,222		-533,697	402,614	-2	19,601

SPRINGFIELD TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
General Obligation Notes	Note	1998	2023	8,250,000	4,921,000		350,000		4,571,000		4,571,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	4,571,000
Capitalized lease obligations	
Net debt	4,571,000

SPRINGFIELD TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire	247,466		247,466
Gas System			
General Government	67,294	149,596	216,890
Health	18,185		18,185
Housing			
Libraries			
Mass Transit			
Parks	4,674	76,512	81,186
Police	86,355		86,355
Recreation	65,076	66,977	132,053
Sewer		22,431	22,431
Solid Waste	487,433		487,433
Streets / Highways	387,437	344,729	732,166
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	1,363,920	660,245	2,024,165

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	8,281,397

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the Municipality

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We, the undersigned, the duly elected (or appointed replacement), qualified, and Acting Controller/Auditors of the SPRINGFIELD TWP have audited, adjusted and settled the various funds and account groups of the SPRINGFIELD TWP for the year ended December 31, 2013. My/Our audit, adjustment and settlement was made in accordance with law rather than with generally accepted auditing standards

(PLEASE CROSS OUT ONLY IF ON MODIFIED ACCRUAL/ACCRUAL BASIS)
This municipality's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenues and the related assets are recognized when received rather than when earned, and certain expenditures or expenses are recognized when paid rather than when a liability is incurred. Accordingly, the accompanying financial statements are not intended to present the financial position and results of operations of this municipality in conformity with generally accepted accounting principles.

These financial statements do not include all of the disclosures required by generally accepted accounting principles.

In my/our opinion, the aforementioned financial statements present the financial position of the various funds and account groups of the municipality of SPRINGFIELD TWP for the year ended December 31, 2013, and the results of operations of such funds in accordance with the law.

SIGNATURE AND VERIFICATION

Signed: James T. DeLizzio Elected Auditor

Robert B. Simpson Elected Auditor

Joseph T. Rago Elected Auditor

Subscribed and sworn to before me this 11 day of September, 2014.

SEAL

Signed: _____

Witness (Controller)/Auditor (Auditors)

SPRINGFIELD TWP, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 04/01/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231233 SWARTHMORE BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

SWARTHMORE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	624,427	225,512	377,235	39,458	203,613		5,553,088			7,023,333
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds							16,391			16,391
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		624,427	225,512	377,235	39,458	203,613		5,569,479			7,039,724
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	17,881									17,881
200-209, 231-239	All Other Current Liabilities							14,877			14,877
230.00	Due To Other Funds	16,391									16,391

SWARTHMORE BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		34,272						14,877			49,149
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	590,155	225,512	377,235	39,458	203,613		5,554,602			6,990,575
291-299	Other Equity										
Total Fund and Account Group Equity		590,155	225,512	377,235	39,458	203,613		5,554,602			6,990,575
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											7,039,724

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,644,437	184,026		172,245				2,000,708
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	201,272							201,272
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	89,509							89,509
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		1,935,218	184,026		172,245				2,291,489
Licenses and Permits									
320-322	All Other Licenses and Permits	22,550							22,550
321.80	Cable Television Franchise Fees	95,364							95,364
Total Licenses and Permits		117,914							117,914
Fines and Forfeits									
330-332	Fines and Forfeits	30,739							30,739
Total Fines and Forfeits		30,739							30,739

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	211	18	93		168		803,687	804,177
342.00	Rents and Royalties								
Total Interest, Rents and Royalties		211	18	93		168		803,687	804,177
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets			27,182					27,182
354.09	Community Development								
354.15	Recycling / Act 101					13,321			13,321
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	2,783							2,783
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		113,158						113,158
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid		97,109						97,109
355.07	Foreign Fire Insurance Tax Distribution	52,801							52,801
355.08	Local Share Assessment/Gaming Proceeds								

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		55,584	210,267	27,182		13,321			306,354
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants	15,930							15,930
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		15,930							15,930
Charges for Service									
361.00	General Government	900							900
362.00	Public Safety	315,707	7,198						322,905
363.20	Parking	67,513							67,513
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)					923,948			923,948
364.30	Solid Waste Collection and Disposal Charge (trash)					498,168			498,168
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	20,295							20,295

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service					26,570			26,570
Total Charges for Service		404,415	7,198			1,448,686			1,860,299
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	116,000		33,293					149,293
388.00	Fiduciary Fund Pension Contributions							417,267	417,267
389.00	All Other Unclassified Operating Revenues	5,571						9,761	15,332
Total Unclassified Operating Revenues		121,571		33,293				427,028	581,892
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers		35,362	42,000		30,000			107,362
393.00	Proceeds of General Long-Term Debt	37,523		500,000					537,523
394.00	Proceeds of Short Term-Debt								

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	24,485							24,485
Total Other Financing Sources		62,008	35,362	542,000		30,000			669,370
TOTAL REVENUES		2,743,590	436,871	602,568	172,245	1,492,175		1,230,715	6,678,164
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body								
401.00	Executive (Manager or Mayor)	63,637				27,273			90,910
402.00	Auditing Services / Financial Administration	11,822				4,829			16,651
403.00	Tax Collection	7,944				6,040			13,984
404.00	Solicitor / Legal Services	45,189				7,250			52,439
405.00	Secretary / Clerk	58,190				31,956			90,146
406.00	Other General Government Administration	24,809							24,809
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services			2,000					2,000
409.00	General Government Buildings and Plant	85,845		20,000					105,845
Total General Government		297,436		22,000		77,348			396,784
Public Safety									
410.00	Police	1,023,041							1,023,041
411.00	Fire	173,712		5,514					179,226
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	450							450
414.00	Planning and Zoning	24,307							24,307
415.00	Emergency Management and Communications								

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		1,221,510		5,514					1,227,024
Health and Human Services									
420.00-425.00	Health and Human Services	1,100							1,100
Total Health and Human Services		1,100							1,100
Public Works - Sanitation									
426.00	Recycling Collection and Disposal					78,076			78,076
427.00	Solid Waste Collection and Disposal (garbage)					293,833			293,833
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection					653,133			653,133
Total Public Works - Sanitation						1,025,042			1,025,042
Public Works - Highways and Streets									
430.00	General Services - Administration	42,592	4,240	22,791		40,561			110,184
431.00	Cleaning of Streets and Gutters	8,936	450						9,386
432.00	Winter Maintenance – Snow Removal	6,929	4,913						11,842
433.00	Traffic Control Devices	10,801	9,122						19,923
434.00	Street Lighting	53,852	9,437						63,289
435.00	Sidewalks and Crosswalks	19,358							19,358
436.00	Storm Sewers and Drains	7,738	5,237			5,975			18,950

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery		10,591						10,591
438.00	Maintenance and Repairs of Roads and Bridges	2,784	16,060			11,122			29,966
439.00	Highway Construction and Rebuilding Projects			327,610					327,610
Total Public Works - Highways and Streets		152,990	60,050	350,401		57,658			621,099
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	21,000							21,000
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	27,661							27,661
455.00	Shade Trees	37,080							37,080
456.00	Libraries	120,000							120,000

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation								
Total Culture and Recreation		205,741							205,741
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing	20,000		3,058					23,058
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development		20,000		3,058					23,058
Debt Service									
471.00	Debt Principal (short-term and long-term)	47,829			141,568	90,368			279,765
472.00	Debt Interest (short-term and long-term)	7,266			36,716	24,791			68,773
475.00	Fiscal Agent Fees			2,250					2,250
Total Debt Service		55,095		2,250	178,284	115,159			350,788
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	90,823							90,823
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions		303,578			47,963			351,541
484.00	Worker Compensation Insurance	24,646				4,553			29,199

SWARTHMORE BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	314,243				66,141			380,384
Total Employer Paid Benefits and Withholding Items		429,712	303,578			118,657			851,947
Insurance									
486.00	Insurance, Casualty, and Surety	32,917				9,832			42,749
Total Insurance		32,917				9,832			42,749
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							285,400	285,400
489.00	All Other Unclassified Expenditures	857						14,869	15,726
Total Unclassified Operating Expenditures		857						300,269	301,126
Other Financing Uses									
491.00	Refund of Prior Year Revenues	16,813							16,813
492.00	Interfund Operating Transfers	77,362				30,000			107,362
493.00	All Other Financing Uses								
Total Other Financing Uses		94,175				30,000			124,175
TOTAL EXPENDITURES		2,511,533	363,628	383,223	178,284	1,433,696		300,269	5,170,633
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		232,057	73,243	219,345	-6,039	58,479		930,446	1,507,531

SWARTHMORE BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GON	Note	2000	2015	1,640,000	436,000		138,000		298,000		298,000
GON	Note	2002	2022	580,000	352,000		29,000		323,000		323,000
GON	Note	2004	2024	885,000	496,000		33,000		463,000		463,000
GON	Note	2006	2026	870,000	680,000		36,000		644,000		644,000
GON	Note	2008	2028	500,000	429,000		20,000		409,000		409,000
GON	Note	2013	2033	500,000	0	500,000	0		500,000		500,000
Revenue Bonds and Notes											
Lease Rental Debt											
Capital Lease	Lease Rentals	2012	2014	3,472	21,605	0	10,462		11,143		11,143
Police Car	Note	2013	2015	37,523	0	37,523	13,303		24,220		24,220
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	2,672,363
Capitalized lease obligations	
Net debt	2,672,363

SWARTHMORE BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	40,816		40,816
Recreation			
Sewer		7,400	7,400
Solid Waste			
Streets / Highways	22,791	327,610	350,401
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	63,607	335,010	398,617

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,329,306

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane, Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

SWARTHMORE BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 03/29/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231323 TRAINER BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

TRAINER BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	612,946	132,904								745,850
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		612,946	132,904								745,850
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	3,097									3,097
200-209, 231-239	All Other Current Liabilities	122									122
230.00	Due To Other Funds										

TRAINER BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities										
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		3,219									3,219
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	609,727	132,904								742,631
291-299	Other Equity										
Total Fund and Account Group Equity		609,727	132,904								742,631
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											745,850

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	1,181,121							1,181,121
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	9,837							9,837
310.20	Earned Income Taxes / Wage Taxes	917,903							917,903
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	48,393							48,393
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		2,157,254							2,157,254
Licenses and Permits									
320-322	All Other Licenses and Permits	66,139							66,139
321.80	Cable Television Franchise Fees	23,960							23,960
Total Licenses and Permits		90,099							90,099
Fines and Forfeits									
330-332	Fines and Forfeits	11,371							11,371
Total Fines and Forfeits		11,371							11,371

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	718	134						852
342.00	Rents and Royalties	6,739	5,975						12,714
Total Interest, Rents and Royalties		7,457	6,109						13,566
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	2,723							2,723
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		33,441						33,441
355.04	Alcoholic Beverage Licenses	50							50
355.05	General Municipal Pension System State Aid	42,728							42,728
355.07	Foreign Fire Insurance Tax Distribution	10,406							10,406
355.08	Local Share Assessment/Gaming Proceeds								

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		55,907	33,441						89,348
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services								
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units									
Charges for Service									
361.00	General Government	40,507							40,507
362.00	Public Safety								
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)								
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	4,268	4,158						8,426

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		44,775	4,158						48,933
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	70,000							70,000
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues	8,451							8,451
Total Unclassified Operating Revenues		78,451							78,451
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers		11,629						11,629
393.00	Proceeds of General Long-Term Debt	129,301							129,301
394.00	Proceeds of Short Term-Debt	300,000							300,000

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources		429,301	11,629						440,930
TOTAL REVENUES		2,874,615	55,337						2,929,952
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	13,437							13,437
401.00	Executive (Manager or Mayor)	3,144							3,144
402.00	Auditing Services / Financial Administration	36,154							36,154
403.00	Tax Collection	4,153							4,153
404.00	Solicitor / Legal Services	13,016							13,016
405.00	Secretary / Clerk	32,114							32,114
406.00	Other General Government Administration	10,561							10,561
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	57,801							57,801
409.00	General Government Buildings and Plant	26,931							26,931
Total General Government		197,311							197,311
Public Safety									
410.00	Police	938,058							938,058
411.00	Fire	115,607							115,607
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	3,410							3,410
414.00	Planning and Zoning								
415.00	Emergency Management and Communications								

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety	169							169
Total Public Safety		1,057,244							1,057,244
Health and Human Services									
420.00-425.00	Health and Human Services	28,576							28,576
Total Health and Human Services		28,576							28,576
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	113,137							113,137
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		113,137							113,137
Public Works - Highways and Streets									
430.00	General Services - Administration	88,365	49,529						137,894
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal		2,541						2,541
433.00	Traffic Control Devices		5,402						5,402
434.00	Street Lighting	34,058							34,058
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	6,277	2,672						8,949
438.00	Maintenance and Repairs of Roads and Bridges	2,652	318						2,970
439.00	Highway Construction and Rebuilding Projects								
Total Public Works - Highways and Streets		131,352	60,462						191,814
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	6,591							6,591
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	6,748							6,748
455.00	Shade Trees								
456.00	Libraries								

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers	1,000							1,000
459.00	All Other Culture and Recreation		18,478						18,478
Total Culture and Recreation		14,339	18,478						32,817
Community Development									
461.00	Conservation of Natural Resources	2,000							2,000
462.00	Community Development and Housing	2,396							2,396
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development		4,396							4,396
Debt Service									
471.00	Debt Principal (short-term and long-term)	345,635							345,635
472.00	Debt Interest (short-term and long-term)	8,090							8,090
475.00	Fiscal Agent Fees								
Total Debt Service		353,725							353,725
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	75,645							75,645
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	114,785							114,785
484.00	Worker Compensation Insurance	59,865							59,865

TRAINER BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	233,477							233,477
Total Employer Paid Benefits and Withholding Items		483,772							483,772
Insurance									
486.00	Insurance, Casualty, and Surety	50,010							50,010
Total Insurance		50,010							50,010
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures	10,001							10,001
Total Unclassified Operating Expenditures		10,001							10,001
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	11,629							11,629
493.00	All Other Financing Uses								
Total Other Financing Uses		11,629							11,629
TOTAL EXPENDITURES		2,455,492	78,940						2,534,432
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		419,123	-23,603						395,520

TRAINER BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Revenue Bonds and Notes											
Lease Rental Debt											
Police Cars - Dodge Charger (4)	Note	2013	2015	129,301	0	129,301	45,635		83,666		83,666
Other											
Tax Anticipation Note	Note	2013	2013	300,000	0	300,000	300,000		0		0

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	83,666
Capitalized lease obligations	
Net debt	83,666

TRAINER BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	171,958		171,958
Recreation			
Sewer			
Solid Waste			
Streets / Highways	49,529		49,529
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	221,487		221,487

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	824,597

Independent Public Accountant/Certified Public Accountant Submission Page

Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Barbacane, Thornton & Company LLP Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

TRAINER BORO, DELAWARE County

December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 05/07/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231353 UPLAND BORO, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

UPLAND BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	552,110	242,679	1,125,230	298,194	91,756					2,309,969
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds										
131-139, 150-159	Other Current Assets					35,314					35,314
160-169	Fixed Assets										
180-189	Other Debits	18,331								1,776,954	1,795,285
Total Assets and Other Debits		570,441	242,679	1,125,230	298,194	127,070				1,776,954	4,140,568
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	4,914									4,914
200-209, 231-239	All Other Current Liabilities					35,314					35,314
230.00	Due To Other Funds										

UPLAND BORO, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities									1,691,828	1,691,828
240-259	Current Portion of Long-Term Debt and Other Credits									85,126	85,126
Total Liabilities and Other Credits		4,914				35,314				1,776,954	1,817,182
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	565,527	242,679	1,125,230	298,194	91,756					2,323,386
291-299	Other Equity										
Total Fund and Account Group Equity		565,527	242,679	1,125,230	298,194	91,756					2,323,386

TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY	4,140,568

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	149,028							149,028
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	1,428							1,428
310.10	Real Estate Transfer Taxes	6,158							6,158
310.20	Earned Income Taxes / Wage Taxes	1,979,735							1,979,735
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	194,634							194,634
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes		183,765						183,765
	Other: _____								
Total Taxes		2,330,983	183,765						2,514,748
Licenses and Permits									
320-322	All Other Licenses and Permits	386,625							386,625
321.80	Cable Television Franchise Fees	50,712							50,712
Total Licenses and Permits		437,337							437,337
Fines and Forfeits									
330-332	Fines and Forfeits	59,683							59,683

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Total Fines and Forfeits		59,683							59,683
Interest, Rents and Royalties									
341.00	Interest Earnings	12	72	223					307
342.00	Rents and Royalties	18,000				784,415			802,415
Total Interest, Rents and Royalties		18,012	72	223		784,415			802,722
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101								
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	2,585							2,585
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		57,390						57,390
355.04	Alcoholic Beverage Licenses								
355.05	General Municipal Pension System State Aid	69,918							69,918
355.07	Foreign Fire Insurance Tax Distribution	16,301							16,301

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.08	Local Share Assessment/Gaming Proceeds								
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		88,804	57,390						146,194
Local Government Units									
357.03	Highways and Streets								
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	4,050							4,050
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes	33,277							33,277
Total Local Government Units		37,327							37,327
Charges for Service									
361.00	General Government	14,673							14,673
362.00	Public Safety								
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	143,610							143,610
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health	1,945							1,945
366.00	Human Services								

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
367.00	Culture and Recreation								
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		160,228							160,228
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	58,414	15,499			940			74,853
388.00	Fiduciary Fund Pension Contributions								
389.00	All Other Unclassified Operating Revenues								
Total Unclassified Operating Revenues		58,414	15,499			940			74,853
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers	737,141	10,000	500,000	148,047	3,862			1,399,050
393.00	Proceeds of General Long-Term Debt								

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
394.00	Proceeds of Short Term-Debt								
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources		737,141	10,000	500,000	148,047	3,862			1,399,050
TOTAL REVENUES		3,927,929	266,726	500,223	148,047	789,217			5,632,142
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	132,087							132,087
401.00	Executive (Manager or Mayor)	37,396							37,396
402.00	Auditing Services / Financial Administration	10,740							10,740
403.00	Tax Collection	14,680							14,680
404.00	Solicitor / Legal Services	100,035							100,035
405.00	Secretary / Clerk	31,295							31,295
406.00	Other General Government Administration	73,658							73,658
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	142,457							142,457
409.00	General Government Buildings and Plant	698,992							698,992
Total General Government		1,241,340							1,241,340
Public Safety									
410.00	Police	686,305							686,305
411.00	Fire	52,299							52,299
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement								
414.00	Planning and Zoning	260,820							260,820

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Safety									
415.00	Emergency Management and Communications								
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		999,424							999,424
Health and Human Services									
420.00-425.00	Health and Human Services	1,000							1,000
Total Health and Human Services		1,000							1,000
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	315,924							315,924
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		315,924							315,924
Public Works - Highways and Streets									
430.00	General Services - Administration	13,534							13,534
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal								
433.00	Traffic Control Devices								
434.00	Street Lighting	31,909							31,909
435.00	Sidewalks and Crosswalks								

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Public Works - Highways and Streets									
436.00	Storm Sewers and Drains								
437.00	Repairs of Tools and Machinery	62,637							62,637
438.00	Maintenance and Repairs of Roads and Bridges								
439.00	Highway Construction and Rebuilding Projects		72,572						72,572
Total Public Works - Highways and Streets		108,080	72,572						180,652
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	12,665							12,665
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks								
455.00	Shade Trees								

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
456.00	Libraries								
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	11,000							11,000
Total Culture and Recreation		23,665							23,665
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development					493,181			493,181
Total Community Development						493,181			493,181
Debt Service									
471.00	Debt Principal (short-term and long-term)				82,236				82,236
472.00	Debt Interest (short-term and long-term)				62,578				62,578
475.00	Fiscal Agent Fees								
Total Debt Service					144,814				144,814
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation	99,379				20,591			119,970
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	75,007							75,007
484.00	Worker Compensation Insurance	116,636							116,636

UPLAND BORO, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	205,809							205,809
Total Employer Paid Benefits and Withholding Items		496,831				20,591			517,422
Insurance									
486.00	Insurance, Casualty, and Surety	66,015				54,670			120,685
Total Insurance		66,015				54,670			120,685
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid								
489.00	All Other Unclassified Expenditures								
Total Unclassified Operating Expenditures									
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	661,909	328,283	200,000		208,858			1,399,050
493.00	All Other Financing Uses								
Total Other Financing Uses		661,909	328,283	200,000		208,858			1,399,050
TOTAL EXPENDITURES		3,914,188	400,855	200,000	144,814	777,300			5,437,157
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		13,741	-134,129	300,223	3,233	11,917			194,985

UPLAND BORO

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Note A-2	Note	2012	2032	652,000	652,000		0		652,000		652,000
Note	Note	2009	2029	850,000	771,549		29,643		741,906		741,906
Note	Note	1999	2019	216,658	87,640		12,593		75,047		75,047
Note A-1	Note	2012	2020	348,000	348,000		40,000		308,000		308,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	1,776,953
Capitalized lease obligations	
Net debt	1,776,953

UPLAND BORO, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government	462,518	72,615	535,133
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	23,677		23,677
Recreation			
Sewer			
Solid Waste			
Streets / Highways		63,689	63,689
Water			
Other: _____			
Community Development	12,364	129,067	141,431
TOTAL CAPITAL EXPENDITURES	498,559	265,371	763,930

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,165,755

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: John Hanna Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

UPLAND BORO, DELAWARE County
December 31, 2013

NOTES / COMMENTS

Note 3 - Pension information has been omitted from the Fiduciary Fund because the independent audit firm was not engaged to audit the Pension Fund.

Note 2 - Other Current Assets and Other Current Liabilities recorded in the Enterprise Fund represent escrow deposits maintained on behalf of tenants and developers

Note 1 - Other Debits recorded in the General Fund represent a payroll tax deposit processed by the bank as of December 31, 2013 to cover the payroll scheduled for January 2, 2014.

DCED-CLGS-30 (9-09)
Received by DCED: 05/05/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231384 UPPER CHICHESTER TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

UPPER CHICHESTER TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	5,098,343	921,231	933,731				13,739,561			20,692,866
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)										
130.00	Due From Other Funds	17,109	460								17,569
131-139, 150-159	Other Current Assets							68,157			68,157
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		5,115,452	921,691	933,731				13,807,718			20,778,592
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings										
200-209, 231-239	All Other Current Liabilities							1,061,241			1,061,241
230.00	Due To Other Funds	460	17,109								17,569

UPPER CHICHESTER TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	1,005									1,005
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		1,465	17,109					1,061,241			1,079,815
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	5,113,987	904,582	933,731							6,952,300
291-299	Other Equity							12,746,477			12,746,477
Total Fund and Account Group Equity		5,113,987	904,582	933,731				12,746,477			19,698,777
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											20,778,592

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	4,481,438							4,481,438
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes								
310.10	Real Estate Transfer Taxes	241,393							241,393
310.20	Earned Income Taxes / Wage Taxes	4,608,495							4,608,495
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	268,209							268,209
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes	3,170							3,170
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		9,602,705							9,602,705
Licenses and Permits									
320-322	All Other Licenses and Permits	822,648							822,648
321.80	Cable Television Franchise Fees	377,455							377,455
Total Licenses and Permits		1,200,103							1,200,103
Fines and Forfeits									
330-332	Fines and Forfeits	69,457							69,457
Total Fines and Forfeits		69,457							69,457

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	5,583	523	184				647,241	653,531
342.00	Rents and Royalties	80,388							80,388
Total Interest, Rents and Royalties		85,971	523	184				647,241	733,919
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	23,278							23,278
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	10,714							10,714
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		314,818						314,818
355.04	Alcoholic Beverage Licenses	3,050							3,050
355.05	General Municipal Pension System State Aid	271,905							271,905
355.07	Foreign Fire Insurance Tax Distribution	123,193							123,193
355.08	Local Share Assessment/Gaming Proceeds								

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements								
356.00	State Payments in Lieu of Taxes								
Total State		432,140	314,818						746,958
Local Government Units									
357.03	Highways and Streets	25,920							25,920
357.00	All Other Local Governmental Units Capital and Operating Grants	81,236							81,236
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	57,728							57,728
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		164,884							164,884
Charges for Service									
361.00	General Government	75,579							75,579
362.00	Public Safety	69,518							69,518
363.20	Parking								
363.00	All Other Charges for Highway & Street Services	47,035							47,035
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)								
364.30	Solid Waste Collection and Disposal Charge (trash)	883,943							883,943
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services								
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	84,050	113,995						198,045

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service	47,760							47,760
Total Charges for Service		1,207,885	113,995						1,321,880
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors		50,000						50,000
388.00	Fiduciary Fund Pension Contributions							957,619	957,619
389.00	All Other Unclassified Operating Revenues	2,970							2,970
Total Unclassified Operating Revenues		2,970	50,000					957,619	1,010,589
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition								
392.00	Interfund Operating Transfers	742,694	215,460	160,000					1,118,154
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures								
Total Other Financing Sources		742,694	215,460	160,000					1,118,154
TOTAL REVENUES		13,508,809	694,796	160,184				1,604,860	15,968,649
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	20,625							20,625
401.00	Executive (Manager or Mayor)	19,630							19,630
402.00	Auditing Services / Financial Administration	30,937							30,937
403.00	Tax Collection	21,500							21,500
404.00	Solicitor / Legal Services	104,663							104,663
405.00	Secretary / Clerk	41,841							41,841
406.00	Other General Government Administration	721,844							721,844
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	243,554							243,554
409.00	General Government Buildings and Plant								
Total General Government		1,204,594							1,204,594
Public Safety									
410.00	Police	3,931,758	2,652						3,934,410
411.00	Fire	373,586							373,586
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	312,788							312,788
414.00	Planning and Zoning	18,738							18,738
415.00	Emergency Management and Communications	26,340							26,340

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety	9,318							9,318
Total Public Safety		4,672,528	2,652						4,675,180
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	1,031,545							1,031,545
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection								
Total Public Works - Sanitation		1,031,545							1,031,545
Public Works - Highways and Streets									
430.00	General Services - Administration	1,300,097							1,300,097
431.00	Cleaning of Streets and Gutters								
432.00	Winter Maintenance – Snow Removal	26,871							26,871
433.00	Traffic Control Devices	40,908							40,908
434.00	Street Lighting	144,234							144,234
435.00	Sidewalks and Crosswalks								
436.00	Storm Sewers and Drains								

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery								
438.00	Maintenance and Repairs of Roads and Bridges	18,541							18,541
439.00	Highway Construction and Rebuilding Projects	354,211							354,211
Total Public Works - Highways and Streets		1,884,862							1,884,862
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	212,374							212,374
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	138,827							138,827
455.00	Shade Trees								
456.00	Libraries	73,200							73,200

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers	12,000							12,000
459.00	All Other Culture and Recreation								
Total Culture and Recreation		436,401							436,401
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)	465,240							465,240
472.00	Debt Interest (short-term and long-term)	148,321							148,321
475.00	Fiscal Agent Fees								
Total Debt Service		613,561							613,561
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	809,383							809,383
484.00	Worker Compensation Insurance								

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits								
Total Employer Paid Benefits and Withholding Items		809,383							809,383
Insurance									
486.00	Insurance, Casualty, and Surety								
Total Insurance									
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							913,602	913,602
489.00	All Other Unclassified Expenditures							21,777	21,777
Total Unclassified Operating Expenditures								935,379	935,379
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	375,460	324,245		418,449				1,118,154
493.00	All Other Financing Uses								
Total Other Financing Uses		375,460	324,245		418,449				1,118,154
TOTAL EXPENDITURES		11,028,334	326,897		418,449			935,379	12,709,059
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		2,480,475	367,899	160,184	-418,449			669,481	3,259,590

UPPER CHICHESTER TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
General Obligation Bond	Bond	1999	2019	706,700	239,266		34,260		205,006		205,006
General Obligation Bond	Bond	2001	2021	559,000	280,454		26,980		253,474		253,474
General Obligation Note	Note	2002	2022	1,230,000	720,000		61,000		659,000		659,000
General Obligation Note	Note	2005	2025	300,000	220,000		13,000		207,000		207,000
General Obligation Bond	Bond	2010	2022	4,680,000	3,880,000		330,000		3,550,000		3,550,000
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	4,874,480
Capitalized lease obligations	
Net debt	4,874,480

UPPER CHICHESTER TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government			
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	71,075		71,075
Recreation		7,787	7,787
Sewer			
Solid Waste	22,140		22,140
Streets / Highways	72,197		72,197
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	165,412	7,787	173,199

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	3,945,226

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

UPPER CHICHESTER TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

DCED-CLGS-30 (9-09)
Received by DCED: 04/04/2014

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013 MUNICIPAL ANNUAL AUDIT AND FINANCIAL REPORT

231445 UPPER PROVIDENCE TWP, DELAWARE COUNTY

DCED-CLGS-30 (9-09)

BALANCE SHEET

DCED-CLGS-30 (09-09)

UPPER PROVIDENCE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Assets and Other Debits											
100-120	Cash and Investments	845,683	548,043	908,672		23,030		5,240,818			7,566,246
140-144	Tax Receivable										
121-129, 145-149	Accounts Receivable (excluding taxes)	52,602									52,602
130.00	Due From Other Funds		4,736								4,736
131-139, 150-159	Other Current Assets										
160-169	Fixed Assets										
180-189	Other Debits										
Total Assets and Other Debits		898,285	552,779	908,672		23,030		5,240,818			7,623,584
Liabilities and Other Credits											
210-229	Payroll Taxes and Other Payroll Withholdings	4,533									4,533
200-209, 231-239	All Other Current Liabilities					4,736					4,736
230.00	Due To Other Funds										

UPPER PROVIDENCE TWP, DELAWARE County

BALANCE SHEET

December 31, 2013

		Governmental Funds				Proprietary Funds		Fid. Fund	Account Groups		Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	General Fixed Assets	General Long Term Debt	Memorandum Only
Liabilities and Other Credits											
260-269	Long-Term-Liabilities	17,882						108,850			126,732
240-259	Current Portion of Long-Term Debt and Other Credits										
Total Liabilities and Other Credits		22,415				4,736		108,850			136,001
Fund and Account Group Equity											
281-284	Contributed Capital										
290.00	Investment in General Fixed Assets										
270-289	Fund Balance / Retained Earnings on 12/31	875,870	552,779	908,672		18,294					2,355,615
291-299	Other Equity							5,131,968			5,131,968
Total Fund and Account Group Equity		875,870	552,779	908,672		18,294		5,131,968			7,487,583
TOTAL LIABILITIES AND FUND AND ACCOUNT GROUP EQUITY											7,623,584

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Taxes									
301.00	Real Estate Taxes	2,996,459	184,022						3,180,481
305.00	Occupation Taxes (levied under municipal code)								
308.00	Residence Taxes (levied by cities of the 3rd Class)								
309.00	Regional Asset District Sales Tax (Allegheny County municipalities only)								
310.00	Per Capita Taxes	30,526							30,526
310.10	Real Estate Transfer Taxes	1,312,350							1,312,350
310.20	Earned Income Taxes / Wage Taxes								
310.30	Business Gross Receipts Taxes								
310.40	Occupation Taxes (levied under Act 511)								
310.50	Local Services Tax **	95,661							95,661
310.60	Amusement / Admission Taxes								
310.70	Mechanical Device Taxes								
310.90	Other Local Tax Enabling Act / Act 511 / Taxes								
	Other: _____								
Total Taxes		4,434,996	184,022						4,619,018
Licenses and Permits									
320-322	All Other Licenses and Permits	224,534							224,534
321.80	Cable Television Franchise Fees	260,497							260,497
Total Licenses and Permits		485,031							485,031
Fines and Forfeits									
330-332	Fines and Forfeits	143,420							143,420
Total Fines and Forfeits		143,420							143,420

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Interest, Rents and Royalties									
341.00	Interest Earnings	1,998	639	390	3,323	23		703,585	709,958
342.00	Rents and Royalties		60,000						60,000
Total Interest, Rents and Royalties		1,998	60,639	390	3,323	23		703,585	769,958
Federal									
351.03	Highways and Streets								
351.09	Community Development								
351.00	All Other Federal Capital and Operating Grants								
352.01	National Forest								
352.00	All Other Federal Shared Revenue and Entitlements								
353.00	Federal Payments in Lieu of Taxes								
Total Federal									
State									
354.03	Highways and Streets								
354.09	Community Development								
354.15	Recycling / Act 101	8,767							8,767
354.00	All Other State Capital and Operating Grants								
355.01	Public Utility Realty Tax (PURTA)	5,207							5,207
355.02-355.03	Motor Vehicle Fuel Tax (Liquid Fuels Tax) and State Road Turnback		210,199						210,199
355.04	Alcoholic Beverage Licenses	1,400							1,400
355.05	General Municipal Pension System State Aid	137,539							137,539
355.07	Foreign Fire Insurance Tax Distribution	100,909							100,909
355.08	Local Share Assessment/Gaming Proceeds								

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

REVENUES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
State									
355.09	Marcellus Shale Impact Fee Distribution								
355.00	All Other State Shared Revenues and Entitlements	121,660							121,660
356.00	State Payments in Lieu of Taxes								
Total State		375,482	210,199						585,681
Local Government Units									
357.03	Highways and Streets	14,243							14,243
357.00	All Other Local Governmental Units Capital and Operating Grants								
358.00	Local Government Unit Shared Payments for Contracted Intergovernmental Services	32,148							32,148
359.00	Local Governmental Units and Authorities Payments in Lieu of Taxes								
Total Local Government Units		46,391							46,391
Charges for Service									
361.00	General Government	5,558							5,558
362.00	Public Safety	5,291							5,291
363.20	Parking								
363.00	All Other Charges for Highway & Street Services								
364.10	Wastewater / Sewage (including connection / tapping fees, sewer usage charges, reserve capacity fee, etc.)	29,833							29,833
364.30	Solid Waste Collection and Disposal Charge (trash)		111,899						111,899
364.60	Host Municipality Benefit Fee for Solid Waste Facility								
364.00	All Other Charges for Sanitation Services	589							589
365.00	Health								
366.00	Human Services								
367.00	Culture and Recreation	14,535							14,535

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Charges for Service									
368.00	Airports								
369.00	Bars								
370.00	Cemeteries								
372.00	Electric System								
373.00	Gas System								
374.00	Housing System								
375.00	Markets								
377.00	Transit Systems								
378.00	Water System								
379.00	All Other Charges for Service								
Total Charges for Service		55,806	111,899						167,705
Unclassified Operating Revenues									
383.00	Special Assessments								
386.00	Escheats (sale of personal property)								
387.00	Contributions and Donations from Private Sectors	3,800							3,800
388.00	Fiduciary Fund Pension Contributions							341,102	341,102
389.00	All Other Unclassified Operating Revenues	3,508							3,508
Total Unclassified Operating Revenues		7,308						341,102	348,410
Other Financing Sources									
391.00	Proceeds of General Fixed Asset Disposition	14,331							14,331
392.00	Interfund Operating Transfers		8,500	1,249,374		11,421			1,269,295
393.00	Proceeds of General Long-Term Debt								
394.00	Proceeds of Short Term-Debt								

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
REVENUES									
Other Financing Sources									
395.00	Refunds of Prior Year Expenditures	2,941							2,941
Total Other Financing Sources		17,272	8,500	1,249,374		11,421			1,286,567
TOTAL REVENUES		5,567,704	575,259	1,249,764	3,323	11,444		1,044,687	8,452,181
EXPENDITURES									
General Government									
400.00	Legislative (Governing) Body	222,638							222,638
401.00	Executive (Manager or Mayor)	89,618							89,618
402.00	Auditing Services / Financial Administration	121,700							121,700
403.00	Tax Collection	12,669							12,669
404.00	Solicitor / Legal Services	26,192							26,192
405.00	Secretary / Clerk								
406.00	Other General Government Administration			1,050					1,050
407.00	IT-Networking Services-Data Processing								
408.00	Engineering Services	159,575							159,575
409.00	General Government Buildings and Plant	80,532	28,857	11,421					120,810
Total General Government		712,924	28,857	12,471					754,252
Public Safety									
410.00	Police	2,151,705							2,151,705
411.00	Fire	210,781	61,057						271,838
412.00	Ambulance / Rescue								
413.00	UCC and Code Enforcement	65,476							65,476
414.00	Planning and Zoning	3,597							3,597
415.00	Emergency Management and Communications								

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Safety									
416.00	Militia and Armories								
417.00	Examination of Licensed Occupations								
418.00	Public Scales (weights and measures)								
419.00	Other Public Safety								
Total Public Safety		2,431,559	61,057						2,492,616
Health and Human Services									
420.00-425.00	Health and Human Services								
Total Health and Human Services									
Public Works - Sanitation									
426.00	Recycling Collection and Disposal								
427.00	Solid Waste Collection and Disposal (garbage)	668	126,286						126,954
428.00	Weed Control								
429.00	Wastewater / Sewage Treatment and Collection	6,284							6,284
Total Public Works - Sanitation		6,952	126,286						133,238
Public Works - Highways and Streets									
430.00	General Services - Administration	158,689							158,689
431.00	Cleaning of Streets and Gutters	291							291
432.00	Winter Maintenance – Snow Removal	86,970							86,970
433.00	Traffic Control Devices	13,411	3,943						17,354
434.00	Street Lighting		37,322						37,322
435.00	Sidewalks and Crosswalks	1,943							1,943
436.00	Storm Sewers and Drains	23,582							23,582

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
EXPENDITURES									
Public Works - Highways and Streets									
437.00	Repairs of Tools and Machinery	37,368							37,368
438.00	Maintenance and Repairs of Roads and Bridges	62,356							62,356
439.00	Highway Construction and Rebuilding Projects	289,421	88,228						377,649
Total Public Works - Highways and Streets		674,031	129,493						803,524
Other Public Works Enterprises									
440.00	Airports								
441.00	Cemeteries								
442.00	Electric System								
443.00	Gas System								
444.00	Markets								
445.00	Parking								
446.00	Storm Water and Flood Control								
447.00	Transit System								
448.00	Water System								
449.00	Water Transport and Terminals								
Total Other Public Works Enterprises									
Culture and Recreation									
451.00	Culture-Recreation Administration	22,316							22,316
452.00	Participant Recreation								
453.00	Spectator Recreation								
454.00	Parks	27,370							27,370
455.00	Shade Trees								
456.00	Libraries		80,000						80,000

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Culture and Recreation									
457.00	Civil and Military Celebrations								
458.00	Senior Citizens' Centers								
459.00	All Other Culture and Recreation	70,125							70,125
Total Culture and Recreation		119,811	80,000						199,811
Community Development									
461.00	Conservation of Natural Resources								
462.00	Community Development and Housing								
463.00	Economic Development								
464.00	Economic Opportunity								
465-469	All Other Community Development								
Total Community Development									
Debt Service									
471.00	Debt Principal (short-term and long-term)		36,700	496,237		9,300			542,237
472.00	Debt Interest (short-term and long-term)		6,246	100,088		2,121			108,455
475.00	Fiscal Agent Fees								
Total Debt Service			42,946	596,325		11,421			650,692
Employer Paid Benefits and Withholding Items									
481.00	Employer Paid Withholding Taxes and Unemployment Compensation								
482.00	Judgments and Losses								
483.00	Pension / Retirement Fund Contributions	259,400							259,400
484.00	Worker Compensation Insurance								

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF REVENUES AND EXPENDITURES

December 31, 2013

EXPENDITURES

		Governmental Funds				Proprietary Funds		Fiduciary Fund	Total
		General Fund	Special Revenue (Including State Liquid Fuels)	Capital Projects	Debt Service	Enterprise	Internal Service	Trust and Agency	Memorandum Only
Employer Paid Benefits and Withholding Items									
487.00	Other Group Insurance Benefits	126,228							126,228
Total Employer Paid Benefits and Withholding Items		385,628							385,628
Insurance									
486.00	Insurance, Casualty, and Surety	54,013	482						54,495
Total Insurance		54,013	482						54,495
Unclassified Operating Expenditures									
488.00	Fiduciary Fund Benefits and Refunds Paid							274,640	274,640
489.00	All Other Unclassified Expenditures	49						63,715	63,764
Total Unclassified Operating Expenditures		49						338,355	338,404
Other Financing Uses									
491.00	Refund of Prior Year Revenues								
492.00	Interfund Operating Transfers	1,269,295							1,269,295
493.00	All Other Financing Uses								
Total Other Financing Uses		1,269,295							1,269,295
TOTAL EXPENDITURES		5,654,262	469,121	608,796		11,421		338,355	7,081,955
EXCESS/DEFICIT OF REVENUES OVER EXPENDITURES		-86,558	106,138	640,968	3,323	23		706,332	1,370,226

UPPER PROVIDENCE TWP

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
GOB	Bond	2000	2009	295,000	155,000		16,000		139,000		139,000
GOB	Bond	2009	2019	5,005,000	2,607,000		310,000		2,297,000		2,297,000
GON	Note	2001	2009	950,000	701,000		30,000		671,000		671,000
GON	Note	2005	2009	1,700,000	581,504		186,237		395,267		395,267
Revenue Bonds and Notes											
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	3,502,267
Capitalized lease obligations	
Net debt	3,502,267

UPPER PROVIDENCE TWP, DELAWARE County

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

Category	Capital Purchases	Capital Construction	Total
Electric			
Fire			
Gas System			
General Government		12,630	12,630
Health			
Housing			
Libraries			
Mass Transit			
Parks			
Police	52,199		52,199
Recreation	9,975		9,975
Sewer			
Solid Waste			
Streets / Highways		233,441	233,441
Water			
Other: _____			
Community Development			
TOTAL CAPITAL EXPENDITURES	62,174	246,071	308,245

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	1,867,002

Independent Public Accountant/Certified Public Accountant Submission Page
Opinion page was provided in lieu of signature page.

SIGNATURE AND VERIFICATION

Signed: Leitzell & Economidis, PC Appointed Auditor/CPA

DCED-CLGS-30 (9-09)

UPPER PROVIDENCE TWP, DELAWARE County
December 31, 2013

NOTES / COMMENTS

Appendix 7: City of Chester 2012 Property Tax Revenues

THE CITY OF CHESTER
NOTES TO FINANCIAL STATEMENTS
FOR THE YEAR ENDED DECEMBER 31, 2012

Note 4 RECEIVABLES, (Continued)

Property Taxes, (Continued)

Following schedule details property taxes collections for 2012, and a ten year summary of property taxes showing the relationship between amount levied and amount actually collected.

TAX LEVIES AND TAX COLLECTIONS FOR THE
LAST TEN FISCAL YEARS

Fiscal Year	Net Total Tax Levy	Amount of Current Taxes Collected	Percent of Current Taxes Collected
2003	$ 8,355,625	$ 6,017,976	72.02%
2004	$ 8,320,357	$ 6,277,397	75.45%
2005	$ 8,308,503	$ 6,254,179	75.27%
2006	$ 7,920,967	$ 6,267,533	79.13%
2007	$ 7,887,274	$ 6,552,978	83.08%
2008	$ 7,844,101	$ 6,522,135	83.15%
2009	$ 7,799,215	$ 6,426,365	82.40%
2010	$ 7,750,361	$ 6,422,303	82.86%
2011	$ 7,765,079	$ 6,221,450	80.12%
2012	$ 7,694,586	$ 6,283,197	81.66%

Trash Assessments Receivable

Gross trash assessments receivable	$ 2,427,115
Less: allowance for uncollectible accounts	(2,176,358)
	$ 250,757

Other Receivables

Harrah's gaming fee	$ 556,508
Covanta host fees	1,339,232
Commonwealth of Pennsylvania / gaming revenue	1,404,178
Payments in lieu of taxes	1,007,393
Chester Upland School District	799,526
Reimbursements	190,722
Grants	4,070
Other receivables	96,919
	5,398,548
Less: allowance for uncollectible accounts	(694,761)
	$ 4,703,787

Appendix 8: Debt for Overlapping Entities

DCED-CLGS-20 (10-05)
Received by DCED: 03/25/2015

Department of Community & Economic Development
Governor's Center for Local Government Services
Commonwealth Keystone Building
400 North Street, 4th Floor
Harrisburg, PA 17120-0225
Ph: 888-223-6837 | fax: 717-783-1402

2013

COUNTY

ANNUAL FINANCIAL REPORT

23 COUNTY OF DELAWARE

County of DELAWARE

GOVERNMENT-WIDE STATEMENT OF NET ASSETS

December 31, 2013

	Governmental Activities	Business-Type Activities	Total
CURRENT ASSETS:			
Cash and cash equivalents	58,782,090	3,724,155	62,506,245
Investments	174,954,385		174,954,385
Receivables (net of allowance for uncollectibles)	54,799,700	18,552,842	73,352,542
Due from other governments	7,475,000		7,475,000
Internal balances	-4,158,910	4,158,910	
Cash and cash equivalents	46,619,450	796,261	47,415,711
Other: Subcontractors	222,377		222,377
Other: Miscellaneous Assets	7,499,931	17,485	7,517,416
NON-CURRENT ASSETS:			
Land	10,770,883		10,770,883
Construction in progress	9,012,202		9,012,202
Buildings and system	121,768,904	8,467,387	130,236,291
Machinery and equipment	23,627,767	3,414,682	27,042,449
Infrastructure	3,983,690		3,983,690
TOTAL ASSETS	515,357,469	39,131,722	554,489,191
LIABILITIES:			
Accounts payable	30,306,539	3,884,940	34,191,479
Unearned revenue	35,964,171	2,151,463	38,115,634
Debt due within one year	23,235,438	2,377,247	25,612,685
Other current liabilities	15,809,665		15,809,665
Debt due in more than one year	416,956,585	30,718,072	447,674,657
Other: Liabilities payable from restricted assets	122,489		122,489
Other: Accrued interest payable	1,868,735		1,868,735
TOTAL LIABILITIES:	524,263,622	39,131,722	563,395,344
NET ASSETS:			
Net investment in capital assets	-67,891,655	-21,213,250	-89,104,905
Restricted	10,474,592		10,474,592

County of DELAWARE

GOVERNMENT-WIDE STATEMENT OF NET ASSETS

December 31, 2013

	Governmental Activities	Business-Type Activities	Total
NET ASSETS:			
Unrestricted	48,510,910	21,213,250	69,724,160
TOTAL NET ASSETS:	-8,906,153		-8,906,153

County of DELAWARE

GOVERNMENT-WIDE STATEMENT OF ACTIVITIES

Proprietary Funds

December 31, 2013

	Expenses	Charges for Services	Operating Grants and Contributions	Capital Grants and Contributions	Governmental Activities	Business-type Activities	Total Fiduciary
Governmental Activities:							
General government - administrative	130,258,805	10,410,962	43,873,623		-75,974,220		-75,974,220
General government - judicial	48,371,935	5,206,386	22,692,111		-20,473,438		-20,473,438
Corrections	70,790,012	12,500,228	798,420		-57,491,364		-57,491,364
Highways and streets	2,807,351		1,107,553	1,462,919	-236,879		-236,879
Health and welfare	248,301,666		234,512,578		-13,789,088		-13,789,088
Interest on long term debt	8,457,413				-8,457,413		-8,457,413
TOTAL GOVERNMENTAL ACTIVITIES	508,987,182	28,117,576	302,984,285	1,462,919	-176,422,402		-176,422,402
Major Business Type Activities:							
Business 1	80,763,126	75,172,541				-5,590,585	-5,590,585
TOTAL BUSINESS-TYPE ACTIVITIES	80,763,126	75,172,541				-5,590,585	-5,590,585
TOTAL PRIMARY GOVERNMENTS	589,750,308	103,290,117	302,984,285	1,462,919	-176,422,402	-5,590,585	-182,012,987

County of DELAWARE

GOVERNMENT-WIDE STATEMENT OF ACTIVITIES

December 31, 2013

	Governmental Activities	Business-Type Activities	Total
TOTAL PRIMARY GOVERNMENTS	-176,422,402	-5,590,585	-182,012,987
GENERAL REVENUES:			
Real estate	164,661,208		164,661,208
Hotel room rental	1		1
Gaming Revenue	9,334,840		9,334,840
License & Permits			
Investment Earnings			
General Grants			
Other			
Licenses and permits			
Grants and contributions not restricted	352,508		352,508
Unrestricted investment earnings	2,830,737	1,107,882	3,938,619
Transfers	-4,482,704	4,482,703	-1
TOTAL GENERAL REVENUES AND TRANSFERS	172,696,590	5,590,585	178,287,175
CHANGE IN NET ASSETS	-3,725,812		-3,725,812
NET POSITION - BEGINNING OF YEAR	-3,397,408		-3,397,408
PRIOR PERIOD ADJUSTMENT	-1,782,933		-1,782,933
NET ASSETS - END OF YEAR	-8,906,153		-8,906,153

County of DELAWARE

BALANCE SHEET - GOVERNMENT FUNDS

(Including the Reconciliation of Total Governmental Fund Balance to Net Assets of Governmental Actvities)

December 31, 2013

	General	Capital Projects	Health and Human Services	Major #3	Major #4	Major #5	Other Governmental Funds	Total Government Funds
ASSETS:								
Cash and cash equivalents	30,798,765	1,479,468	8,366,857				14,607,103	55,252,193
Receivables (net of allowance for uncollectibles)	20,273,216	1,405,867	20,747,007				6,522,273	48,948,363
Due from other governments	2,000,000	5,475,000						7,475,000
Due from other funds	29,153,991		11,904,540				8,901,375	49,959,906
Other: assets	1,381,507		4,292,193				102,907	5,776,607
Other: Other restricted asset	4,772,777	33,455,056	8,391,617					46,619,450
Other: Due from Subcontractors							222,377	222,377
Other: Other Receivables	166,295							166,295
TOTAL ASSETS	88,546,551	41,815,391	53,702,214				30,356,035	214,420,191
LIABILITIES:								
Accounts payable	12,816,625	937,796	13,230,677				3,321,441	30,306,539
Due to other funds	18,285,669	15,457,787	11,009,122				12,327,168	57,079,746
Unearned revenue	4,653,785		23,963,017				7,347,369	35,964,171
Other: Payable from restricted asset	122,489							122,489
Other: Other Liablilities	9,566,135		5,499,398				1,102,703	16,168,236
TOTAL LIABILITIES	45,444,703	16,395,583	53,702,214				24,098,681	139,641,181
FUND BALANCE:								
Not in spendable form	1,381,507							1,381,507
Requirement to be maintained intact		5,475,000						5,475,000
Other: Highways & Streets							1,777,099	1,777,099
Other: Library							682,598	682,598
Other: Community Developement							3,797,657	3,797,657
Other: Title IV D program	1,870,555							1,870,555
Other: Capital Project		19,435,592						19,435,592
Other: Capital Project		509,216						509,216
Other: County Geriatric Center	11,400,000							11,400,000
Other: Employee Healthcare cost	11,400,000							11,400,000

County of DELAWARE

BALANCE SHEET - GOVERNMENT FUNDS

(Including the Reconciliation of Total Governmental Fund Balance to Net Assets of Governmental Actvities)

December 31, 2013

	General	Capital Projects	Health and Human Services	Major #3	Major #4	Major #5	Other Governmental Funds	Total Government Funds
FUND BALANCE:								
Unassigned fund balance*	9,532,158							9,532,158
TOTAL FUND BALANCE	35,584,220	25,419,808					6,257,354	67,261,382
Unavailable Revenue	7,517,628							7,517,628
	7,517,628							7,517,628
TOTAL LIABILITIES AND FUND BALANCE	88,546,551	41,815,391	53,702,214				30,356,035	214,420,191

Amounts reported for governmental activities in the statement of net assets are different because:	
Internal service funds are used by management to charge certain costs to county departments and employees	
The assets, deferred outflows of resources, liabilities and deferred inflows of resources of the internal service funds are included in governmental activities in the STATEMENT OF NET POSITION	
Long-term liabilities and deferred inflows are not due and payable in the current period and therefore are not reported as a fund liability	-431,619,301
The difference in net position between full accrual accounting and modified accrual accounting is due to differing revenue recognition criteria between the two methods	
The difference in net position between full accrual accounting and modified accrual accounting is due to differing expenditure recognition criteria between the two methods	
Capital assets used in government activities are not financial resources and, therefore, are not reported in the funds	344,117,831
Other: _____	
Other: Accrued interest	-1,868,735
Other: Allowance for Doubtful Accounts	-900,710
Other: Property Taxes Receivable	14,103,380
NET ASSETS OF GOVERNMENTAL ACTIVITIES	-8,906,153

County of DELAWARE

STATEMENT OF REVENUES, EXPENDITURES AND CHANGES IN FUND BALANCES

GOVERNMENTAL FUNDS

December 31, 2013

	General	Capital Projects	Health and Human Services	Major #3	Major #4	Major #5	Other Governmental Funds	Total Government Funds
REVENUES:								
Taxes								
Real estate	164,860,852							164,860,852
Hotel room rental	2,028,918							2,028,918
Other: Gaming Revenue	9,334,840							9,334,840
Other: License & Permits	62,948							62,948
Other: General Grants	24,778,008	2,723,820					41,944,350	69,446,178
Other: Investment Earnings	934,677	153,896						1,088,573
Other: Other	6,404,596		2,233					6,406,829
TOTAL TAXES	208,404,839	2,877,716	2,233				41,944,350	253,229,138
Intergovernmental Revenues								
Combination			234,003,423					234,003,423
TOTAL INTERGOVERNMENTAL REVENUES			234,003,423					234,003,423
Charges for Service	22,860,520							22,860,520
	22,860,520							22,860,520
Miscellaneous Revenues								
TOTAL MISCELLANEOUS REVENUES								
TOTAL REVENUES	231,265,359	2,877,716	234,005,656				41,944,350	510,093,081
EXPENDITURES:								
General government - administrative	22,575,866							22,575,866
General government - judicial	50,000,068							50,000,068
Corrections	63,059,037							63,059,037
Highways and streets							1,187,336	1,187,336
Health and welfare			240,428,656					240,428,656
Other: Transportation	6,921,000							6,921,000
Other: Other	47,263,253	101,894					47,321,758	94,686,905

County of DELAWARE

STATEMENT OF REVENUES, EXPENDITURES AND CHANGES IN FUND BALANCES

GOVERNMENTAL FUNDS

December 31, 2013

	General	Capital Projects	Health and Human Services	Major #3	Major #4	Major #5	Other Governmental Funds	Total Government Funds
Other: Debt Service - Principal	16,179,257							16,179,257
Other: Debt Service - Interest	8,068,452	498,111						8,566,563
Other: Capital Outlay		10,460,337						10,460,337
TOTAL EXPENDITURES	214,066,933	11,060,342	240,428,656				48,509,094	514,065,025
OTHER FINANCING SOURCES/(USES):								
Other: Issuance of Note		25,000,000						25,000,000
Other: Transfers In	1,922,404		6,423,000				7,798,587	16,143,991
Other: Transfers Out	-18,704,290	-382,404					-1,540,000	-20,626,694
TOTAL OTHER FINANCING SOURCES/(USES)	-16,781,886	24,617,596	6,423,000				6,258,587	20,517,297
CHANGE IN FUND BALANCE	416,540	16,434,970					-306,157	16,545,353
FUND BALANCE (DEFICIT) - BEGINNING OF YEAR	35,167,680	8,984,838					6,563,511	50,716,029
FUND BALANCE - END OF YEAR	35,584,220	25,419,808					6,257,354	67,261,382

County of DELAWARE

RECONCILIATION OF THE STATEMENT OF REVENUES, EXPENDITURES AND CHANGES IN FUND BALANCES OF GOVERNMENTAL FUNDS TO THE STATEMENT OF ACTIVITIES

December 31, 2013

Amounts reported for governmental activities in the statement of activities are different because:

Net changes in fund balances (deficit) - total governmental funds	16,545,353
The net revenue (expense) of certain activities of the internal services fund is reported with governmental activities	-1,292,700
The issuance of long-term debt (e.g. bonds, leases) provides current financial resources to governmental funds, while the repayment of the principal of long-term debt consumes the current financial resources of governmental funds. Neither transaction, however, has any effect on net position. Additionally, various other long-term liabilities and deferred inflows do not require the use of current financial resources and, therefore are not reported as expenditures in governmental funds. This amount is the net effect of the differences in the treatment of long-term liabilities and deferred inflows on the statement of activities	-7,141,911
Other: SEPTA Contribution	7,607,246
Other: Revenues related to Real estate	-209,481
Other: Collections related to Chester City	-133,611
Other: Accrued Interest Payable	109,149
Other: OPEB (Pension) does no tconsume current financial resources	-19,555,000
Other: Early retirement expense	357,713
Other: Allowance for doubtful real estate taxes receivable	-12,570
CHANGE IN NET ASSESTS OF GOVERNMENTAL ACTIVITIES	-3,725,812

County of DELAWARE

STATEMENT OF NET ASSETS FUNDS

Proprietary Funds

December 31, 2013

	Nursing Home	Major Bus. #2	Major Bus. #3	Major Bus. #4	Major Bus. #5	Other Business Funds	Total Business Funds	Internal Service Fund
CURRENT ASSETS								
Cash and cash equivalents	3,724,155						3,724,155	3,529,897
Receivables (net of allowance for uncollectibles)	18,552,842						18,552,842	
Due from other funds	4,158,910						4,158,910	6,272,766
Other: Prepaid Expense	17,485						17,485	1,723,324
TOTAL CURRENT ASSETS	26,453,392						26,453,392	11,525,987
NON-CURRENT ASSETS								
Other: Noncurrent Assets	11,882,069						11,882,069	
Other: Other Retricted Assets	796,261						796,261	
TOTAL NON-CURRENT ASSETS	12,678,330						12,678,330	
TOTAL ASSETS	39,131,722						39,131,722	11,525,987
CURRENT LIABILITIES								
Accounts payable	3,884,940						3,884,940	
Due to other funds								3,311,836
Unearned revenue	2,151,463						2,151,463	
Other: General obligation bonds & notes	2,377,247						2,377,247	
Other: Claims Payable								5,893,559
TOTAL CURRENT LIABILITIES	8,413,650						8,413,650	9,205,395

County of DELAWARE

STATEMENT OF NET ASSETS FUNDS

Proprietary Funds

December 31, 2013

	Nursing Home	Major Bus. #2	Major Bus. #3	Major Bus. #4	Major Bus. #5	Other Business Funds	Total Business Funds	Internal Service Fund
NON-CURRENT LIABILITIES								
Other non-current liabilities								2,320,592
Other: General Obligation bonds & notes payable	30,718,072						30,718,072	
TOTAL NON-CURRENT LIABILITIES	30,718,072						30,718,072	2,320,592
TOTAL LIABILITIES	39,131,722						39,131,722	11,525,987
NET ASSETS								
TOTAL NET ASSETS								
TOTAL LIABILITIES AND NET ASSETS	39,131,722						39,131,722	11,525,987

Adjustments to reflect the consolidation of internal service fund activities related to enterprise funds	
Changes in Net Assets of Business-type Activities	

County of DELAWARE

STATEMENT OF REVENUES, EXPENSES AND CHANGES IN FUND NET ASSETS-

Proprietary Funds

December 31, 2013

	Nursing Home	Major Bus. #2	Major Bus. #3	Major Bus. #4	Major Bus. #5	Other Business Funds	Total Business Funds	Internal Service Fund
OPERATING REVENUES								
Charges for service	75,172,541						75,172,541	46,907,965
TOTAL OPERATING REVENUES	75,172,541						75,172,541	46,907,965
OPERATING EXPENSES								
Personnel services	12,487,777						12,487,777	111,506
Repairs and maintenance	10,681,461						10,681,461	
Depreciation and amortization	2,028,095						2,028,095	
Other: Nursing	22,549,020						22,549,020	
Other: Dietary	7,416,679						7,416,679	
Other: Medical & Physical therapy	4,539,422						4,539,422	
Other: Employee Benefits	19,360,193						19,360,193	
Other: Insurance Claims								46,796,719
TOTAL OPERATING EXPENSES	79,062,647						79,062,647	46,908,225
OPERATING INCOME/(LOSS)	-3,890,106						-3,890,106	-260
NONOPERATING REVENUES/(EXPENSES)								
Investment earnings	1,107,882						1,107,882	260
Interest expense	-1,700,479						-1,700,479	
TOTAL NONOPERATING REVENUES/(EXPENSES)	-592,597						-592,597	260
TRANSFERS IN/(OUT)	4,482,703						4,482,703	
CHANGE IN NET ASSETS								

County of DELAWARE

STATEMENT OF REVENUES, EXPENSES AND CHANGES IN FUND NET ASSETS-

Proprietary Funds

December 31, 2013

	Nursing Home	Major Bus. #2	Major Bus. #3	Major Bus. #4	Major Bus. #5	Other Business Funds	Total Business Funds	Internal Service Fund
NET ASSETS - END OF YEAR								

Adjustments to reflect the consolidation of internal service fund activities related to enterprise funds	
Changes in Net Assets of Business-type Activities	

County of DELAWARE

STATEMENT OF FIDUCIARY NET ASSETS

Fiduciary Funds

December 31, 2013

	Deshong	Pension	Fiduciary #3	Fiduciary #4	Fiduciary #5	Total Fiduciary
ASSETS						
Cash and cash equivalents	283,225	95,402,512				95,685,737
Investments, at fair value		352,992,804				352,992,804
Other: Gov't Securities						
Other: Corporate bonds						
Other: common & preferred stocks						
Other: Guaranteed investment contrats						
Other: fixed income						
TOTAL ASSETS	283,225	448,395,316				448,678,541
LIABILITIES						
TOTAL LIABILITIES						
LIABILITIES						
Accounts payable and other current liabilities	16,216	493,240				509,456
Other: death benefits						
Other: contribution refunds						
Other: administrative expenses						
Other: retirement allowance						
Other: employee benefits						
TOTAL LIABILITIES	16,216	493,240				509,456
NET ASSETS						
Assets held in trust for pension/other post employment benefits	267,009	447,902,076				448,169,085
TOTAL NET ASSETS	267,009	447,902,076				448,169,085
TOTAL LIABILITIES AND NET ASSETS	283,225	448,395,316				448,678,541

County of DELAWARE

STATEMENT OF CHANGES IN FIDUCIARY NET ASSETS

Fiduciary Funds

December 31, 2013

	Deshong	Pension	Fiduciary #3	Fiduciary #4	Fiduciary #5	Total Fiduciary
ADDITIONS						
Contributions						
Employer		7,146,528				7,146,528
Plan members		10,041,381				10,041,381
TOTAL CONTRIBUTIONS		17,187,909				17,187,909
Investment Earnings						
Interest	17	9,142,187				9,142,204
Net increase/(decrease) in the fair value of investments		60,654,467				60,654,467
TOTAL INVESTMENT EARNINGS	17	69,796,654				69,796,671
Less Investment Expenses		2,093,439				2,093,439
TOTAL ADDITIONS	17	84,891,124				84,891,141
DEDUCTIONS						
Benefits		1,726,099				1,726,099
Administrative Expenses	24,414	32,567				56,981
Other: Refunds of contributions		2,297,218				2,297,218
Other: Retirement allowance		17,035,905				17,035,905
TOTAL DEDUCTIONS	24,414	21,091,789				21,116,203

County of DELAWARE

STATEMENT OF CHANGES IN FIDUCIARY NET ASSETS

Fiduciary Funds

December 31, 2013

	Deshong	Pension	Fiduciary #3	Fiduciary #4	Fiduciary #5	Total Fiduciary
CHANGE IN NET ASSETS	-24,397	63,799,335				63,774,938
NET POSITION - BEGINNING OF YEAR	291,406	384,102,741				384,394,147
NET ASSETS - END OF YEAR	267,009	447,902,076				448,169,085

County of DELAWARE

December 31, 2013

DEBT STATEMENT

OUTSTANDING BONDS AND NOTES
Listed below are all currently outstanding bond and note issues according to our files, excluding bond issues redeemed or refunded and defeased. Please show the principal payments and make any other necessary corrections and additions.

Purpose	Bond (B) Capital Lease (C) Lease Rental (L) Note (N)	Issue Year (yyyy)	Maturity Year (yyyy)	Original Amount of Issue	Outstanding Beginning of Year (1)	Principal Incurred This Year	Principal Paid This Year	Current Year Accretion on Compound Interest Bonds	Outstanding at Year End (1)	Plus (less) Unamortized Premium (Discount)	Total Balance
General Obligation Bonds and Notes											
Refinance 1999 notes for various SEPTA project	Note	2002	2022	61,524,000	40,124,000		4,113,000		36,011,000		36,011,000
Refund 2008 General Obligation Note	Bond	2010	2028	45,180,000	45,175,000		5,000		45,170,000		45,170,000
Voting machines and Various County Projects	Bond	2005	2019	10,000,000	3,092,000		432,000		2,660,000		2,660,000
Refund 1999 General Obligation Note	Bond	2009	2019	54,750,000	45,335,000		5,905,000		39,430,000		39,430,000
Refund 1997 bond	Bond	2007	2016	15,584,000	8,399,000		2,057,000		6,342,000		6,342,000
Refinance 1995 Bonds For SEPTA and various County Projects	Bond	2005	2021	69,425,000	65,130,000		3,115,000		62,015,000		62,015,000
Grant funds for Chester Waterfront & Stadium	Bond	2009	2039	28,595,000	26,930,000		605,000		26,325,000		26,325,000
Fund SEPTA projects and various County projects	Bond	2012	2032	20,000,000	20,000,000		1,000		19,999,000		19,999,000
Fund SEPTA Projects and various County projecct	Bond	1997	2022	50,000,000	49,850,000		40,000		49,810,000		49,810,000
Fund SEPTA & County Bldgs	Bond	2013	2033	25,000,000	25,000,000		1,000		24,999,000		24,999,000
Revenue Bonds and Notes											
Refinance 2004 note	Note	2007	2027	26,720,000	23,125,000		2,130,000		20,995,000		20,995,000
Refund 2002 bond & portions 2007 note	Bond	2008	2017	9,537,000	5,359,000		1,036,000		4,323,000		4,323,000
Lease Rental Debt											
Other											

(1) - excludes unamortized premium/discount

Total bonds and notes outstanding	338,079,000
Capitalized lease obligations	
Net debt	338,079,000

County of DELAWARE

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

	Capital Purchases	Capital Construction	Total
GOVERNMENTAL-TYPE ACTIVITY:			
General Government - administrative	8,276,470		8,276,470
Corrections	23,702		23,702
Other: Infrastructure	172,206		172,206
Health and welfare	144,017		144,017
Culture - recreation	16,569		16,569
BUSINESS-TYPE ACTIVITY:			

County of DELAWARE

STATEMENT OF CAPITAL EXPENDITURES

December 31, 2013

	Capital Purchases	Capital Construction	Total
TOTAL CAPITAL EXPENDITURES	8,632,964		8,632,964

EMPLOYEE COMPENSATION

Total salaries, wages, commissions, etc. paid this year (including all employees and elected officials)	148,085,506

ELECTED CONTROLLER'S/AUDITOR'S CERTIFIED OPINION

To the: Governing Body of the County

President Judge of the Court of Common Pleas

Secretary of the Department of Community & Economic Development

I/We*, the undersigned, the duly elected (or appointed replacement) and Acting Controller/Auditors* of the County of DELAWARE have audited, adjusted and settled the accounts of the County of DELAWARE for the year ended December 31, 2013. My/Our* audit, adjustment and settlement was made in accordance with Act 103 of 2002 rather than with U.S. generally accepted auditing standards

The County has prepared these financial statements on bases of accounting consistent with U.S. generally accepted accounting principles; consisting of the accrual basis for the government-wide, proprietary fund and fiduciary fund financial statements, and the modified accrual basis for the governmental fund financial statements.

Due to the absence of notes and other disclosures required by U.S. generally accepted accounting principles, these financial statements are not intended to be a complete presentation in accordance with U.S. generally accepted accounting principles.

In my/our* opinion, these financial statements accurately reflect the results of operations and the financial position of the county of DELAWARE for the year ended December 31, 2013

SIGNATURE AND VERIFICATION

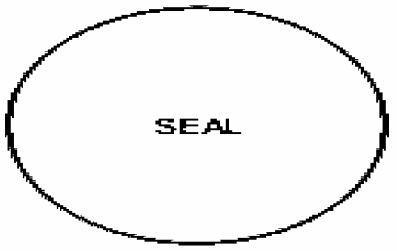
Signed: edward olone Controller

Subscribed and sworn to before me this 15 day of April, 2015.

Signed: _____

Witness (Controller)/Auditor (Auditors)

Counties are encouraged to have financial statement audits performed in accordance with U.S. generally accepted auditing standards or the standards applicable to financial audits contained in "Government Auditing Standards", issued by the Comptroller general of the United States. Controllers may submit opinions resulting from such audits in lieu of this page.



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December 31, 2013

NOTES / COMMENTS

Appendix 9: Real Estate Assessments

Commonwealth of Pennsylvania
STATE TAX EQUALIZATION BOARD
2012 School District Yearly Market Values

Date : 7/14/2014

AUN	SD#	School District	M#	Municipality	C#	Tax County	SD County	Market Value	Assessed Value	Ratio
125231232	204	Chester-Upland	0201	Chester City	23	Delaware	Delaware	673,368,806	499,974,541	74.25%
125231232	204	Chester-Upland	0202	Chester Township	23	Delaware	Delaware	209,035,936	166,372,624	79.59%
125231232	204	Chester-Upland	0203	Upland Borough	23	Delaware	Delaware	87,871,941	73,309,647	83.43%
125231303	205	Chichester	0401	Lower Chichester Township	23	Delaware	Delaware	119,928,228	117,035,679	97.59%
125231303	205	Chichester	0402	Marcus Hook Borough	23	Delaware	Delaware	140,590,064	116,190,987	82.65%
125231303	205	Chichester	0403	Trainer Borough	23	Delaware	Delaware	70,507,134	66,071,740	93.71%
125231303	205	Chichester	0406	Upper Chichester Township	23	Delaware	Delaware	1,129,271,698	863,725,764	76.49%
125234103	206	Garnet Valley	0601	Bethel Township	23	Delaware	Delaware	843,893,336	696,610,283	82.55%
125234103	206	Garnet Valley	0602	Chester Heights Borough	23	Delaware	Delaware	266,487,913	187,756,098	70.46%
125234103	206	Garnet Valley	0603	Concord Township	23	Delaware	Delaware	2,045,205,373	1,509,697,767	73.82%
125235103	208	Interboro	1001	Glenolden Borough	23	Delaware	Delaware	338,612,919	249,110,169	73.57%
125235103	208	Interboro	1002	Norwood Borough	23	Delaware	Delaware	264,779,102	196,520,340	74.22%
125235103	208	Interboro	1003	Prospect Park Borough	23	Delaware	Delaware	294,877,884	217,045,658	73.61%
125235103	208	Interboro	1004	Tinicum Township	23	Delaware	Delaware	589,882,410	478,127,124	81.05%
125235502	209	Marple Newtown	1201	Marple Township	23	Delaware	Delaware	2,399,028,191	1,758,289,636	73.29%
125235502	209	Marple Newtown	1202	Newtown Township	23	Delaware	Delaware	2,074,985,636	1,512,388,891	72.89%
125236903	210	Penn Delco	1401	Aston Township	23	Delaware	Delaware	1,245,105,581	919,578,672	73.86%
125236903	210	Penn Delco	1402	Brookhaven Borough	23	Delaware	Delaware	540,973,806	393,014,407	72.65%
125236903	210	Penn Delco	1403	Parkside Borough	23	Delaware	Delaware	91,130,712	67,899,114	74.51%
125237702	212	Ridley	1801	Eddystone Borough	23	Delaware	Delaware	227,955,948	189,419,263	83.09%
125237702	212	Ridley	1802	Ridley Park Borough	23	Delaware	Delaware	406,745,239	303,232,493	74.55%
125237702	212	Ridley	1803	Ridley Township	23	Delaware	Delaware	1,741,924,382	1,313,341,810	75.40%
125237903	213	Rose Tree Media	2001	Edgemont Township	23	Delaware	Delaware	672,450,268	501,483,801	74.58%
125237903	213	Rose Tree Media	2002	Media Borough	23	Delaware	Delaware	590,087,590	391,169,011	66.29%
125237903	213	Rose Tree Media	2003	Middletown Township	23	Delaware	Delaware	1,557,628,872	1,145,742,590	73.56%
125237903	213	Rose Tree Media	2004	Upper Providence Township	23	Delaware	Delaware	1,139,439,569	843,161,197	74.00%
125238502	215	Springfield	2401	Morton Borough	23	Delaware	Delaware	155,694,813	117,959,943	75.76%
125238502	215	Springfield	2402	Springfield Township	23	Delaware	Delaware	2,334,306,470	1,642,022,122	70.34%
125239603	217	Wallingford-Swarthmore	2801	Nether Providence Township	23	Delaware	Delaware	1,242,996,450	874,050,502	70.32%
125239603	217	Wallingford-Swarthmore	2802	Rose Valley Borough	23	Delaware	Delaware	133,461,799	106,809,228	80.03%
125239603	217	Wallingford-Swarthmore	2803	Rutledge Borough	23	Delaware	Delaware	52,001,868	33,524,081	64.47%
125239603	217	Wallingford-Swarthmore	2804	Swarthmore Borough	23	Delaware	Delaware	542,897,902	371,723,868	68.47%

Source File: TED_Market_Value_2012.xls

Commonwealth of Pennsylvania
STATE TAX EQUALIZATION BOARD
2013 School District Yearly Market Values

Date : 7/31/2014

AUN	SD#	School District	M#	Municipality	C#	Tax County	SD County	Market Value	Assessed Value	Ratio
125231232	204	Chester-Upland	0201	Chester City	23	Delaware	Delaware	668,332,484	497,524,766	74.44%
125231232	204	Chester-Upland	0202	Chester Township	23	Delaware	Delaware	211,331,072	167,877,514	79.44%
125231232	204	Chester-Upland	0203	Upland Borough	23	Delaware	Delaware	86,916,839	72,698,137	83.64%
125231303	205	Chichester	0401	Lower Chichester Township	23	Delaware	Delaware	119,803,390	116,864,938	97.55%
125231303	205	Chichester	0402	Marcus Hook Borough	23	Delaware	Delaware	140,432,669	116,051,582	82.64%
125231303	205	Chichester	0403	Trainer Borough	23	Delaware	Delaware	80,303,015	82,554,675	102.80%
125231303	205	Chichester	0406	Upper Chichester Township	23	Delaware	Delaware	1,131,350,161	865,387,438	76.49%
125234103	206	Garnet Valley	0601	Bethel Township	23	Delaware	Delaware	851,442,202	703,441,311	82.62%
125234103	206	Garnet Valley	0602	Chester Heights Borough	23	Delaware	Delaware	266,784,394	187,954,031	70.45%
125234103	206	Garnet Valley	0603	Concord Township	23	Delaware	Delaware	2,074,567,574	1,531,206,549	73.81%
125235103	208	Interboro	1001	Glenolden Borough	23	Delaware	Delaware	338,795,100	249,248,874	73.57%
125235103	208	Interboro	1002	Norwood Borough	23	Delaware	Delaware	264,502,064	196,307,655	74.22%
125235103	208	Interboro	1003	Prospect Park Borough	23	Delaware	Delaware	295,032,728	217,167,038	73.61%
125235103	208	Interboro	1004	Tinicum Township	23	Delaware	Delaware	589,140,557	477,575,604	81.06%
125235502	209	Marple Newtown	1201	Marple Township	23	Delaware	Delaware	2,405,956,904	1,763,119,251	73.28%
125235502	209	Marple Newtown	1202	Newtown Township	23	Delaware	Delaware	2,116,962,376	1,530,209,600	72.28%
125236903	210	Penn Delco	1401	Aston Township	23	Delaware	Delaware	1,244,551,376	919,050,188	73.85%
125236903	210	Penn Delco	1402	Brookhaven Borough	23	Delaware	Delaware	541,287,028	393,146,444	72.63%
125236903	210	Penn Delco	1403	Parkside Borough	23	Delaware	Delaware	91,240,609	67,980,944	74.51%
125237702	212	Ridley	1801	Eddystone Borough	23	Delaware	Delaware	226,703,647	188,235,673	83.03%
125237702	212	Ridley	1802	Ridley Park Borough	23	Delaware	Delaware	405,569,802	302,575,418	74.61%
125237702	212	Ridley	1803	Ridley Township	23	Delaware	Delaware	1,744,630,085	1,315,442,198	75.40%
125237903	213	Rose Tree Media	2001	Edgemont Township	23	Delaware	Delaware	674,554,080	503,615,677	74.66%
125237903	213	Rose Tree Media	2002	Media Borough	23	Delaware	Delaware	590,852,918	391,582,233	66.27%
125237903	213	Rose Tree Media	2003	Middletown Township	23	Delaware	Delaware	1,546,015,387	1,133,593,165	73.32%
125237903	213	Rose Tree Media	2004	Upper Providence Township	23	Delaware	Delaware	1,166,565,930	862,618,954	73.95%
125238502	215	Springfield	2401	Morton Borough	23	Delaware	Delaware	155,311,247	117,661,239	75.76%
125238502	215	Springfield	2402	Springfield Township	23	Delaware	Delaware	2,332,826,856	1,641,431,659	70.36%
125239603	217	Wallingford-Swarthmore	2801	Nether Providence Township	23	Delaware	Delaware	1,242,612,683	873,582,294	70.30%
125239603	217	Wallingford-Swarthmore	2802	Rose Valley Borough	23	Delaware	Delaware	131,187,125	105,078,158	80.10%
125239603	217	Wallingford-Swarthmore	2803	Rutledge Borough	23	Delaware	Delaware	52,079,034	33,573,811	64.47%
125239603	217	Wallingford-Swarthmore	2804	Swarthmore Borough	23	Delaware	Delaware	542,909,677	371,717,578	68.47%

Source file: TED_Market_Value_2013.xls

Appendix 10: Tax Rates

Reporting Year	Municipality	School District	Tax Name	Municipal Tax Amount	School District Tax Amount	Total Tax Rate
2012	CHESTER CITY	CHESTER-UPLAND S D	Real Estate - General Purpose (mills)	29.792	0	29.792
2012	CHESTER CITY	CHESTER-UPLAND S D	Real Estate - Debt Service (mills)	2.392	0	2.392
2012	CHESTER CITY	CHESTER-UPLAND S D	Real Estate - Library (mills)	1.5	0	1.5
2012	CHESTER CITY	CHESTER-UPLAND S D	Mercantile/Business Privilege - Wholesale (mills)	2.74	0	2.74
2012	CHESTER CITY	CHESTER-UPLAND S D	Mercantile/Business Privilege - Retail (mills)	3.65	0	3.65
2012	CHESTER CITY	CHESTER-UPLAND S D	Mercantile/Business Privilege - Other (mills)	4.19	0	4.19
2012	PARKSIDE BORO	PENN-DELCO S D	Real Estate - General Purpose (mills)	9.5	22.422	31.922

Reporting Year	Municipality	School District	Tax Name	Municipal Tax Amount	School District Tax Amount	Total Tax Rate
2013	ASTON TWP	PENN-DELCO S D	Real Estate - General Purpose (mills)	3.39	25.276	28.666
2013	ASTON TWP	PENN-DELCO S D	Real Estate - Debt Service (mills)	0.47	0	0.47
2013	ASTON TWP	PENN-DELCO S D	Real Estate - Fire Equipment & Firehouses (mills)	0.1	0	0.1
2013	ASTON TWP	PENN-DELCO S D	Real Estate - Library (mills)	0.04	0	0.04
2013	ASTON TWP	PENN-DELCO S D	Mercantile/Business Privilege - Wholesale (mills)	1	0	1
2013	ASTON TWP	PENN-DELCO S D	Mercantile/Business Privilege - Retail (mills)	1.5	0	1.5
2013	ASTON TWP	PENN-DELCO S D	Mercantile/Business Privilege - Other (mills)	1.5	0	1.5
2013	BETHEL TWP	GARNET VALLEY S D	Real Estate - General Purpose (mills)	1.69	0	1.69
2013	BETHEL TWP	GARNET VALLEY S D	Real Estate - Fire Equipment & Firehouses (mills)	0.125	0	0.125
2013	BETHEL TWP	GARNET VALLEY S D	Real Estate - Library (mills)	0.05	0	0.05
2013	BROOKHAVEN BORO	PENN-DELCO S D	Real Estate - General Purpose (mills)	4.35	25.276	29.626
2013	BROOKHAVEN BORO	PENN-DELCO S D	Mercantile/Business Privilege - Wholesale (mills)	0.1	0	0.1
2013	BROOKHAVEN BORO	PENN-DELCO S D	Mercantile/Business Privilege - Retail (mills)	0.15	0	0.15
2013	CHESTER TWP	CHESTER-UPLAND S D	Real Estate - General Purpose (mills)	8	0	8
2013	CHESTER TWP	CHESTER-UPLAND S D	Real Estate - Fire Equipment & Firehouses (mills)	0.8	0	0.8
2013	CHESTER TWP	CHESTER-UPLAND S D	Mercantile/Business Privilege - Wholesale (mills)	1	0	1
2013	CHESTER TWP	CHESTER-UPLAND S D	Mercantile/Business Privilege - Retail (mills)	1.5	0	1.5
2013	EDDYSTONE BORO	RIDLEY S D	Real Estate - General Purpose (mills)	5.49	39.125	44.615
2013	EDDYSTONE BORO	RIDLEY S D	Real Estate - Debt Service (mills)	0.26	0	0.26
2013	EDGMONT TWP	ROSE TREE MEDIA S D	Real Estate - General Purpose (mills)	0.611	22.9445	23.5555
2013	EDGMONT TWP	ROSE TREE MEDIA S D	Real Estate - Ambulance & Rescue Squads (mills)	0.0311	0	0.0311
2013	EDGMONT TWP	ROSE TREE MEDIA S D	Real Estate - Fire Equipment & Firehouses (mills)	0.1862	0	0.1862

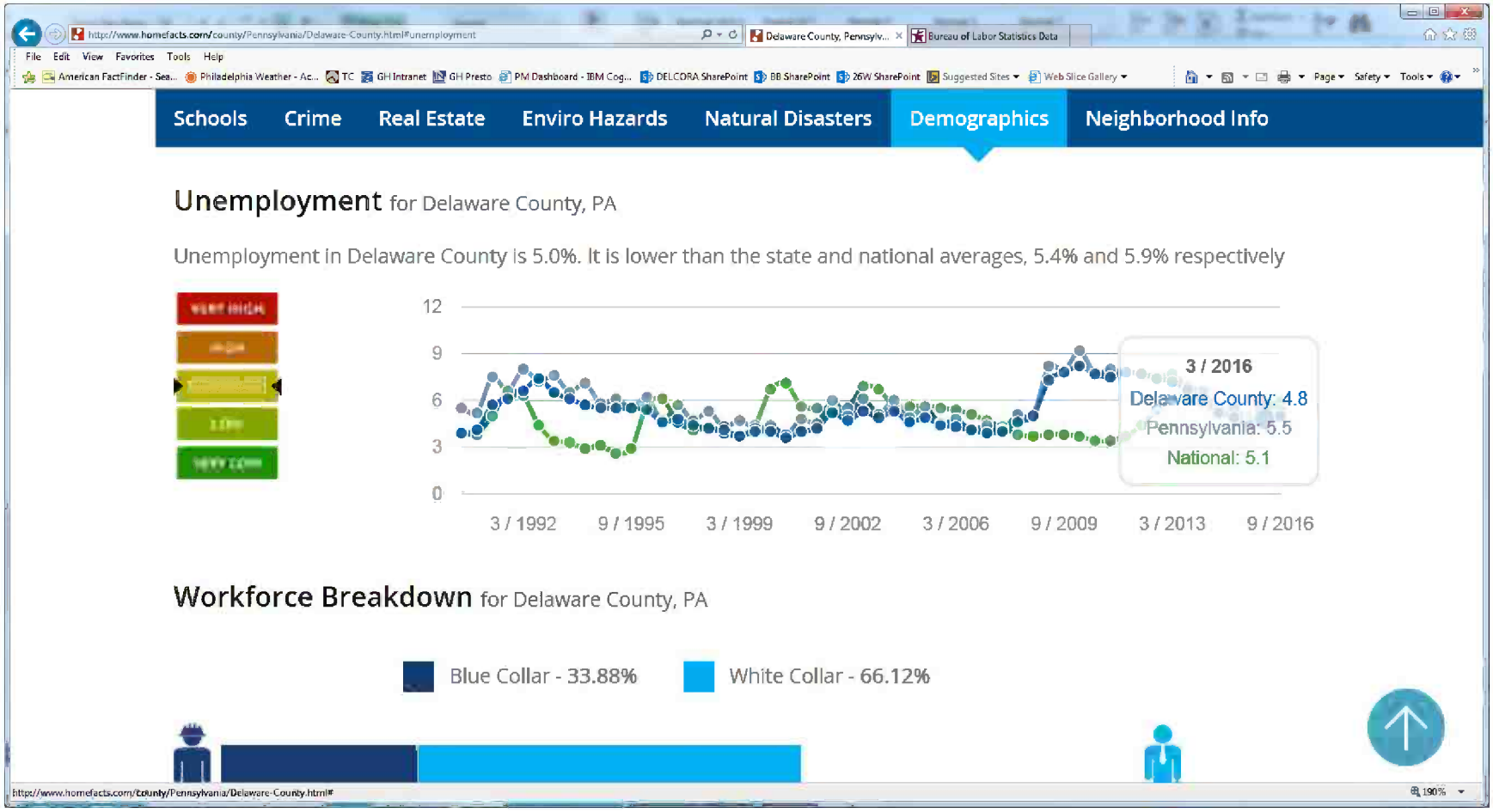
Reporting Year	Municipality	School District	Tax Name	Municipal Tax Amount	School District Tax Amount	Total Tax Rate
2013	MARCUS HOOK BORO	CHICHESTER S D	Real Estate - General Purpose (mills)	11.47	0	11.47
2013	MARCUS HOOK BORO	CHICHESTER S D	Real Estate - Debt Service (mills)	0.7	0	0.7
2013	MARCUS HOOK BORO	CHICHESTER S D	Real Estate - Fire Equipment & Firehouses (mills)	0.18	0	0.18
2013	MARPLE TWP	MARPLE NEWTOWN S D	Real Estate - General Purpose (mills)	4.184	17.6839	21.8679
2013	MARPLE TWP	MARPLE NEWTOWN S D	Mercantile/Business Privilege - Wholesale (mills)	1	0	1
2013	MARPLE TWP	MARPLE NEWTOWN S D	Mercantile/Business Privilege - Retail (mills)	1.5	0	1.5
2013	MARPLE TWP	MARPLE NEWTOWN S D	Mercantile/Business Privilege - Other (mills)	1.5	0	1.5
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Real Estate - General Purpose (mills)	0.44	22.9445	23.3845
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Real Estate - Debt Service (mills)	0.87	0	0.87
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Real Estate - Fire Equipment & Firehouses (mills)	0.185	0	0.185
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Real Estate - Library (mills)	0.105	0	0.105
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Mercantile/Business Privilege - Wholesale (mills)	1.5	0	1.5
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Mercantile/Business Privilege - Retail (mills)	2.25	0	2.25
2013	MIDDLETOWN TWP	ROSE TREE MEDIA S D	Mercantile/Business Privilege - Other (mills)	2.25	0	2.25
2013	MORTON BORO	SPRINGFIELD S D	Real Estate - General Purpose (mills)	4.38	0	4.38
2013	MORTON BORO	SPRINGFIELD S D	Real Estate - Debt Service (mills)	0.179	0	0.179
2013	MORTON BORO	SPRINGFIELD S D	Real Estate - Fire Equipment & Firehouses (mills)	0.456	0	0.456
2013	MORTON BORO	SPRINGFIELD S D	Real Estate - Street Lighting (mills)	0.098	0	0.098
2013	MORTON BORO	SPRINGFIELD S D	Real Estate - Distressed Pension Systems Recovery Program (mills)	3.048	0	3.048
2013	MORTON BORO	SPRINGFIELD S D	Mercantile/Business Privilege - Wholesale (mills)	0.5	0.5	1
2013	MORTON BORO	SPRINGFIELD S D	Mercantile/Business Privilege - Retail (mills)	0.75	0.75	1.5

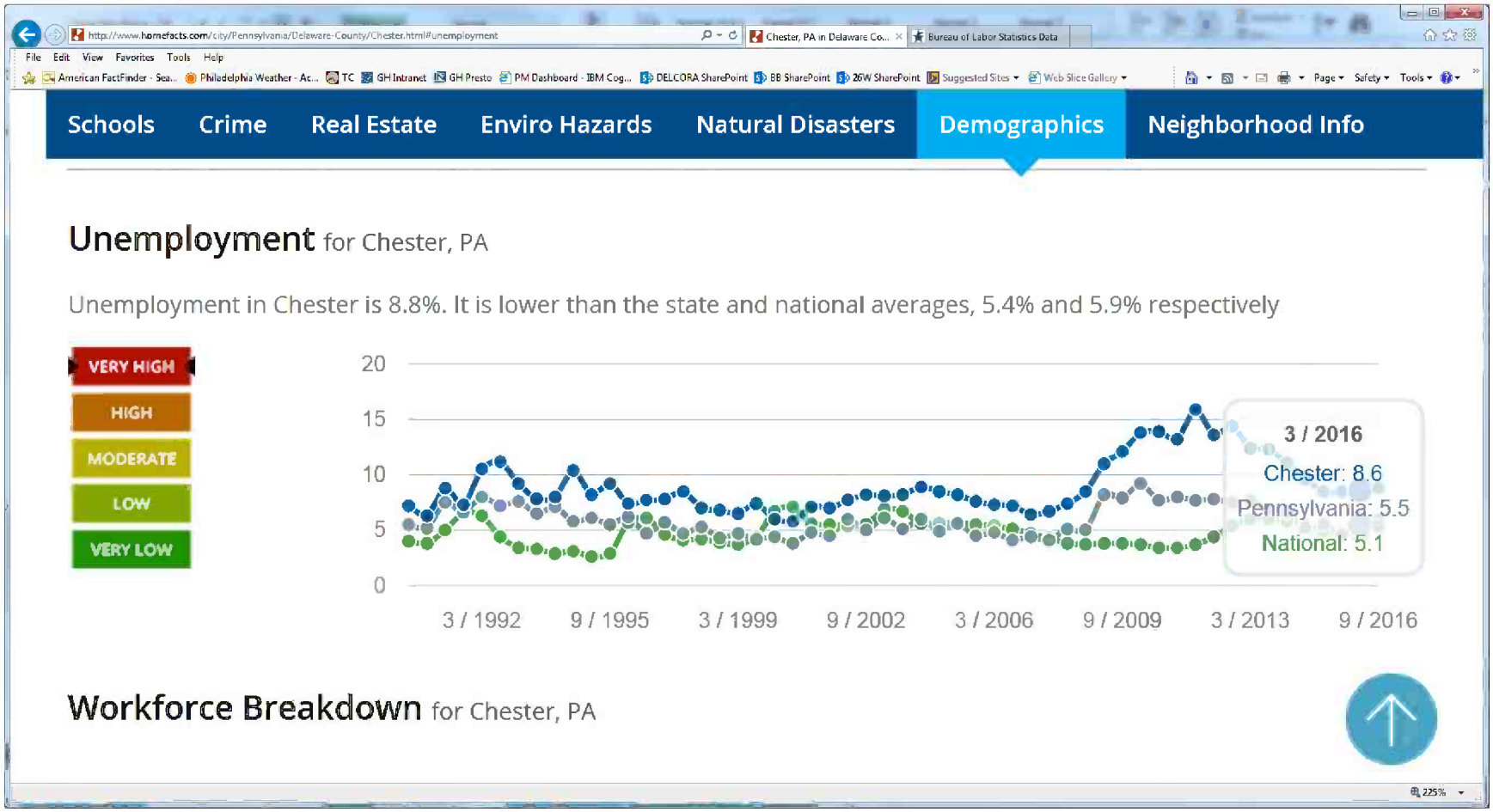
Reporting Year	Municipality	School District	Tax Name	Municipal Tax Amount	School District Tax Amount	Total Tax Rate
2013	NETHER PROVIDENCE TWP	WALLINGFRD-SWARTHMR S D	Real Estate - General Purpose (mills)	4.68	39.693	44.373
2013	NETHER PROVIDENCE TWP	WALLINGFRD-SWARTHMR S D	Real Estate - Community Colleges (mills)	0	0	0
2013	NEWTOWN TWP	MARPLE NEWTOWN S D	Real Estate - General Purpose (mills)	2.5037	17.6839	20.1876
2013	PROSPECT PARK BORO	INTERBORO S D	Real Estate - General Purpose (mills)	8.72	0	8.72
2013	RIDLEY PARK BORO	RIDLEY S D	Real Estate - General Purpose (mills)	5.94	39.125	45.065
2013	RIDLEY PARK BORO	RIDLEY S D	Real Estate - Debt Service (mills)	0.98	0	0.98
2013	RIDLEY PARK BORO	RIDLEY S D	Real Estate - Fire Equipment & Firehouses (mills)	0.32	0	0.32
2013	RIDLEY PARK BORO	RIDLEY S D	Real Estate - Library (mills)	0.34	0	0.34
2013	RIDLEY PARK BORO	RIDLEY S D	Real Estate - Recreation (mills)	0.21	0	0.21
2013	RIDLEY TWP	RIDLEY S D	Real Estate - General Purpose (mills)	5.819	39.125	44.944
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Ambulance & Rescue Squads (mills)	0.025	0	0.025
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Debt Service (mills)	0.946	0	0.946
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Fire Equipment & Firehouses (mills)	0.16	0	0.16
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Library (mills)	0.373	0	0.373
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Pensions and Retirement (mills)	0.11	0	0.11
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Recreation (mills)	0.5	0	0.5
2013	RIDLEY TWP	RIDLEY S D	Real Estate - Fire and Water District (mills)	0.083	0	0.083
2013	RIDLEY TWP	RIDLEY S D	Mercantile/Business Privilege - Wholesale (mills)	1	0	1
2013	RIDLEY TWP	RIDLEY S D	Mercantile/Business Privilege - Retail (mills)	1.5	0	1.5
2013	RUTLEDGE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - General Purpose (mills)	5.28	39.693	44.973
2013	RUTLEDGE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - Community Colleges (mills)	0	0.419	0.419
2013	SPRINGFIELD TWP	SPRINGFIELD S D	Real Estate - General Purpose (mills)	5.32	0	5.32

Reporting Year	Municipality	School District	Tax Name	Municipal Tax Amount	School District Tax Amount	Total Tax Rate
2013	SPRINGFIELD TWP	SPRINGFIELD S D	Mercantile/Business Privilege - Wholesale (mills)	0.5	0.5	1
2013	SPRINGFIELD TWP	SPRINGFIELD S D	Mercantile/Business Privilege - Retail (mills)	0.75	0.75	1.5
2013	SPRINGFIELD TWP	SPRINGFIELD S D	Mercantile/Business Privilege - Other (mills)	3	0	3
2013	SWARTHMORE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - General Purpose (mills)	4.484	39.693	44.177
2013	SWARTHMORE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - Debt Service (mills)	0.468	0	0.468
2013	SWARTHMORE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - Pensions and Retirement (mills)	0.5	0	0.5
2013	SWARTHMORE BORO	WALLINGFRD-SWARTHMR S D	Real Estate - Community Colleges (mills)	0	0.419	0.419
2013	TRAINER BORO	CHICHESTER S D	Real Estate - General Purpose (mills)	14.75	0	14.75
2013	UPLAND BORO	CHESTER-UPLAND S D	Real Estate - General Purpose (mills)	2	0	2
2013	UPPER CHICHESTER TWP	CHICHESTER S D	Real Estate - General Purpose (mills)	5.1	0	5.1
2013	UPPER CHICHESTER TWP	CHICHESTER S D	Real Estate - Debt Service (mills)	0	0	0
2013	UPPER PROVIDENCE TWP	ROSE TREE MEDIA S D	Real Estate - General Purpose (mills)	3.734	22.9445	26.6785

Appendix 11: Bureau of Labor Statistics Data

Source: www.homefacts.com

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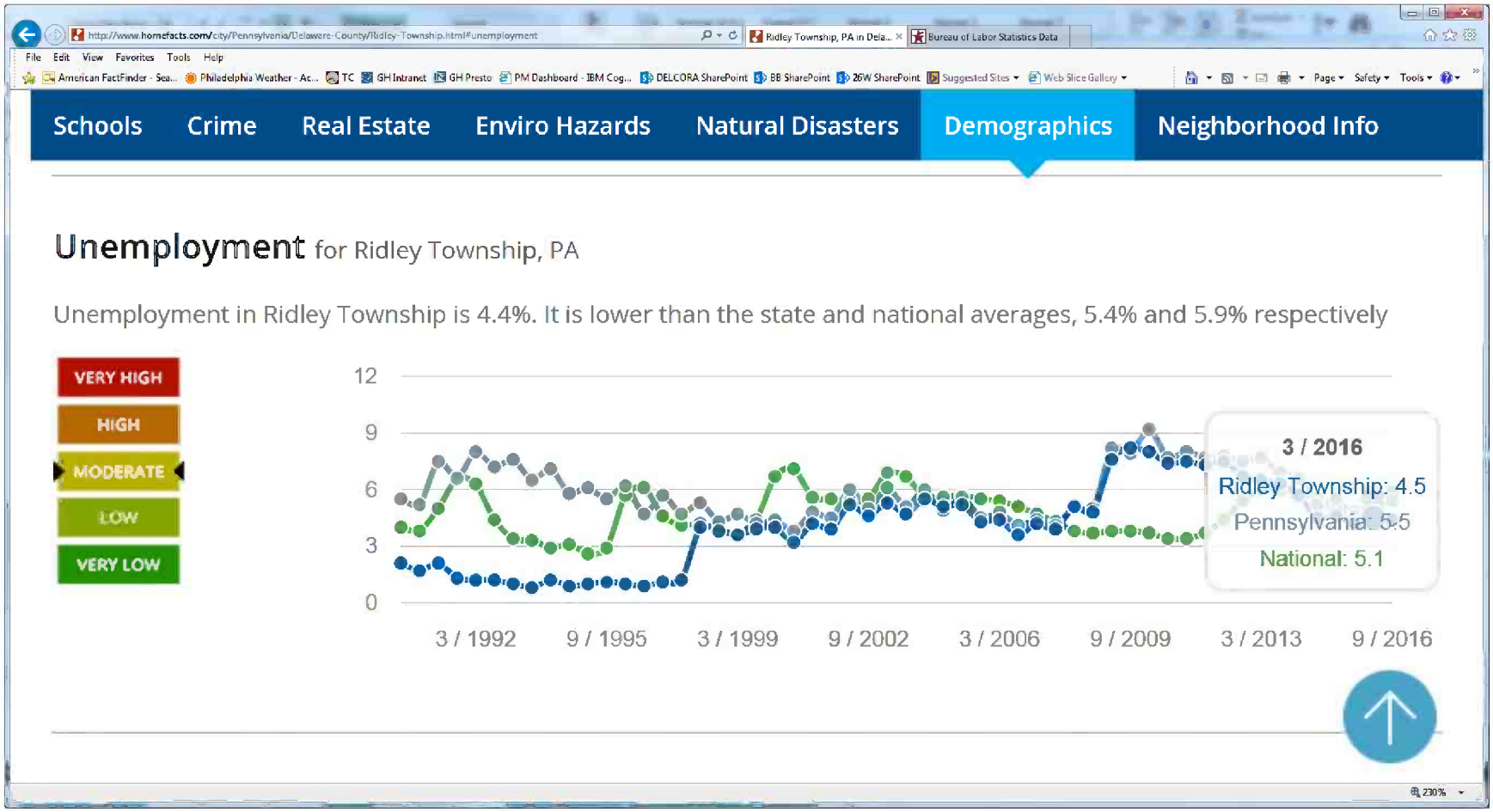
Chester, PA in Delaware Co...
Bureau of Labor Statistics Data
File Edit View Favorites Tools Help
Schools
Crime
Real Estate
Enviro Hazards
Natural Disasters
Demographics
Neighborhood Info
Unemployment for Chester, PA
Unemployment in Chester is 8.8%. It is lower than the state and national averages, 5.4% and 5.9% respectively
VERY HIGH
HIGH
MODERATE
LOW
VERY LOW
20
15
10
5
0
3 / 1992
9 / 1995
3 / 1999
9 / 2002
3 / 2006
9 / 2009
3 / 2013
9 / 2016
3 / 2016
Chester: 8.6
Pennsylvania: 5.5
National: 5.1
Workforce Breakdown for Chester, PA


Schools
Crime
Real Estate
Enviro Hazards
Natural Disasters
Demographics
Neighborhood Info
Unemployment for Ridley Township, PA
Unemployment in Ridley Township is 4.4%. It is lower than the state and national averages, 5.4% and 5.9% respectively
VERY HIGH
HIGH
MODERATE
LOW
VERY LOW
12
9
6
3
0
3 / 1992
9 / 1995
3 / 1999
9 / 2002
3 / 2006
9 / 2009
3 / 2013
9 / 2016
3 / 2016
Ridley Township: 4.5
Pennsylvania: 5.5
National: 5.1

Chester, PA Unemployment Rate Report

Chester, PA Historical Unemployment Trends

Type City Name vs Type City Name

Since 2005 the unemployment rate in Chester, Pennsylvania has ranged from 4.9% in April 2000 to 17.4% in July 2011. The current unemployment rate for Chester is 8.8% in September 2016. See how other local areas compare by using our Unemployment Compare tool.

Chester, PA Unemployment Rate by Month

Very High Unemployment Area

Chester, PA Current Unemployment - 8.8%

2016 **1974 Chester, PA Unemployment Rate**

Month/Year	Chester, PA%	Pennsylvania%	National %
1 / 2016	7.9%	5.2%	5.1%
2 / 2016	7.4%	5.3%	5.2%
3 / 2016	8.6%	5.5%	5.1%
4 / 2016	8.4%	5.2%	5.1%
5 / 2016	9.1%	5.5%	5.1%
6 / 2016	9.3%	5.6%	5.4%
7 / 2016	10.5%	6.1%	5.5%
8 / 2016	10.9%	6.0%	5.5%
9 / 2016	8.8%	5.4%	5.9%

Appendix 12: U.S. Census/American Community Survey Data

S1903: MEDIAN INCOME IN THE PAST 12 MONTHS (IN 2013 INFLATION-ADJUSTED DOLLARS)
2009-2013 American Community Survey 5-Year Estimates

Subject	Aston township, Delaware County, Pennsylvania		Bethel township, Delaware County, Pennsylvania		Brookhaven borough, Delaware County, Pennsylvania		Chester city, Delaware County, Pennsylvania		Chester township, Delaware County, Pennsylvania		Eddystone borough, Delaware County, Pennsylvania	
	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Households	5,862	77,966	3,053	120,869	3,522	63,808	11,817	27,249	1,341	44,353	877	41,832
One race--												
White	97.8%	77,977	92.5%	120,061	96.6%	64,913	15.1%	24,167	20.9%	43,667	83.5%	42,829
Black or African American	0.7%	71,310	1.8%	85,956	1.7%	56,700	80.4%	29,266	74.1%	46,600	14.5%	27,750
American Indian and Alaska Native	0.0%	-	0.0%	-	0.0%	-	0.2%	-	1.7%	43,661	0.0%	-
Asian	1.4%	98,125	5.2%	193,929	1.7%	26,829	0.2%	35,536	0.0%	-	0.0%	-
Native Hawaiian and Other Pacific Islander	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-
Some other race	0.0%	-	0.0%	-	0.0%	-	2.4%	17,050	2.6%	14,688	0.0%	-
Two or more races	0.2%	-	0.5%	-	0.0%	-	1.7%	20,357	0.7%	-	2.1%	41,111
Hispanic or Latino origin (of any race)	0.9%	-	1.2%	-	1.2%	48,365	5.8%	17,687	2.2%	14,375	1.4%	-
White alone, not Hispanic or Latino	96.8%	78,252	91.8%	119,394	95.4%	65,550	12.5%	24,119	20.9%	43,667	82.1%	42,961
HOUSEHOLD INCOME BY AGE OF HOUSEHOLDER												
15 to 24 years	0.4%	33,750	0.0%	-	1.4%	-	7.0%	18,316	1.8%	-	4.6%	33,571
25 to 44 years	28.5%	91,341	23.4%	138,472	27.9%	77,414	31.2%	25,104	36.3%	47,396	33.4%	41,793
45 to 64 years	44.8%	83,271	51.1%	129,076	40.0%	87,813	38.9%	34,951	44.1%	46,618	41.3%	43,929
65 years and over	26.3%	36,675	25.5%	68,787	30.7%	40,116	22.9%	26,443	17.7%	26,932	20.8%	41,458
FAMILIES												
Families	4,170	88,992	2,500	126,803	2,162	89,216	6,885	33,822	920	52,583	545	46,563
With own children under 18 years	45.5%	92,183	45.5%	152,663	33.9%	105,032	43.0%	20,813	50.9%	47,083	47.7%	41,250
With no own children under 18 years	54.5%	84,973	54.5%	118,646	66.1%	85,208	57.0%	42,351	49.1%	54,000	52.3%	51,875
Married-couple families	82.2%	95,572	90.4%	134,275	80.9%	90,031	31.6%	60,852	38.8%	69,761	54.7%	61,591
Female householder, no husband present	11.4%	53,789	6.6%	77,386	14.1%	53,482	58.6%	22,105	49.2%	38,693	34.7%	29,479
Male householder, no wife present	6.4%	52,750	3.0%	64,900	5.0%	100,074	9.9%	41,776	12.0%	33,889	10.6%	47,000
NONFAMILY HOUSEHOLDS												
Nonfamily households	1,692	43,300	553	72,566	1,360	35,042	4,932	19,922	421	19,482	332	33,387
Female householder	59.2%	34,943	80.7%	59,107	59.4%	33,173	60.7%	19,265	58.2%	19,496	47.6%	21,875
Living alone	55.4%	29,125	72.5%	58,125	56.3%	31,853	50.8%	18,879	56.1%	19,315	43.4%	19,891
Not living alone	3.8%	56,806	8.1%	78,558	3.2%	121,146	10.0%	24,375	2.1%	-	4.2%	53,125
Male householder	40.8%	52,841	19.3%	99,650	40.6%	40,000	39.3%	22,059	41.8%	19,375	52.4%	34,400
Living alone	31.3%	43,864	9.0%	-	33.9%	36,518	33.1%	20,799	31.4%	11,691	44.6%	40,000
Not living alone	9.5%	97,039	10.3%	86,528	6.7%	54,297	6.1%	23,419	10.5%	234,286	7.8%	-
PERCENT IMPUTED												
Household income in the past 12 months	34.3%	(X)	23.7%	(X)	27.0%	(X)	56.4%	(X)	45.6%	(X)	21.8%	(X)
Family income in the past 12 months	36.0%	(X)	24.6%	(X)	32.2%	(X)	60.0%	(X)	43.0%	(X)	25.3%	(X)
Nonfamily income in the past 12 months	29.7%	(X)	19.9%	(X)	18.8%	(X)	49.4%	(X)	44.4%	(X)	16.0%	(X)

S1903: MEDIAN INCOME IN THE PAST 12 MONTHS (IN 2013 INFLATION-ADJUSTED DOLLARS)
2009-2013 American Community Survey 5-Year Estimates

Subject	Edgmont township, Delaware County, Pennsylvania		Lower Chichester township, Delaware County, Pennsylvania		Marcus Hook borough, Delaware County, Pennsylvania		Marple township, Delaware County, Pennsylvania		Middletown township, Delaware County, Pennsylvania		Morton borough, Delaware County, Pennsylvania	
	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Households	1,640	114,355	1,165	53,460	832	39,167	8,339	74,503	5,839	85,593	1,088	59,022
One race--												
White	95.0%	117,000	87.3%	56,378	85.9%	41,528	92.3%	75,720	94.7%	84,759	69.7%	65,000
Black or African American	0.7%	-	10.2%	23,109	12.7%	30,789	2.4%	38,485	1.1%	51,453	24.6%	39,189
American Indian and Alaska Native	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.5%	-	0.0%	-
Asian	4.3%	69,311	0.9%	-	0.0%	-	4.9%	108,021	3.3%	118,214	3.4%	46,528
Native Hawaiian and Other Pacific Islander	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-
Some other race	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-
Two or more races	0.0%	-	1.6%	-	1.3%	-	0.4%	41,667	0.4%	-	2.3%	163,281
Hispanic or Latino origin (of any race)	0.0%	-	2.8%	-	0.0%	-	2.1%	29,503	1.7%	183,142	0.0%	-
White alone, not Hispanic or Latino	95.0%	117,000	87.0%	56,506	85.9%	41,528	90.2%	76,847	93.2%	84,408	69.7%	65,000
HOUSEHOLD INCOME BY AGE OF HOUSEHOLDER												
15 to 24 years	0.4%	-	1.0%	-	8.2%	23,611	0.9%	34,875	0.8%	6,528	0.5%	-
25 to 44 years	18.7%	173,750	45.8%	49,092	38.7%	44,435	18.8%	95,926	19.8%	114,853	27.7%	69,766
45 to 64 years	43.2%	132,148	39.6%	56,681	34.6%	41,176	48.6%	95,016	41.6%	113,843	53.2%	64,542
65 years and over	37.7%	66,458	13.6%	56,625	18.5%	30,109	31.7%	46,079	37.8%	42,416	18.7%	29,671
FAMILIES												
Families	1,047	147,969	785	52,049	582	39,200	6,122	91,898	3,966	107,013	663	69,375
With own children under 18 years	40.4%	161,125	56.4%	48,698	56.0%	34,457	36.7%	101,591	40.5%	114,688	37.1%	67,000
With no own children under 18 years	59.6%	141,842	43.6%	69,786	44.0%	46,250	63.3%	84,278	59.5%	100,400	62.9%	73,456
Married-couple families	90.0%	160,104	64.8%	71,007	40.2%	63,438	83.0%	96,796	86.9%	115,980	76.3%	81,250
Female householder, no husband present	7.4%	112,917	32.5%	24,511	48.6%	33,207	11.7%	67,396	10.6%	51,757	11.5%	59,000
Male householder, no wife present	2.6%	166,042	2.7%	60,972	11.2%	21,250	5.3%	74,125	2.4%	88,661	12.2%	32,708
NONFAMILY HOUSEHOLDS												
Nonfamily households	593	55,375	380	55,431	250	34,792	2,217	40,877	1,873	37,396	425	36,964
Female householder	68.3%	51,528	39.5%	55,086	43.2%	33,125	56.9%	33,825	69.1%	31,026	57.4%	29,342
Living alone	65.1%	46,875	32.4%	51,442	39.6%	32,250	51.0%	31,690	62.6%	28,733	49.4%	27,895
Not living alone	3.2%	-	7.1%	91,625	3.6%	-	5.9%	83,750	6.5%	81,458	8.0%	90,357
Male householder	31.7%	66,042	60.5%	62,900	56.8%	37,717	43.1%	56,058	30.9%	51,528	42.6%	40,281
Living alone	26.8%	51,821	44.5%	48,798	51.6%	37,663	36.8%	46,336	22.4%	41,750	28.0%	32,656
Not living alone	4.9%	-	16.1%	72,813	5.2%	-	6.4%	99,236	8.5%	84,091	14.6%	41,938
PERCENT IMPUTED												
Household income in the past 12 months	28.9%	(X)	52.0%	(X)	35.7%	(X)	37.4%	(X)	30.2%	(X)	33.2%	(X)
Family income in the past 12 months	21.5%	(X)	46.9%	(X)	32.8%	(X)	39.3%	(X)	25.9%	(X)	32.4%	(X)
Nonfamily income in the past 12 months	40.8%	(X)	62.6%	(X)	42.4%	(X)	32.2%	(X)	38.0%	(X)	34.4%	(X)

S1903: MEDIAN INCOME IN THE PAST 12 MONTHS (IN 2013 INFLATION-ADJUSTED DOLLARS)
2009-2013 American Community Survey 5-Year Estimates

Subject	Nether Providence township, Delaware County, Pennsylvania		Newtown township, Delaware County, Pennsylvania		Parkside borough, Delaware County, Pennsylvania		Prospect Park borough, Delaware County, Pennsylvania		Ridley township, Delaware County, Pennsylvania		Ridley Park borough, Delaware County, Pennsylvania		Rutledge borough, Delaware County, Pennsylvania	
	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Households	5,098	98,608	4,586	93,565	827	51,103	2,438	67,143	12,270	62,500	2,873	57,516	294	71,923
One race--														
White	89.0%	96,756	96.5%	93,704	83.0%	57,000	95.5%	68,239	89.9%	62,874	96.6%	57,938	92.9%	71,875
Black or African American	4.8%	94,306	0.2%	-	10.9%	42,174	1.2%	-	6.1%	45,078	1.3%	-	2.7%	70,833
American Indian and Alaska Native	0.0%	-	0.0%	-	1.1%	-	0.0%	-	0.2%	63,611	0.0%	-	0.0%	-
Asian	4.2%	131,518	3.2%	82,120	2.1%	-	2.5%	-	2.2%	79,484	0.7%	116,750	3.1%	121,875
Native Hawaiian and Other Pacific Islander	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-
Some other race	0.0%	-	0.0%	-	0.0%	-	0.8%	-	0.5%	29,375	0.0%	-	1.4%	-
Two or more races	2.0%	103,264	0.1%	-	3.0%	93,438	0.0%	-	1.0%	41,743	1.4%	39,327	0.0%	-
Hispanic or Latino origin (of any race)	1.4%	103,611	0.2%	-	2.9%	116,944	2.2%	-	2.2%	73,780	2.1%	-	2.0%	-
White alone, not Hispanic or Latino	88.1%	96,614	96.3%	93,889	83.0%	57,000	94.1%	69,176	88.5%	62,770	94.8%	58,750	92.2%	72,125
HOUSEHOLD INCOME BY AGE OF HOUSEHOLDER														
15 to 24 years	0.5%	-	0.0%	-	2.3%	46,705	0.0%	-	0.9%	43,811	1.6%	51,528	9.5%	40,000
25 to 44 years	24.3%	102,464	20.7%	105,733	44.1%	63,482	39.2%	61,477	34.7%	67,684	31.8%	63,698	18.7%	68,125
45 to 64 years	46.6%	120,042	45.4%	133,750	39.7%	46,250	44.1%	75,102	41.1%	71,686	43.3%	70,398	56.1%	88,875
65 years and over	28.6%	59,982	33.9%	42,909	13.9%	21,991	16.7%	30,395	23.3%	34,199	23.2%	39,740	15.6%	59,500
FAMILIES														
Families	3,750	121,039	3,147	120,746	600	59,167	1,536	72,075	7,829	76,076	1,681	78,413	214	89,250
With own children under 18 years	42.4%	134,133	39.1%	129,222	49.2%	48,068	50.7%	53,056	43.0%	70,253	43.8%	80,208	48.1%	71,023
With no own children under 18 years	57.6%	110,841	60.9%	112,125	50.8%	65,341	49.3%	86,250	57.0%	80,390	56.2%	74,609	51.9%	106,875
Married-couple families	84.3%	131,906	88.3%	127,045	56.7%	85,000	69.8%	82,000	73.5%	88,922	74.2%	92,574	78.5%	108,333
Female householder, no husband present	9.9%	73,681	10.9%	68,088	35.5%	34,036	17.6%	38,304	20.8%	47,025	18.5%	53,508	18.7%	40,750
Male householder, no wife present	5.7%	80,556	0.8%	33,194	7.8%	52,708	12.6%	51,546	5.8%	66,275	7.3%	35,972	2.8%	-
NONFAMILY HOUSEHOLDS														
Nonfamily households	1,348	53,977	1,439	34,984	227	35,114	902	36,855	4,441	36,365	1,192	36,893	80	36,250
Female householder	70.3%	49,000	62.0%	30,556	51.5%	25,625	40.8%	21,886	53.6%	26,432	64.0%	35,610	61.3%	34,250
Living alone	60.9%	41,582	56.8%	29,063	49.3%	24,375	36.7%	21,075	49.1%	23,329	55.3%	32,917	43.8%	22,250
Not living alone	9.4%	91,635	5.1%	63,750	2.2%	-	4.1%	80,375	4.5%	86,330	8.7%	66,250	17.5%	48,214
Male householder	29.7%	58,929	38.0%	41,625	48.5%	45,227	59.2%	49,786	46.4%	43,333	36.0%	38,792	38.8%	43,250
Living alone	26.4%	56,042	32.4%	36,875	37.9%	21,944	46.6%	48,929	35.8%	38,750	33.1%	38,833	33.8%	44,250
Not living alone	3.3%	82,727	5.6%	118,558	10.6%	85,313	12.6%	74,643	10.6%	66,050	2.9%	37,431	5.0%	-
PERCENT IMPUTED														
Household income in the past 12 months	27.2%	(X)	38.6%	(X)	34.3%	(X)	22.6%	(X)	26.9%	(X)	22.1%	(X)	27.9%	(X)
Family income in the past 12 months	27.5%	(X)	40.2%	(X)	40.0%	(X)	23.4%	(X)	26.6%	(X)	23.7%	(X)	26.6%	(X)
Nonfamily income in the past 12 months	25.7%	(X)	34.7%	(X)	19.4%	(X)	21.3%	(X)	25.8%	(X)	19.8%	(X)	31.3%	(X)

S1903: MEDIAN INCOME IN THE PAST 12 MONTHS (IN 2013 INFLATION-ADJUSTED DOLLARS)
2009-2013 American Community Survey 5-Year Estimates

Subject	Springfield township, Delaware County, Pennsylvania		Swarthmore borough, Delaware County, Pennsylvania		Trainer borough, Delaware County, Pennsylvania		Upland borough, Delaware County, Pennsylvania		Upper Chichester township, Delaware County, Pennsylvania		Upper Providence township, Delaware County, Pennsylvania	
	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income	Total	Median income
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Households	8,632	92,468	2,006	117,604	639	40,863	1,171	31,597	6,528	68,294	3,845	104,399
One race--												
White	95.9%	91,640	94.9%	117,656	79.7%	40,156	64.4%	38,864	83.7%	71,168	91.7%	105,194
Black or African American	1.2%	49,625	3.8%	138,447	18.6%	42,014	34.8%	20,057	13.3%	44,886	2.8%	61,131
American Indian and Alaska Native	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.3%	-	0.0%	-
Asian	2.4%	103,958	1.3%	-	0.6%	-	0.0%	-	1.6%	108,750	5.1%	106,429
Native Hawaiian and Other Pacific Islander	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-	0.0%	-
Some other race	0.1%	-	0.0%	-	1.1%	-	0.9%	-	0.5%	-	0.3%	-
Two or more races	0.3%	125,870	0.0%	-	0.0%	-	0.0%	-	0.6%	49,125	0.2%	-
Hispanic or Latino origin (of any race)	0.4%	19,489	7.0%	138,939	4.2%	76,250	4.9%	72,361	2.8%	31,955	0.9%	172,946
White alone, not Hispanic or Latino	95.9%	91,721	89.5%	117,308	76.5%	37,263	60.8%	38,295	82.1%	70,678	90.8%	104,423
HOUSEHOLD INCOME BY AGE OF HOUSEHOLDER												
15 to 24 years	0.5%	70,000	3.3%	-	0.5%	-	1.8%	26,875	2.2%	31,026	2.2%	48,250
25 to 44 years	26.2%	107,623	19.7%	121,473	37.4%	37,393	38.1%	40,714	28.2%	79,722	29.7%	105,119
45 to 64 years	42.9%	111,824	48.1%	132,944	38.2%	53,500	31.6%	43,750	43.6%	79,063	47.3%	124,821
65 years and over	30.4%	44,780	28.9%	79,861	23.9%	40,417	28.5%	22,556	26.1%	35,647	20.9%	78,182
FAMILIES												
Families	6,733	105,586	1,290	172,222	491	41,280	763	42,061	4,156	81,962	2,703	131,856
With own children under 18 years	40.2%	108,635	45.0%	204,044	46.2%	40,240	52.8%	27,750	34.4%	82,917	39.3%	149,605
With no own children under 18 years	59.8%	101,346	55.0%	150,481	53.8%	44,000	47.2%	54,207	65.6%	81,800	60.7%	115,078
Married-couple families	85.0%	110,601	92.2%	181,226	53.2%	57,981	38.1%	67,917	77.0%	96,070	81.7%	142,432
Female householder, no husband present	10.7%	57,988	6.0%	52,589	35.0%	29,625	53.3%	26,477	16.9%	48,897	12.2%	64,271
Male householder, no wife present	4.3%	44,875	1.8%	-	11.8%	38,750	8.5%	75,458	6.1%	71,875	6.1%	105,066
NONFAMILY HOUSEHOLDS												
Nonfamily households	1,899	36,858	716	52,885	148	30,652	408	17,169	2,372	32,619	1,142	51,250
Female householder	55.8%	25,725	61.7%	56,786	48.6%	28,750	66.9%	16,496	59.3%	30,984	52.4%	56,250
Living alone	52.9%	24,574	53.2%	60,993	43.9%	26,719	55.4%	15,677	48.9%	24,107	42.6%	48,750
Not living alone	2.9%	83,929	8.5%	2,500-	4.7%	-	11.5%	70,391	10.5%	66,739	9.8%	104,700
Male householder	44.2%	60,430	38.3%	45,500	51.4%	31,346	33.1%	24,844	40.7%	34,886	47.6%	45,900
Living alone	35.4%	46,442	36.5%	39,375	36.5%	33,750	31.9%	25,714	24.3%	26,820	42.2%	44,000
Not living alone	8.8%	111,875	1.8%	-	14.9%	30,357	1.2%	-	16.4%	63,611	5.4%	147,273
PERCENT IMPUTED												
Household income in the past 12 months	25.0%	(X)	29.5%	(X)	41.3%	(X)	39.8%	(X)	34.0%	(X)	29.8%	(X)
Family income in the past 12 months	24.3%	(X)	23.1%	(X)	40.5%	(X)	44.7%	(X)	29.8%	(X)	28.3%	(X)
Nonfamily income in the past 12 months	25.7%	(X)	41.1%	(X)	43.9%	(X)	30.6%	(X)	41.4%	(X)	32.6%	(X)

Appendix 13: Flow Allocation

Appendix 13

Determination of Chester City's Wet Weather Flow as Fraction of Total Wet Weather Flow

DELCORA's system serves a variety of customers from numerous municipalities in Delaware County, PA, as depicted in the schematic diagram depicted in Figure 1-1. The majority of the sewer systems within the Model Area have separated sanitary sewers, with the exception of a portion of Chester City, which is served by combined sewers. While the combined sewer outfalls in DELCORA's service area are all located within the City of Chester, it is recognized that wet weather flow from customers outside of the City of Chester may influence the conveyance of flow from the City of Chester, thereby affecting the CSO volume discharged from Chester City's outfalls.

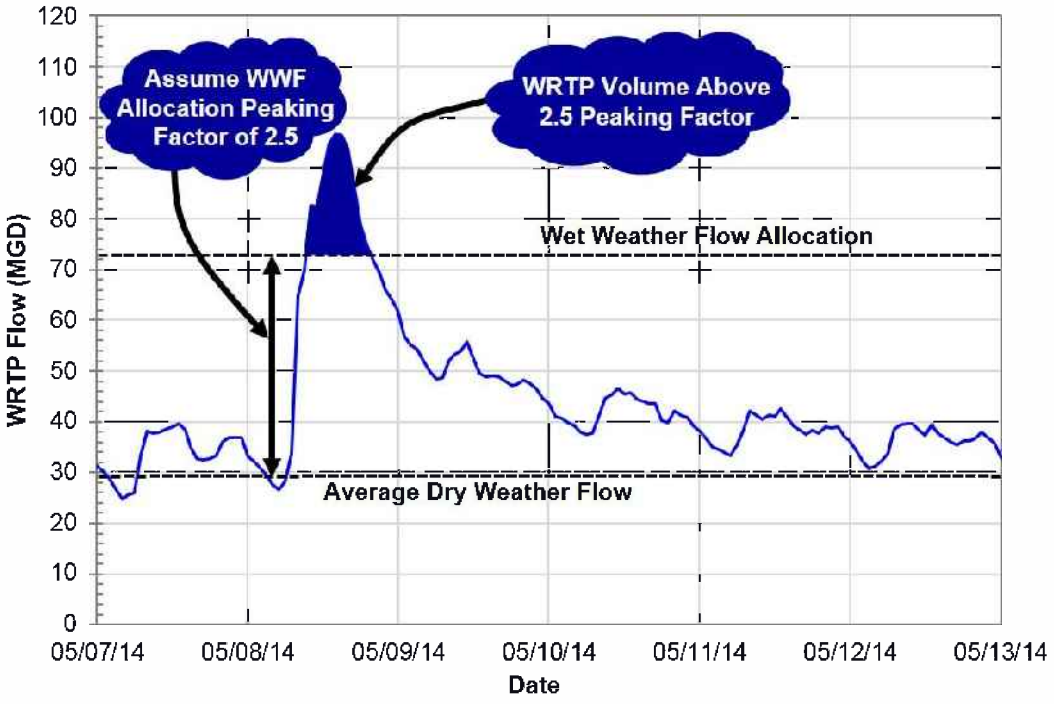
Because the service area includes many municipalities, DELCORA must consider distributing costs among its customers in relation to the services each customer group receives and must set rates in a fair and reasonable manner. Thus, for the purpose of the Draft FCA, the allocation of CSO LTCP costs between Chester City and the separate sewer systems in the Model Area is based on separate sewer system's share of the Model Area's total excess Wet Weather Flow (WWF) volume.

The existing Hydrologic and Hydraulic (H&H) Model focuses on the Chester City collection system. As part of updates to the CSO LTCP, the H&H model will be calibrated and modified to allow for estimation of the relative contributions to wet weather flow from the Model Area customers. At this time, the H&H Model has not yet been updated, so an alternative method for approximating wet weather flow contributions will be used for this Draft FCA as described below.

Excessive wet weather flow is defined as flows exceeding the peaking factor of 2.5 times dry weather flow. In addition, flow that never reaches the plant during wet weather but instead is discharged into a receiving stream would also be characterized as excessive flow. Total excess wet weather flow would then be the sum of these two items.

Dry weather flow was estimated based on an analysis of hourly flow data for the Western Regional Treatment Plant (WRTP). Flow data for the period 2009-2013 was obtained. For each year, dry weather day flow was estimated as the 5^{th} percentile of the WRTP flow (i.e. 5% of the days the flow will be less than the estimated DWF). With the dry weather flow baseline established, the peaking factor of 2.5 was applied and the flow data was re-analyzed to obtain an estimate of excess flow, which was the summed to estimate excess volume for a storm. Figure A13-1 shows an example WRTP's WWF volume from a single storm event in May 2014. The annual sum of excess wet weather volume for the WRTP was assigned to the separate sewer segments of the Model Area.

Figure A13-1: Basis for Estimating Wet Weather Flow from Separate Sewer Areas



CSO discharge data for the same time period (2009-2013) was obtained and analyzed to determine the annual CSO discharge volume. As this flow emanates from Chester City, this wet weather volume was assigned to Chester City.

The relative allocation for Chester City would then be the ratio of Chester City's excess wet weather volume to the total excess wet weather volume for the Model Area. Similarly, the allocation for the remainder of the Model Area (i.e., the separated sewer areas) would be the ration of the excess volume from the separate sewer areas to the total excess wet weather volume.

Conceptually, the allocation can be summarized as:

Vs = Excess WWF Volume from Separate Sewer Areas = Excess WRTP Volume ..... (Eq A13-1)

Vc = Excess Chester City WWF Volume = CSO Discharge..... (Eq A13-2)

Vt = Total Excess WWF Volume = Excess WRTP Volume + CSO Discharge..... (Eq A13-3)

Chester City Allocation = Vc/(Vs + Vc)..... (Eq A13-4)

Separate Sewer System Area Allocation = Vs/(Vs + Vc)..... (Eq A13-5)

Results of the analysis are summarized in Table A13-1, which indicates that the separate sewer system has about a 3 percent to 5 percent share of the total wet weather volume.

Table A13-1: CSO Volume as Percent of Total Wet Weather Volume

Year	WRTP WWF Volume above 2.5 Peak Factor (MG)	CSO Volume (MG)	Total Wet Weather Volume (MG)	Percent CSO
2009	24.2	785	809.2	97%
2010	39.3	696	735.3	95%
2011	30.0	1144	1174.0	97%
2012	6.6	538	544.6	99%
2013	13.5	744	757.5	98%
Average	22.7	781.4	804.1	97%

DISCUSSION

As mentioned above, the existing Hydrologic and Hydraulic (H&H) Model focuses on the Chester City collection system and is in the process of being updated as part of the updates to the CSO LTCP. At this time, the H&H Model has not yet been updated, so the alternative method for approximating wet weather flow contributions described above was used for this Draft FCA. Further hydraulic evaluations are required to better understand the separate sewer system flows and refine the separate sewer system share of the CSO LTCP costs. Therefore for this Draft FCA, it is assumed 15 percent of CSO LTCP costs would be allocated to the separate sewer system and 85 percent of the CSO LTCP costs would allocated to combined sewer system in Chester City. For the final FCA, the updated hydrologic and hydraulic (H&H) model will be used to improve the estimate of CSO attributable to Chester City and to the remainder of the Model Area.

BACKING DATA

Plant flow and CSO discharge data is approximately 800 pages and will be provided upon request.

Appendix 14: Worksheet Details

Explanation for Worksheet 1			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A1a	100	Input Data	Existing O&M costs based on DELCORA's cost of service for each customer.
A1b	101	Input Data	Existing debt service based on DELCORA's debt cost for each customer.
A1c	102	101+102	
A2a	103	(1.5% of capital cost) * (1.03)^n	where n = number of years after completion of construction
A2b	104	Input Data	Projected additional costs for non-CSO projects Future CSO LTCP costs are based on annualized costs, assuming total CSO cost is divided into three projects as described in Draft FCA. Allocation to municipalities based on fraction of excess flow as described in the Draft FCA Appendix 13. Annualized costs for captial projects are based on bond term and interest rate described in the Draft FCA. Reported in 2035 dollars.
A2c	105	103+104	
A3	106a	102+105	
B	106b	(Western collection costs for Chester City + Retail I&I for Chester City) / Chester City Usage	Modeled on costs for DELCORA's retail customers.
C	106c	106a+106b	
D	NA	Input Data	Usage from DELCORA records and projections.
E	NA	(106c*10^6) / D	
F	107	input data: 55,000	Residential water usage (typ); based on Chester Water Authority data (2010-15)
G	108	D / F	
H	109a	E * F	
I	109b	Input data	Assumed projected SW cost of $45/Household (2016 dollars). Cost adjusted to the year used for FCA analysis by assuming inflation of 3% per year ($79/HH in 2035 dollars; $44/HH in 2015 dollars)
J	109c	H + I	

Explanation for Worksheet 2			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A1	201	Input data	Input based on US Census Bureau's 5-year American Community Survey (ACS), 2009-2013. See Draft FCA Appendix 12.
A2		Input data	Input: Year Ym
A3		Input data	Input: Data year Yf
A4		Input data	Input: MHI Inflation Rate
A5	202	(1+r) ^ (Yf-Ym)	r=MHI inflation rate, Yf=FCA Analysis year, Ym=Year of MHI Estimate. See Draft FCA Appendix 4
A6		Line 201 * Line 202	
B		Line 109c	
C		Line 204 / Line 203 * 100	

Explanation for Worksheet 3			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A	301	Input data	DELCORA has no general obligation bond. A weighted composite from the bond rating and number of households of the municipalities was determined. Strong was weighted as a 3 for investment grade, mid-range was weighted 2 for the line of investment grade (Baa, BBB), and weak was weighted 1 for junk bonds.
B	302	Input data	DELCORA's revenue bond as of 2015 from "2015 Official Statement"

Explanation for Worksheet 4			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A	401	Input data * pro-rate factor	Input data from Municipal Annual Audit and Financial Reports (MAAFR) in "Excess/Deficit of Revenues" in the "General Obligation Bonds and Notes" section at the end of each city's report. See Draft FCA Appendix 6. **Exception:** City of Chester Debt obtained from 2012 Independent Audit, Note 8 "Long-Term Debt", pg 43 Pro-rated for partial areas based on the fraction of a municipality's land area that is within the DELCORA service area. Land areas were obtained through GIS analysis. (see Table WS4.E below)
B	402	See below for more detail	Input for County Outstanding debt from Delaware County Comprehensive Annual Financial Report. Pro-rated for partial areas. Input for debt of school districts from PA State website.
C	403	Line 401 + Line 402	
D	404	Input data * pro-rate factor	Input from PA State Tax Equalization Board (STEB) - Tax Equalization Division (TED) Pro-rated for partial areas based on the fraction of a municipality's land area that is within the DELCORA service area. Land areas were obtained through GIS analysis. (see Table WS4.E below)
E		Line 403 / Line 404	

Explanation for Worksheet 4, Line 402: Calculation of Proportionate Share of Debt from Overlapping Entities

Overlapping entity: Delaware County

1. Determine Percent chargeable to service area (i.e., pro-rate factor)

Row	Description	Formula	Notes
AA	Municipality Full Market Property Value 2013 (PA STEB)	Input data	See Appendix 9
BB	Delaware County Full Market Property Value 2013 (PA STEB)	Input data	See Appendix 9
CC	Percent chargeable to your service area	Row AA / Row BB	

See Table WS4.A below for example

2. Determine Share of Debt

Row	Description	Formula	Notes
DD	Delaware County Oustanding Debt	Input data	See Appendix 8
EE	Percent chargeable to your service area	Row CC	
FF	Delaware County Debt attributable to permitee's service area	Row DD * Row EE	

See Table WS4.B below for example

Explanation for Worksheet 4, Line 402: Calculation of Proportionate Share of Debt from Overlapping Entities

Overlapping entity: School Districts

1. Identify school districts and their debts (see Table WS4.C below)

2. Determine percent chargeable to service area based on fraction of school district that is within municipality (pro-rate factor 1) and fraction of municipality that is within the service area (pro-rate factor 2).

Row	Description	Formula	Notes
GG	Municipality Full Market Property Value 2013 (PA STEB)	Input data	See Appendix 9
HH	School District Full Market Property Value 2013 (PA STEB)	Sum of FMPV for all municiaplities served by the school district	See Appendix 9
II	Percent of school district chargeable to municipality	Row GG/ Row HH	
JJ	Percent of municipality chargeable to your service area	Input data	Obtained though GIS analysis of municipality land area that is within the service area
KK	Overall percent chargeable to your service area	Row II * Row JJ	

3. Determine Share of Debt

Row	Description	Formula	Notes
LL	School District Oustanding Debt	Input data	See Table WS4.C below
MM	Percent chargeable to your service area	Row KK	
NN	Delaware County Debt attributable to permitee's service area	Row LL * Row MM	

Explanation for Worksheet 4 (cont.)

Table WS4.A

		Retail Customers						Wholesale Customers		Western				Southwest				
										Southern								
Row	Description	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township
AA	Municipality Full Market Property Value 2013 (PA STEB)	$ 668,332,484	$ 140,432,669	$ 86,916,839	$ 211,331,072	$ 80,303,015	$ 140,432,669	$ 541,287,028	$ 1,242,612,683	$ 851,442,202	$ 1,131,350,161	$ 226,703,647	$ 119,803,390	$ 1,244,551,376	$ 541,287,028	$ 211,331,072	$ 1,546,015,387	$ 1,166,565,930
BB	Delaware County Full Market Property Value 2013 (PA STEB)	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931
CC	Percent chargeable to your service area	1.61%	0.34%	0.21%	0.51%	0.19%	0.34%	1.31%	3.00%	2.05%	2.73%	0.55%	0.29%	3.00%	1.31%	0.51%	3.73%	2.81%

		Central Delaware County Authority											
Row	Description	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)
AA	Municipality Full Market Property Value 2013 (PA STEB)	$ 674,554,080	$ 2,405,956,904	$ 155,311,247	$ 1,242,612,683	$ 2,116,962,376	$ 295,032,728	$ 405,569,802	$ 1,744,630,085	$ 52,079,034	$ 2,332,826,856	$ 542,909,677	$ 1,166,565,930
BB	Delaware County Full Market Property Value 2013 (PA STEB)	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931	$41,457,785,931
CC	Percent chargeable to your service area	1.63%	5.80%	0.37%	3.00%	5.11%	0.71%	0.98%	4.21%	0.13%	5.63%	1.31%	2.81%

Table WS4.B

		Retail Customers						Wholesale Customers		Western				Southwest				
										Southern								
Row	Description	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township
DD	Delaware County Debt	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000
EE	Percent chargeable to your service area	1.61%	0.34%	0.21%	0.51%	0.19%	0.34%	1.31%	3.00%	2.05%	2.73%	0.55%	0.29%	3.00%	1.31%	0.51%	3.73%	2.81%
FF	Delaware County Debt attributable to permitee's service area	$ 408,146	$ 85,761	$ 53,080	$ 129,059	$ 49,041	$ 85,761	$ 330,560	$ 758,855	$ 519,970	$ 690,908	$ 138,446	$ 73,163	$ 760,039	$ 330,560	$ 129,059	$ 944,142	$ 712,414

		Central Delaware County Authority											
Row	Description	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)
DD	Delaware County Debt	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000	$ 25,318,000
EE	Percent chargeable to your service area	1.63%	5.80%	0.37%	3.00%	5.11%	0.71%	0.98%	4.21%	0.13%	5.63%	1.31%	2.81%
FF	Delaware County Debt attributable to permitee's service area	$ 411,946	$ 1,469,302	$ 94,848	$ 758,855	$ 1,292,815	$ 180,175	$ 247,679	$ 1,065,434	$ 31,804	$ 1,424,642	$ 331,551	$ 712,414

Explanation for Worksheet 4 (cont.)

Table WS4.C: School District Debts

Chester Upland School District	Chi-Chester School District	Garnet Valley School District	Interboro	Marple Newtown School District	Penn-Delco School District	Ridley School District	Rose Tree Media School District	Springfield School District	Wallingford-Swarthmore School District
$ 72,845,617	$ 63,716,819	$ 115,073,539	$ 43,891,721	$ 91,063,393	$ 86,447,954	$ 64,552,037	$ 83,564,714	$ 48,460,032	$ 91,769,834

Explanation for Worksheet 4 (cont.)

Table WS4.D

		Retail Customers						Wholesale Customers		Western				Southwest				
										Southern								
Row	Description	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township
	School District	Chester-Upland	Penn Delco	Chester-Upland	Chester-Upland	Chi Chester	Chi Chester	Penn Delco	Wallingford - Swarthmore	Garnet Valley	Chi Chester	Ridley	Chi Chester	Penn Delco	Penn Delco	Chester Upland	Rose Tree Media	Rose Tree Media
II	Percent of school district chargeable to municipality	63.4%	7.3%	10.7%	25.9%	5.5%	9.5%	28.1%	63.12%	26.67%	0.77	9.54%	0.08	0.65	28.84%	25.9%	38.86%	29.33%
JJ	Percent of municipality chargeable to your service area	100%	100%	100%	39%	100%	100%	64%	33%	72%	100%	100%	100%	100%	18%	61%	100%	7%
KK	Overall percent chargeable to your service area	63.4%	7.3%	10.7%	10.1%	5.5%	9.5%	18.0%	20.66%	19.28%	1	9.54%	0	1	5.18%	15.8%	38.86%	2.05%
LL	School District Debt	72,845,617	86,447,954	72,845,617	72,845,617	63,716,819	63,716,819	86,447,954	91,769,834	115,073,539	63,716,819	64,522,037	63,716,819	86,447,954	86,447,954	72,845,617	83,564,714	83,564,714
NN	School district debt attributable to service area	$ 46,181,397	$ 6,302,393	$ 7,770,615	$ 7,368,506	$ 3,476,248	$ 6,079,209	$ 15,578,519	$ 18,963,362	$ 22,186,971	$ 48,975,175	$ 6,153,965	$ 5,186,186	$ 55,853,468	$ 4,479,689	$ 11,525,099	$ 32,476,801	$ 1,715,405

		Central Delaware County Authority											
Row	Description	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)
	School District	Rose Tree Media	Marple Newtown	Springfield	Wallingford Swarthmore	Marple Newtown	Interboro	Ridley	Ridley	Wallingford Swarthmore	Springfield	Wallingford Swarthmore	Rose Tree Media
II	Percent of school district chargeable to municipality	16.96%	53.19%	6.24%	63.12%	46.81%	19.83%	17.06%	73.40%	2.65%	93.76%	27.58%	29.33%
JJ	Percent of municipality chargeable to your service area	12%	56%	100%	64%	50%	100%	100%	82%	100%	54%	100%	53%
KK	Overall percent chargeable to your service area	2.03%	29.79%	6.24%	40.18%	23.40%	19.83%	17.06%	60.19%	2.65%	50.63%	27.58%	15.54%
LL	School District Debt	83,564,714	91,063,393	48,460,032	91,769,834	91,063,393	43,891,721	64,522,037	64,522,037	91,769,834	48,460,032	91,769,834	83,564,714
NN	School district debt attributable to service area	$ 1,700,425	$ 27,126,943	$ 3,024,908	$ 36,872,560	$ 21,311,211	$ 8,705,715	$ 11,009,361	$ 38,834,143	$ 2,427,525	$ 24,534,967	$ 25,306,289	$ 12,988,069

Explanation for Worksheet 4 (cont.)

Table WS4.E. Pro-rating factors based on land area

		Retail Customers						Wholesale Customers		Western				Southwest				
										Southern								
Line	Description	Chester City	Parkside Borough	Upland Borough	Chester Township (DELCORA)	Trainer Borough	Marcus Hook Borough	Brookhaven Borough (wholesale)	Nether Providence Township (wholesale)	Bethel Township	Upper Chichester Township	Eddystone Borough	Lower Chichester Township	Aston Township	Brookhaven Borough	Chester Township (SW)	Middletown Township	Upper Providence Township
	Municipality Debt	$ 22,948,627	$ 498,976	$ 652,000			$ 1,314,000	$ 102,532	$ 446,000	$ 676,000	$ 205,006	$ 39,224		$ 3,150,000	$ 102,532		$ 3,260,000	$ 139,000
	Municipality Debt			741,906			112,603	1,434,000	483,000	222,000	253,474	2,880,000		1,703,000	1,434,000		7,390,000	2,297,000
	Municipality Debt			75,047			350,000	2,062,000	9,181		659,000	450,000			2,062,000			671,000
	Municipality Debt			308,000					2,801,000		207,000							395,267
	Municipality Debt								1,031,000		3,550,000							
	Municipality Debt																	
	Total Municipality Debt	22,948,627	498,976	1,776,953	0	0	1,776,603	3,598,532	4,770,181	898,000	4,874,480	3,369,224	0	4,853,000	3,598,532	0	10,650,000	3,502,267
	Fraction of municipality within service area	100%	100%	100%	39%	100%	100%	64%	33%	72%	100%	100%	100%	100%	18%	61%	100%	7%
A	Direct Net Debt (G.O. Bonds Excluding Double-Barreled Bonds) within service area	$ 22,948,627	$ 498,976	$ 1,776,953	$ 0	$ 0	$ 1,776,603	$ 2,307,739	$ 1,561,757	$ 649,254	$ 4,874,480	$ 3,369,224	$ 0	$ 4,853,000	$ 646,656	$ 0	$ 10,650,000	$ 245,159

		Central Delaware County Authority											
Line	Description	Edgmont Township	Marple Township (CDCA)	Morton	Nether Providence Township (CDCA)	Newtown Twp	Prospect Park	Ridley Park Borough	Ridley Township (CDCA)	Rutledge	Springfield	Swarthmore	Upper Providence Township (CDCA)
	Municipality Debt	$ -	$ 815,000	$ 195,000	$ 446,000	$ 2,250,000	$ 44,183	$ 128,844	$ 2,195,000	$ 42,263	$ 4,571,000	$ 298,000	$ 139,000
	Municipality Debt		2,115,000	478,250	483,000	440,000		1,067,962	1,173,000	119,219		323,000	2,297,000
	Municipality Debt		121,666		9,181	36,916			10,000,000			463,000	671,000
	Municipality Debt		1,930,000		2,801,000							644,000	395,267
	Municipality Debt				1,031,000							409,000	
	Municipality Debt											500,000	
	Total Municipality Debt	0	4,981,666	673,250	4,770,181	2,726,916	44,183	1,196,806	13,368,000	161,482	4,571,000	2,637,000	3,502,267
	Fraction of municipality within service area	12%	56%	100%	64%	50%	100%	100%	82%	100%	54%	100%	53%
A	Direct Net Debt (G.O. Bonds Excluding Double-	$ 0	$ 2,789,733	$ 673,250	$ 3,036,697	$ 1,363,458	$ 44,183	$ 1,196,806	$ 10,961,760	$ 161,482	$ 2,468,340	$ 2,637,000	$ 1,856,202

Explanation for Worksheet 5			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A	501	Input data	Input from Bureau of Labor and Statistics. See Draft FCA Appendix 11
B	502	Input data	Input from Bureau of Labor and Statistics. See Draft FCA Appendix 11
C	503	Input data	Input from Bureau of Labor and Statistics. See Draft FCA Appendix 11
D1		Line 501 - Line 503	

Explanation for Worksheet 6			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A1		Input data	Input based on US Census Bureau's 5-year American Community Survey (ACS), 2009-2013. See Draft FCA Appendix 12.
A2		(1+r) ^ (Yf-Ym)	r=MHI inflation rate, Yf=FCA Analysis year, Ym=Year of MHI Estimate. See Draft FCA Appendix 4
A3	601	A1 * A2	
B1	602	Input data	Input based on US Census Bureau's 5-year American Community Survey (ACS), 2009-2013. See Draft FCA Appendix 12.
B2	603	(1+r) ^ (Yf-Ym)	r=MHI inflation rate, Yf=FCA Analysis year, Ym=Year of MHI Estimate. See Draft FCA Appendix 4
B3	604	Line 602 * Line 603	
C1		(Line 601 - Line 604) / Line 604	

Explanation for Worksheet 7			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A	701	Line 404	
B	702	Input data	Input from Line 301 of MAAFR, See Draft FCA Appendix 6.
C	703	Line 702 / Line 701 * 100%	

Explanation for Worksheet 8			
Worksheet Item	**Worksheet Line No.**	**Formula**	**Notes**
A	801	Line 702	
B	802	[Property Assessment (Line 404) * Sum of Municipality Tax Rates] / 100	Assessments obtained from 2013 State Tax Equalization Board (See Draft FCA Appendix 9) except for Chester City.Chester City is classified as a third class city by PA State, allowing them to determine their own assessed values; Chester City assessment is from 2012 Tax rates obtained from 2013, except for Chester City and Parkside which were from 2012 (see Draft FCA Appendix 10).
C	803	Line 801 / Line 802 * 100	

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

VIA CERTIFIED MAIL
RETURN RECEIPT REQUESTED

August 25, 2017

Ms. Margaret Anne Hill
Partner and Chair
Environmental, Energy, and Natural Resources Practice Group
Blank Rome LLP
One Logan Square
Philadelphia, PA 19103

Re: *United States and PADEP v. Delaware County Regional Water Quality Control Authority (DELCORA),* Civil Action No. 15-4652, Draft Financial Capability Assessment (Revised April 2017)

Dear Ms. Hill:

Thank you for the revised *Draft Financial Capability Assessment Report*, May 2016 (Revised April 2017) (Draft FCA) submitted on behalf of the Delaware County Regional Water Quality Control Authority (DELCORA), pursuant to the requirements of Paragraph 18 of the Consent Decree entered in the referenced case and in response to U.S. Environmental Protection Agency (EPA) comments in its letter dated February 16, 2017. This letter requests two items required to complete DELCORA's Draft FCA and provides comments on the Draft FCA consistent with Paragraph 18 of the Consent Decree.

Paragraph 18 of the Consent Decree requires DELCORA to prepare a draft Financial Capability Assessment in accordance with CSO Control Policy Paragraph II.C.8 and "Combined Sewer Overflows—Guidance for Financial Capability Assessment and Schedule Development," EPA 832-B-97-004, February 1997 (FCA Guidance), and to submit it to EPA and Pennsylvania Department of Environmental Protection (PADEP) for review and comment. This letter summarizes EPA's comments to date on the revised April 2017 *Draft Financial Capability Assessment Report*. We are requesting that DELCORA amend certain tables and text as soon as practicable. We are also providing comments that DELCORA should keep in mind as it moves forward in preparing the final version of the Financial Capability Assessment and in implementing the Consent Decree.

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1. ***Requiring Amendment to the Draft FCA.***
We appreciate that DELCORA's latest revision is responsive to several comments from EPA's letters dated September 15, 2016 and February 16, 2017. DELCORA provided detailed backup for current demographic data; and presented the Residential Indicator results in terms of current dollars and demographic characteristics.

Two related aspects of the Residential Indicator analysis still need to be corrected: the service area and the residential share of costs. These issues are not new, and we discussed them at our last meeting. DELCORA need only to provide the pages corrected and added to its Draft FCA to show its revisions.

a. *Service Area.* DELCORA's April 2017 Draft FCA reflected adjustments to the service area used to calculate the Residential Indicator, but failed to meet the service area definition ("Model Area") explicitly established in Paragraph 14.b of the Consent Decree and used in Paragraph 18. Consistent with the Consent Decree definition of the Model Area and with the FCA Guidance,[1] DELCORA's Residential Indicator calculation must include both the entire "Western Service Area" and the entire "Eastern Service Area." As discussed at our May 22, 2017 meeting and consistent with the FCA Guidance and EPA's 2014 Financial Capability Assessment Framework (FCA Framework), DELCORA needs to incorporate all current and projected costs for all the authorities in the Eastern Service Area for which DELCORA collects and sends wastewater to the Philadelphia wastewater treatment plant. The Residential Indicator calculation should also include DELCORA's expected payments to Philadelphia for treatment and Long Term Control Plan (LTCP) costs based on available documentary evidence.[2]

b. *Residential Share of Costs*. DELCORA also needs to calculate the Residential Share of Costs relative to the entire Model Area as defined above. The Residential Share of Costs defines the share of costs assigned to total number of households in the permittee's total wastewater service area. The Residential Share of Costs must be based on total flows generated by residential users throughout the Model Area relative to the total wastewater flows generated. The Residential Share of Costs is to be estimated by determining the flow billed to households relative to total flow billed overall by the utility.[3] Note that the reference point is households, not residential customers. Generally, we accept residential flow estimates that add residential customer flow plus an estimate of the flow generated by households in multifamily buildings that are commercial customers. The Residential Indicator is not a calculation to set rates, but is used to determine whether CSO controls will produce a possible high, midrange, or low financial impact on the permittee's residential users.

2. ***Comments on the Draft FCA***. A number of issues have arisen in discussions with DELCORA regarding the Draft FCA. We offer the following comments as provided for in the Consent Decree. These comments should help DELCORA as it moves into the identification and

[1] Cost Per Household (CPH) is calculated by dividing residential share of costs by "the total number of households (line 108) in the permittee's total wastewater service area." FCA Guidance, Page 14.
[2] "Communities should demonstrate how the CWA work included as costs in the financial capability assessment will be implemented, including appropriate assurances that those expenditures will be made." FCA Framework, Page 3.
[3] This assumes that infiltration and inflow are allocated to customers in the same proportion as billed flow.

evaluation of technical alternatives to control CSOs and the process for approval of DELCORA's revised and updated LTCP.

a. *Calculating Residential Indicator based on Wet Weather Flow volume.* DELCORA's calculation of the Residential Indicator based on Wet Weather Flow volume assigns the majority of CSO flows to Chester City, when, in fact, Chester City is a small proportion of the entire Model Area relative to the total wastewater flow treated or the number of households in the Model Area. As part of the Residential Indicator calculations from the FCA Guidance, the residential share of total costs is proportionate to the residential portion of "total wastewater flow," not wet weather flow. FCA Guidance, Page 14. In addition, the Cost Per Household (CPH) calculation takes into account the current costs for existing wastewater treatment operations and the projected costs for any proposed wastewater treatment and CSO controls. DELCORA's existing wastewater operations at the Western Regional Treatment Plant include treatment of combined and separate flows during dry and wet weather conditions. Therefore, both dry and wet weather flows need to be considered in the CPH calculation.

b. *Goal of 1997 FCA Guidance and Relationship to CD Requirements:* A Financial Capability Assessment combines the Residential Indicator and Permittee Financial Capability Indicator to give an overall assessment of DELCORA's financial capability. DELCORA's Draft FCA states that "[t]he CSO LTCP will be designed and constructed as required to meet the Consent Decree deadline of August 2035 to the limit of Chester City's financial capability." DELCORA misconstrues the purpose of a FCA. The intent of the 1997 FCA Guidance and its use under the Consent Decree is not to limit the design or scope of the CSO controls to a particular geographic area within the overall permittee service area. This assessment is used to help establish an appropriate CSO control implementation schedule. Pursuant to Paragraph 9 of the Consent Decree, the selected CSO controls set forth in the LTCP shall be designed to meet the overarching goals of bringing all CSO discharge points into full compliance with the technology-based and water quality-based requirements of the CWA and minimizing the impacts of CSOs on water quality, aquatic biota, and human health. Furthermore, Paragraph 19 of the Consent Decree states that available CSO control technologies are not intended to be limited by cost, and requires DELCORA to identify an appropriately broad range of technically feasible CSO controls for detailed evaluation, regardless of the cost of each technically feasible CSO control.

c. *Summary of Previous EPA Comments*: Since DELCORA's April 2017 Draft FCA was submitted, EPA, PADEP, and DELCORA have had one in-person meeting on May 22, 2017, and two phone calls, which took place on June 1, 2017 and June 23, 2017. There were a number of questions exchanged between EPA, PADEP, and DELCORA during those discussions, some of which were outside the scope of the Draft FCA. The following responses provide our reply to those questions:

    i. Kimberly-Clark. DELCORA asked whether Kimberly-Clark would be responsible for LTCP costs proportionate to its flow to the treatment plant. The CSO Control Policy recommends that the municipality consider sources of funding in determining the phasing of construction projects, which can include the availability of grants and loans; previous and current *residential, commercial, and*

industrial sewer user fees and rate structures; and other viable funding mechanisms. Emphasis added. The EPA document, "CSOs: Guidance for Funding Options" (1995) states that "because CSO controls benefit the whole service area, permittees should recognize that, in most cases, it will be necessary to use a fee structure that distributes the CSO control costs among all system customers. Recovering costs through increases to system-wide user fees will distribute the cost increases more broadly." The specific rate design that a utility develops is largely in its discretion. The FCA is a uniform and consistent methodology for evaluating the financial impact of proposed CSO LTCP costs and not appropriate for setting rates. Utility rate structures are designed to generate revenues to cover costs and assure that various financial ratios are met. Utility rate design can range from simple to complex, including charges for concentrated waste discharge or lower cost for higher volume customers. Ultimately, the rate design is up to the permittee, balancing the revenue requirements with allocation of costs to various types of customers.

Further, as part of the CSO Policy's Nine Minimum Controls and LTCP requirements, the permittee's publicly owned treatment works (POTW) options are an integral part of the alternatives evaluation process. Specifically, the CSO Policy states that the LTCP should consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. Thus, the permittee should take into account any industrial flow to the treatment plant relative to the POTW's role in addressing CSOs.

ii. 2014 Framework. DELCORA asked EPA to state its position about the relationship between the FCA Framework and the FCA Guidance. The cover memorandum that EPA issued to accompany the FCA Framework notes that the FCA Guidance provides an aid for assessing financial capability as part of negotiating schedules for implementing CWA requirements for municipalities and local authorities. The FCA Guidance also encourages permittees "to submit any additional documentation that would create a more accurate and complete picture of their financial capability" that may "affect the conclusion" of the analysis described in the guidance. The FCA Framework identifies the key elements EPA uses in working with permittees to evaluate how their financial capability should influence schedules. In addition, the FCA Framework provides examples of additional information that may help some communities provide a "more accurate and complete picture" of their financial capability as is envisioned in the FCA Guidance.

iii. Incorporation of dry weather flow. DELCORA asked whether every EPA-approved FCA requires that all dry weather flow areas be included in the FCA and whether there is any provision in the FCA or LTCP/CSO guidance that supports the position that all areas contributing dry weather flows must be included for FCA purposes. The FCA Guidance does not provide for how DELCORA will apportion costs of the LTCP, other than the Residential Indicator calculations, which identifies the impact of wastewater and CSO control costs on individual households based on a flow-based allocation. As part of the Residential Indicator calculations from the FCA Guidance, the residential share of total costs

is proportionate to the residential portion of "total wastewater flow," not wet weather flow. FCA Guidance, Page 14. In addition, the Cost Per Household portion of the Residential Indicator is calculated by dividing the residential share of WWT and CSO costs by "the number of households in the permittee's total wastewater service area," not just households that contribute dry weather flows. FCA Guidance, Page 12.

iv. Proportionate share. DELCORA asked EPA to consider the CWA principles of "proportionate share." EPA's FCA Guidance was developed, in part, based on the experience of EPA in the Construction Grants program. EPA's Construction Grants regulations require that a grantee's user charge system, if not using ad valorem taxes, "shall provide that each user (or user class) pays its proportionate share of operation and maintenance (including replacement) costs of treatment works within the grantee's service area, based on the user's proportionate contribution to the total wastewater loading from all users (or user classes)." 40 C.F.R. 35.2140(a). The CSO Control Policy states that "each permittee is ultimately responsible for aggressively pursuing financial arrangements for the implementation of its long-term CSO control plan." Placing almost all of the financial responsibility upon the City of Chester for implementing the LTCP is not consistent with the CWA principle of "proportionate share" of the DELCORA's treatment and conveyance costs, given that DELCORA should be examining a broad range of compliance options within its overall system. As noted above, the City of Chester is a relatively small proportion of the overall service area and total wastewater loading. Disproportionately burdening the City of Chester would avoid DELCORA's responsibilities under its NPDES permit, the CSO Policy and the Clean Water Act.

3. ***Response to Information Submitted on August 17, 2017.*** Thank you for providing additional information related to DELCORA's FCA methodology, received by EPA on August 17, 2017. EPA encourages permittees to submit any additional documentation that would create a more accurate and complete picture of their financial capability, but we must stress that the FCA analysis is designed to measure the permittee's, i.e., DELCORA's, financial capability to implement CSO controls and therefore review of other cases is not particularly useful.

The purpose of an FCA is to inform development of a CSO LTCP schedule and is not a cost-allocation or rate setting exercise. As part of the long term planning process, DELCORA is responsible for identifying existing user fees and rate structures for wastewater treatment and then developing a new rate structure to finance and implement CSO controls. While this is related to financial capability, it is not part of the FCA. We also reiterate that the FCA Guidance is meant to provide a common basis for financial burden discussions with the permittee when the permittee has identified its CSO control options. In order to maintain this basis for a general comparison of financial conditions between communities across the country, the FCA Guidance provides straightforward calculations that are intended to assess a permittee's financial capability. As noted in the FCA Framework, EPA allows municipalities to submit other relevant financial or demographic information that illustrates the unique or atypical circumstances the permittee faces, allowing for a case-specific assessment of local considerations, including financing and technical implementation. Given the case-specific nature of each FCA, comparisons are of limited utility.

As noted above, there are two items DELCORA needs to provide to complete its Draft FCA. Please send the information at your earliest convenience. Replacement pages and any additional addendum will be sufficient. Consistent with Paragraph 18 of the Consent Decree, this letter also summarizes EPA comments to date on DELCORA's Draft FCA submittals. EPA intends to review the proposed final FCA in accordance with Paragraphs 18 and 34 of the Consent Decree when it is submitted concurrently with the revised and updated LTCP. If you have any questions concerning this letter, please call Philip Yeany at 215-814-2495 or contact him at yeany.philip@epa.gov.

Sincerely,

/s/ Andrew Dinsmore, Chief
NPDES Enforcement Branch

cc: Andrew Seligman
Philip Yeany
Paul Fericelli
Chrisna Baptista
Morgan Rog
Donna Duer
William Gelles

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

October 31, 2017

FED EX - NEXT DAY

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
601 D Street NW
Washington, DC 20004
Re: DOJ No. 90-5-1-1-10972

Philip Yeany
Office of Regional Counsel (3RC20)
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Chief
NPDES Enforcement Branch (3WP42)
Water Protection Division
U.S. EPA, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

Program Manager - Clean Water Program
PA DEP
Southeast Regional Office
2 East Main Street
Norristown, PA 19401

RE: Civil Action Number Case 2:15-cv-04652-RB &
DOJ Case Number 90-5-1-1-10972
DELCORA CSO Long Term Control Plan Update
Draft Financial Capability Assessment Report May 2016
(Revised April 2017)

Dear Sir/Madam:

By this letter the Delaware County Regional Water Quality Control Authority is providing the following responses to USEPA / PADEP comments related to the above mentioned report in accordance with the requirements of the Consent Decree.

DELCORA Responses to USEPA / PADEP Comments (including referenced attachment):

Two related aspects of the Residential Indicator analysis still need to be corrected: the service area and the residential share of costs. These issues are not new, and we discussed them at our last meeting. DELCORA need only to provide the pages corrected and added to its Draft FCA to show its revisions.

1. ***Requiring Amendment to the Draft FCA***

Comment:

a. *Service Area*. DELCORA's April 2017 Draft FCA reflected adjustments to the service area used to calculate the Residential Indicator, but failed to meet the service area definition ("Model Area") explicitly established in Paragraph 14.b of the Consent Decree and used in Paragraph 18. Consistent with the Consent Decree definition of the Model Area and with the FCA Guidance, DELCORA's Residential Indicator calculation must include both the entire "Western Service Area" and the entire "Eastern Service Area." As discussed at our May 22, 2017 meeting and consistent with the FCA Guidance and EPA's 2014 Financial Capability Assessment Framework (FCA Framework), DELCORA needs to incorporate all current and projected costs

for all the authorities in the Eastern Service Area for which DELCORA collects and sends wastewater to the Philadelphia wastewater treatment plant. The Residential Indicator calculation should also include DELCORA's expected payments to Philadelphia for treatment and Long Term Control Plan (LTCP) costs based on available documentary evidence.

Response:

- ***First, in negotiations with the Department of Justice and EPA, DOJ Counsel Marcello Mollo and EPA acknowledged and agreed that wastewater flows from the Eastern Service Area (excluding the Central Authority flows which can be delivered to the DELCORA WRTP or the Philadelphia WWTP) do not hydraulically connect to, or directly affect or indirectly affect the DELCORA WRTP, and more importantly, that this "fact" would be acknowledged as part of the DELCORA FCA submission. In brief, the government agreed that EPA's FCA Guidance document considers unique circumstances and facts associated with individual wastewater treatment systems. DELCORA incorporated its unique circumstances in the preparation of its draft FCA; specifically, the Eastern Service Area does not discharge, nor can it discharge to the DELCORA WRTP.***

- ***Second, EPA's view is contrary to the unambiguous definition of the "Model Area" because it excludes and ignores certain portions of that definition. In EPA's view, the Model Area includes the entire Western Service Area and Eastern Service Area without exception. Paragraph 14 b. defines the Model Area to include: "hydrologic representation of all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems*** that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, ***regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area" depicted on Figure 1-2 of the Long-Term Control Plan submitted by DELCORA in April 2012, and attached as Appendix A hereto (collectively, the "Model Area").***"

- ***EPA seizes upon the language underlined above in concluding that the applicable Model Area must include the DELCORA's entire service area (Western and Eastern) without any regard to hydraulic connectivity or impacts upon the WRTP or CSOs. This interpretation ignores and renders meaningless the non-bolded language in the definition set forth above and is contrary to DELCORA's and DOJ's intent during negotiations of the Consent Decree. A more reasonable interpretation would give effect to both clauses meaning that the Model Area includes all areas in the Western and Eastern Service Areas to the extent that those areas are hydraulically connected or directly or indirectly influence flow to the CSOs and /or the WRTP.***

- ***It should also be noted that the current version of the FCA is a "Draft". The FCA will continue to be updated and the final version will be included with the completion of the Long Term Control Plan Update.***

Comment:

b. *Residential Share of Costs*. DELCORA also needs to calculate the Residential Share of Costs relative to the entire Model Area as defined above. The Residential Share of Costs defines the share of costs assigned to total number of households in the permittee's total wastewater service area. The Residential Share of Costs must be based on total flows generated by residential users throughout the Model Area relative to the total wastewater flows generated. The Residential Share of Costs is to be estimated by determining the flow billed to households

relative to total flow billed overall by the utility Note that the reference point is households, not residential customers. Generally, we accept residential flow estimates that add residential customer flow plus an estimate of the flow generated by households in multifamily buildings that are commercial customers. The Residential Indicator is not a calculation to set rates, but is used to determine whether CSO controls will produce a possible high, midrange, or low financial impact on the permittee's residential users.

Response:

See the response to "a" above.

2. ***Comments on the Draft FCA.*** *A number of issues have arisen in discussions with DELCORA regarding the Draft FCA. We offer the following comments as provided for in the Consent Decree. These comments should help DELCORA as it moves into the identification and evaluation of technical alternatives to control CSOs and the process for approval of DELCORA's revised and updated LTCP.*

Comment:

a. *Calculating Residential Indicator based on Wet Weather Flow volume. DELCORA's calculation of the Residential Indicator based on Wet Weather Flow volume assigns the majority of CSO flows to Chester City, when, in fact, Chester City is a small proportion of the entire Model Area relative to the total wastewater flow treated or the number of households in the Model Area. As part of the Residential Indicator calculations from the FCA Guidance, the residential share of total costs is proportionate to the residential portion of "total wastewater flow," not wet weather flow. FCA Guidance, Page 14. In addition, the Cost Per Household (CPH) calculation takes into account the current costs for existing wastewater treatment operations and the projected costs for any proposed wastewater treatment and CSO controls. DELCORA's existing wastewater operations at the Western Regional Treatment Plant include treatment of combined and separate flows during dry and wet weather conditions. Therefore, both dry and wet weather flows need to be considered in the CPH calculation.*

Response:

Attached are Responses to USEPA comments received February 23, 2017. See response to Comment No. 2. Totalizing all dry and wet weather flows and dividing that flow per residential customers does not characterize the true residential burden of addressing the excess wet weather flow in the system.

Comment:

b. *Goal of 1997 FCA Guidance and Relationship to CD Requirements.* A Financial Capability Assessment combines the Residential Indicator and Permittee Financial Capability Indicator to give an overall assessment of DELCORA's financial capability. DELCORA's Draft FCA states that "[t]he CSO LTCP will be designed and constructed as required to meet the Consent Decree deadline of August 2035 to the limit of Chester City's financial capability." DELCORA misconstrues the purpose of a FCA. The intent of the 1997 FCA Guidance and its use under the Consent Decree is not to limit the design or scope of the CSO controls to a particular geographic area within the overall permittee service area. This assessment is used to help establish an appropriate CSO control implementation schedule. Pursuant to Paragraph 9 of the Consent Decree, the selected CSO controls set forth in the LTCP shall be designed to meet the overarching goals of bringing all CSO discharge points into full compliance with the technology-based and water quality-based requirements of the CWA and minimizing the impacts of CSOs on water quality, aquatic biota, and human health. Furthermore, Paragraph 19 of the Consent Decree states that available CSO control technologies are not intended to be limited by cost, and requires DELCORA to identify an appropriately broad range of

technically feasible CSO controls for detailed evaluation, regardless of the cost of each technically feasible CSO control.

Response:

DELCORA will provide a full range of level of control alternatives that are consistent with the National CSO Policy and the Consent Decree. The LTCP will include a schedule for implementation based on various factors including construction phasing. Also attached are responses to USEPA comments received February 23, 2017. See response to Comment No. 3.

Comment:

c. *Summary of Previous EPA Comments. Since DELCORA's April 2017 Draft FCA was submitted, EPA, PADEP, and DELCORA have had one in-person meeting on May 22, 2017, and two phone calls, which took place on June 1, 2017 and June 23, 2017. There were a number of questions exchanged between EPA, PADEP, and DELCORA during those discussions, some of which were outside the scope of the Draft FCA. The following responses provide our reply to those questions:*

i. Kimberly-Clark. DELCORA asked whether Kimberly-Clark would be responsible for LTCP costs proportionate to its flow to the treatment plant. The CSO Control Policy recommends that the municipality consider sources of funding in determining the phasing of construction projects, which can include the availability of grants and loans; previous and current *residential, commercial, and industrial sewer user fees and rate structures*; and other viable funding mechanisms. Emphasis added. The EPA document, "CSOs: Guidance for Funding Options" (1995) states that "because CSO controls benefit the whole service area, permittees should recognize that, in most cases, it will be necessary to use a fee structure that distributes the CSO control costs among all system customers. Recovering costs through increases to system-wide user fees will distribute the cost increases more broadly." The specific rate design that a utility develops is largely in its discretion. The FCA is a uniform and consistent methodology for evaluating the financial impact of proposed CSO LTCP costs and not appropriate for setting rates. Utility rate structures are designed to generate revenues to cover costs and assure that various financial ratios are met. Utility rate design can range from simple to complex, including charges for concentrated waste discharge or lower cost for higher volume customers. Ultimately, the rate design is up to the permittee, balancing the revenue requirements with allocation of costs to various types of customers.

Further, as part of the CSO Policy's Nine Minimum Controls and LTCP requirements, the permittee's publicly owned treatment works (POTW) options are an integral part of the alternatives evaluation process. Specifically, the CSO Policy states that the LTCP should consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. Thus, the permittee should take into account any industrial flow to the treatment plant relative to the POTW's role in addressing CSOs.

Response:

The alternatives analysis will include a review of maximizing flow to the POTW. DELCORA agrees that the specific rate design that a utility develops is largely in its discretion and that the rate design is up to the permittee. DELCORA will consider the other rate impacts as part of the development of the LTCP."

ii. 2014 Framework. DELCORA asked EPA to state its position about the relationship between the FCA Framework and the FCA Guidance. The cover memorandum that EPA

issued to accompany the FCA Framework notes that the FCA Guidance provides an aid for assessing financial capability as part of negotiating schedules for implementing CWA requirements for municipalities and local authorities. The FCA Guidance also encourages permittees "to submit any additional documentation that would create a more accurate and complete picture of their financial capability" that may "affect the conclusion" of the analysis described in the guidance. The FCA Framework identifies the key elements EPA uses in working with permittees to evaluate how their financial capability should influence schedules. In addition, the FCA Framework provides examples of additional information that may help some communities provide a "more accurate and complete picture" of their financial capability as is envisioned in the FCA Guidance.

Response:

Additional information was provided to USEPA on August 17, 2017 that describes DELCORA's unique circumstances.

iii. Incorporation of dry weather flow. DELCORA asked whether every EPA-approved FCA requires that all dry weather flow areas be included in the FCA and whether there is any provision in the FCA or LTCP/CSO guidance that supports the position that all areas contributing dry weather flows must be included for FCA purposes. The FCA Guidance does not provide for how DELCORA will apportion costs of the LTCP, other than the Residential Indicator calculations, which identifies the impact of wastewater and CSO control costs on individual households based on a flow-based allocation. As part of the Residential Indicator calculations from the FCA Guidance, the residential share of total costs is proportionate to the residential portion of "total wastewater flow," not wet weather flow. FCA Guidance, Page 14. In addition, the Cost Per Household portion of the Residential Indicator is calculated by dividing the residential share of WWT and CSO costs by "the number of households in the permittee's total wastewater service area," not just households that contribute dry weather flows. FCA Guidance, Page 12.

Response:

See response to Comment 2a above.

iv. Proportionate share. DELCORA asked EPA to consider the CWA principles of "proportionate share." EPA's FCA Guidance was developed, in part, based on the experience of EPA in the Construction Grants program. EPA's Construction Grants regulations require that a grantee's user charge system, if not using ad valorem taxes, "shall provide that each user (or user class) pays its proportionate share of operation and maintenance (including replacement) costs of treatment works within the grantee's service area, based on the user's proportionate contribution to the total wastewater loading from all users (or user classes)." 40 C.F.R. 35.2140(a). The CSO Control Policy states that "each permittee is ultimately responsible for aggressively pursuing financial arrangements for the implementation of its long-term CSO control plan." Placing almost all of the financial responsibility upon the City of Chester for implementing the LTCP is not consistent with the CWA principle of "proportionate share" of the DELCORA's treatment and conveyance costs, given that DELCORA should be examining a broad range of compliance options within its overall system. As noted above, the City of Chester is a relatively small proportion of the overall service area and total wastewater loading. Disproportionately burdening the City of Chester would avoid DELCORA's responsibilities under its NPDES permit, the CSO Policy and the Clean Water Act.

Response:

See responses to Comments 1b and 2a above.

If there are any questions, please contact me. Thank You.

Sincerely,

Michael J. DiSantis
Director of Operations & Maintenance

MJD:bab
attachment

cc: via email
Margaret Hill, Blank Rome
Marlene Finizio, Greeley and Hansen
Michael Hope, Greeley and Hansen
Charles Hurst, DELCORA
Michael DiSantis, DELCORA
John Pileggi, DELCORA
Robert Willert, DELCORA
File- Consent Order- LTCP CSO

DELCORA LTCPU Task 9: DRAFT Financial Capabilities Assessment Report (rev. Nov. 2016)
Responses to USEPA and PADEP Concerns (Comments received February 23, 2017) DUE April 24, 2017

No.	Reviewer Name	Report Reference	Review Concerns	Response to Concerns
1	EPA/PADEP	Page 1-4	1. Model Area: Consistent with the terms of the Consent Decree, the Model Area must include the entire Eastern Service Area. DELCORA has expanded the FCA's discussion of the basis for having the Model Area include the Western Service Area plus the Central Authority of the Eastern Service Area (Page 1-4, FCA). However, DELCORA's exclusion of the rest of the Eastern Service Area in its assessments is inconsistent with the Consent Decree. Paragraph 18 of the Consent Decree requires that the Financial Capability Assessment include: information on sewer rate setting and median household income and number of households in the entire Model Area (as defined in Paragraph 14.b above), as well as information on all other financial resources available to DELCORA. [Emphasis added.] Paragraph 14.b of the Consent Decree defines "Model Area" to include: all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area." [Emphasis added.]	Paragraph 14.b of the Consent Decree defines the "Model Area" as: all areas tributary to the entire Collection System, as well as all areas tributary to all municipal wastewater collection and transmission systems that are, as of the date the LTCP is submitted, hydraulically connected to, or that directly or indirectly influence flow to, the CSOs and/or the WRTP, regardless of who owns or operates the system(s), including but not limited to the entire "Western Service Area" and "Eastern Service Area." [Emphasis added.] We examined the entire "Western Service Area" and "Eastern Service Area" and found that only the "Western" service area and "Central" portion of the Eastern service area are hydraulically connected to, or directly or indirectly influence flow to the CSOs and/or the WRTP. Therefore, in compliance with the Consent Decree, the entire "Model Area" is defined by the "Western Service Area" and "Central" portion of the "Eastern Service Area," since these areas are hydraulically connected to and/or directly or indirectly influent flow to teh CSOs and/or the WRTP. The remainder of the "Eastern Service Area" flows to the Philadelphia SW plant. This portion of the Eastern Service Area is not hydraulically connected to the WRTP and does not directly or indirectly influence plant flow at the DELCORA WRTP or to CSO outfalls in Chester City.
			1. (cont.) Financially and operationally, DELCORA controls the wastewater flows discharged from the Eastern Service Area and Western Service Area. In the Eastern Service Area, DELCORA owns and operates the three major pumping stations that transmit the wastewater from the Central Delaware County Authority, the Muckinipates Authority and the Darby Creek Authority. DELCORA is responsible for conveying the Eastern Service Area wastewater to DELCORA's WRTP via the DELCORA's central diversion force main or through DELCORA's eastern force mains to the City of Philadelphia's Southwest Water Pollution Control Plant (SWWPCP). DELCORA controls the wastewater flow from the DELCORA's Central Delaware Pump Station that goes either to the WRTP or to the SWWPCP. If flows to the central diversion force main exceed 20 MGD, DELCORA can divert the flow to the SWWPCP. If the flows from the three pump stations to the SWWPCP exceed the limits in the contract with Philadelphia, DELCORA can send more flow to the WRTP up to a maximum of 20 MGD. DELCORA has a contract with Philadelphia to pay for both treatment and a portion of Philadelphia's LTCP costs. As listed above, DELCORA owns the pump stations and force mains located within the Eastern Service Area that transmit wastewater to either the SWWPCP or the WRTP. DELCORA needs to revise the FCA to include the entire Eastern Service area, including the costs of sending wastewater flow to the Philadelphia treatment plant and related Philadelphia LTCP costs.	The Central Delaware Pump Station pumps flow only from the Central Delaware County Authority service area. Normally, flow from this pump station is pumped into the central diversion force main which conveys flow to the WRTP. When flows from this pump station exceed 20 MGD, the excess portion is diverted to the Philadelphia SWWPCP. However, flows from the Muckinipates And Darby Creek Joint Authority service areas do not pass through the Central Delaware Pump Station and cannot be diverted into the central diversion force main. Flows from the Muckinipates and Darby Creek pump stations are conveyed to the Philadelphia SWWPCP only. The only flow that can be diverted from the Eastern Service area to the WRTP is flow originating from the Central Delaware County Authority. As such, this portion of the of the Eastern Service Area is included in the Draft FCA.

DELCORA LTCPU Task 9: DRAFT Financial Capabilities Assessment Report (rev. Nov. 2016) Responses to USEPA and PADEP Concerns (Comments received February 23, 2017) DUE April 24, 2017				
No.	Reviewer Name	Report Reference	Review Concerns	Response to Concerns
2	EPA/PADEP	Pages 4-3 and 4-4	2. Allocation of Financial Capability Based on Wet Weather Flow Relative to Combined Sewers' Documentation. In response to our comment, DELCORA appears to have adjusted the analysis slightly with respect to taking a fuller engineering-based examination of a wide range of options involving the service area beyond Chester City. (Item 4 below also relates to this.) As EPA noted in its letter of September 15, 2016, DELCORA must consider, among other things, "inflow and infiltration to sanitary sewers that may occur during storm events and the impacts of the various control alternatives on such inflow and infiltration." The impact of the calculations described on pages 4-3 and 4-4 of the FCA on DELCORA's ultimate analysis and approach to resolving the CSO and other compliance issues remains unclear. The FCA needs to have a more detailed and transparent explanation of the basis for the calculations and the calculations' impact on the analysis and approach to resolving CSO and other compliance issues.	As described on page 4-3 of the revised report, allocation of costs was based on the customer contribution to CSO volume as well as excess volume generated from separate sewer communities. A review of the WRTP hourly flow records were used to estimate allocation for wet weather flows as the basis to assign costs to communities served by separate sewer systems. The original calculations are based on the hourly records and indicated that 3% of the wet weather flow would have been allocated to other communities and 97% to Chester City. In order to be conservative, this was revised for the draft FCA to be 15% to other communities and 85% to Chester City.The basis for calculation of the allocation along with the backing flow data is included in the revised Appendix. Also, as mentioned in the Draft FCA, the allocation will be revised for the final FCA (to be included as part of the revised LTCP Update) based on the updated, calibrated, and validated hydrologic and hydraulic model. Regarding "...impacts of various control alternatives...," please note that no alternatives have been considered at this time since the Draft FCA is being prepared prior to the LTCP alternative analysis. Alternatives will be presented in the LTCP Update and the FCA will be revised as necessary as part of the LTCP Update.
3	EPA/PADEP	Appendices 6 through 13	3. Backup for Current and Demographic Data. The FCA's Appendices 6 through 13 are partially responsive to EPA's request for detailed backup to the FCA computations. These Appendices include source documents without any explanation or citations of the derivation of the computations in the FCA analysis for the "Model Area." To expedite EPA's review of DELCORA's FCA, we request that DELCORA provide the spreadsheets supporting the FCA calculations, including identification of specific source data and computations. Also note that the Financial Capability Indicator should be for the permit holder, DELCORA, not for Chester City.	Additional explanation for the material in the Appendices has been added. In addition to the Chester City Financial Capability Indicator, the Draft FCA also shows Financial capability indicators for the Model Area.

DELCORA LTCPU Task 9: DRAFT Financial Capabilities Assessment Report (rev. Nov. 2016) Responses to USEPA and PADEP Concerns (Comments received February 23, 2017) DUE April 24, 2017				
No.	Reviewer Name	Report Reference	Review Concerns	Response to Concerns
4	EPA/PADEP		4. Allocation of Costs to Chester City: EPA's September 15, 2016 letter expressed concern that DELCORA was proposing to assign the bulk of the CSO costs to Chester City, an area which accounts for a small percentage of the Model Area households and flow. In the FCA, it appears that DELCORA has slightly adjusted its allocation of costs, but persists in allocating wastewater treatment costs and combined sewer overflow costs specific to Chester City in a proportion greater than Chester City's size relative to the service area flow or households. As a result, Chester's cost per household ($323 on 2015 basis) is significantly higher than the cost per household for the Model Area ($279 on 2015 basis). DELCORA explains the basis for this allocation on page 4-3 of the revised report: "...the allocation of costs for CSO abatement has been revised to distribute costs not to Chester City alone but rather to the Model Area customers in proportion to their contribution to CSO volume as well as excess volume generated from separate sewer communities within the Model Area during wet weather." While EPA accepts the analysis of the potential impact of the LTCP on residents of Chester City, an analysis that allocates all or much of the LTCP costs to Chester City is not acceptable. As the permittee, DELCORA is the responsible party for completing the injunctive relief, not Chester City. Therefore, the concerns EPA expressed in the September 15 letter remain. (EPA requests the underlying basis and calculations supporting the allocations of costs., and notes that the issues raised in Item 2, above, also relate to Item 4.) There are other details, such as cost basis, which EPA has not thoroughly reviewed due to the methodological shortcomings identified above. Thus, EPA may have additional comments on any resubmittals. According to paragraph 35 of the CD, DELCORA has sixty days in which to address these deficiencies and resubmit the revised report to EPA, and/or invoke the Dispute Resolution process set forth in Section XII of the CD.	As described on page 4-3 of the revised report, allocation of costs was based on the customer contribution to CSO volume as well as excess volume generated from separate sewer communities. The basis for calculation of the allocation along with the backing flow data is included in the revised Appendix. Also, as mentioned in the Draft FCA, the allocation will be revised for the final FCA (to be included as part of the revised LTCP Update) based on the revised hydrologic and hydraulic model. DELCORA believes that its “proportional” approach to allocating CSO costs is supported by the Clean Water Act and its implementing regulations. By way of example, when Congress wrote the CWA, it considered the contractual process and financial mechanisms by which wastewater treatment systems are financed and operated by local governmental authorities. By way of example, Section 204(b) of the Clean Water Act states that a wastewater treatment provider can only receive a federal construction grant if it charges the “recipients” of its services a commensurate, or proportional, amount to the services actually received. That section requires an applicant for the grant to have adopted a “system of charges” whereby each “recipient” of waste treatment services be charged its “proportionate share” of the costs of operation and maintenance of any waste water treatment services provided by the applicant. Similarly, the implementing regulations states that a user charge system shall be “based on the users’ proportionate contribution to the total waste water loading from all users.” (40 C.F.R. § 35.939-1). The legislative history to these provisions makes clear that Congress’s intent behind Section 204(b) was to provide localities with flexibility in designing user fee systems. As applied here, any plan to defray CSO costs should be proportionally charged to those who are served by and contribute to the CSO. Conversely, municipalities not contributing to or served by the CSO should not be charged unfairly because they are not serviced by the CSO. The allocation of costs proposed by DELCORA is both proportional and equitable. In addition, it is important that EPA consider the fact that the FCA Guidance states that the two-phase analysis set forth in the FCA Guidance may not provide a complete representation of financial capability, and that other relevant financial or demographic information might demonstrate atypical circumstances. For example, as EPA and DOJ know well, the Eastern Service Area is required to pay the fees associated with the Philadelphia LTCP which has increased substantially from the original amount of $178 Million to over $400 Million (documented in a 2/8/2017 letter to EPA Counsel Yeany). Accordingly, DELCORA will not be considering those municipalities within the Eastern Service Area as responsible towards paying for costs associated with the LTCP for the Western Service Area and plant. In fact, during the consent decree negotiations, both EPA and DOJ were receptive to allowing DELCORA to consider factoring in this specific information into the FCA as supporting DELCORA’s reason not to impose charges on all municipalities.

APPENDIX S

FCA Supplement August 2017

- DELCORA Precedents for DELCORA's FCA Methodology dated August 16, 2017
- Appendix A - Case Studies
- Appendix B - EPA Combined Sewer Overflows - Guidance for Financial Capability Assessment and Schedule Development - Final
- Appendix C - USEPA Financial Capability Assessment Framework for Municipal Clean Water Act Requirements dated November 24, 2014
- Appendix D - Separate Sewer Flow to WWTP Slides
- E-Mail from Margaret Hill (Blank Rome) to USEPA Regarding DELCORA/DRAFT FCA dated August 17, 2017

DELCORA CSO Long Term
Control Plan Update

Precedents for DELCORA's FCA Methodology

Delaware County Regional Water Quality Control Authority

August 16, 2017

GREELEY AND HANSEN

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Section 1 Introduction

The development of and timing for the implementation of a LTCP should be based upon the true affordability of the community and how the CSO LTCP will be financed, which means that all customers in the wastewater service area must pay their fair share of all the services provided by the Authority, including the wholesale customers. Most communities develop rates based on a cost of service to achieve "approval" from the community and their wholesale customers, especially when significant rate increases are required and all users want to understand why their wastewater bill has doubled or tripled. Most Financial Capability Assessments (FCAs) have not used cost of service as an approach because there was either insufficient information available at the time the FCA was developed or there was not enough time to discuss cost sharing options with wholesale customers. More recently, however, cost of service approach has been developed and used by CSO communities with advanced CSO LTCPs that serve as a "lessons learned" for those communities that will need to prepare a future FCAs.

1.1 Purpose

The DELCORA Financial Capability Assessment incorporates unique financial circumstances requiring local considerations and approaches that require the flexibility offered by EPA's 1997 FCA Guidance and the EPA's 2014 FCA Framework. The two purposes of this technical memorandum and the case studies are (1) to identify precedents for DELCORA's FCA approach and (2) provide lessons learned from how Wholesale Customers actually shared in the LTCP costs that could be incorporated into the DELCORA FCA, which better reflects the true affordability for the communities.

1.2 DELCORA's Financial Capability Assessment Objectives

The complexity of DELCORA's service area, number of municipalities, authorities, and industries, and the DELCORA service agreement with the Philadelphia Water Department (PWD) offers unique challenges. To manage these challenges, DELCORA has developed clear objectives for the development of the FCA and identifies a path to minimize financial risks. The FCA objectives are as follows:

- Objective #1: Comply with DELCORA's 2015 Consent Decree regarding the development and implementation of the Long-Term Control Plan for the CSOs in Chester City.
- Objective #2: Develop the DELCORA LTCP Financial Capability Assessment consistent with current rate making practices which are based on industry standard approaches.
  - Allocate LTCP costs in a fair and equitable manner for all DELCORA customers.
  - Calculate LTCP cost allocations based on each municipality, authority, and industrial customer's contribution to the problem (i.e., share of the wet weather volume discharged).
- Objective #3: Minimize DELCORA's financial risks:
  - Minimize the potential loss of an industrial customer. Since industrial flows are ~24% of DELCORA's WRTP flow, loss of an industrial customer would result in an economic loss for the community as the remaining customers would absorb a larger share of fixed costs.
  - Avoid potential litigation from wholesale and industrial customers associated with unfair rate increases or inequitable rate making practices.
  - Minimize potential withdrawal of municipalities, industries, and authorities from the DELCORA facilities (i.e. municipality, industry, or authority could decide to construct its own new WWTP).
  - Allow for a detailed planning model that will allow DELCORA to predict the need for phased-in rate increases that will not result in any large, one-time increases to rates.

Section 2 Financial Capability Assessment Approach

2.1 Flexibility Allowed by EPA Financial Capability Guidance

2.1.1 EPA's 1997 CSO – Guidance for Financial Capability Assessment and Schedule Development

EPA's 1997 Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development (EPA 1997 FCA Guidance) provides a basic framework for preparing the CSO community's Financial Capability Assessment, which is used to facilitate discussions between the permittees and the governmental authorities on phasing in CSO controls and establishes a reasonable implementation schedule based in part on the community's affordability. The EPA 1997 FCA Guidance consistently highlights the importance of "flexibility" in the development of the CSO community's LTCP and FCA. Excerpts from EPA 1997 CSO FCA Guidance are provided in **Table 2-1**.

2.1.2 EPA's 2014 Financial Capability Assessment Framework for Municipal Clean Water Act Requirements

EPA's 2014 Financial Capability Assessment Framework for Municipal Clean Water Act Requirements (EPA 2014 FCA Framework) provided greater clarity on the flexibilities that were already built into the existing 1997 CSO FCA Guidance (See highlighted sentence in Item 1 of **Table 2-2**). Excerpts from EPA 2014 FCA Framework, provided in **Table 2-2**, show the flexibility to calculate the financial metrics differently from the schedules in the EPA 1997 CSO FCA Guidance.

2.2 Unique Financial Circumstances for DELCORA's CSO LTCP FCA

The EPA 2014 FCA Framework's purpose was to provide greater clarity on the flexibilities already built into the EPA 1997 FCA Guidance. Accordingly, the approaches to DELCORA's unique financial circumstances, as shown in **Table 2-3**, are consistent with and acceptable under the EPA 1997 CSO FCA Guidance.

Table 2-3 (below) shows the unique features of the DELCORA FCA and describes the approach used in the FCA.

Table 2-1: EPA 1997 CSO FCA Guidance and Example of DELCORA's Unique Financial Circumstances

Item	Flexibility from EPA 1997 FCA Guidance	Example of DELCORA's Unique Financial Circumstance
1	Section I. "Introduction", Page 7; "**It must be emphasized that the financial indicators found in this guidance might not present the most complete picture of a permittee's financial capability to fund the CSO controls.** *(emphasis added)* However, the financial indicators do provide a common basis for financial burden discussions between the permittee and EPA and state NPDES authorities. **Since flexibility is an important aspect of the CSO Policy, permittees are encouraged to submit any additional documentation that would create a more accurate and complete picture of their financial capability**. *(emphasis added)*"	• DELCORA serves 44 municipalities and 14 major industries. There is a risk of losing wholesale or industrial customers if costs are not allocated to all customers in a transparent, fair and equitable manner. • The EPA 1997 CSO FCA Guidance does not present the complete picture of the complexity of allocating all costs for services to all of DELCORA's retail and wholesale customers in a fair and equitable manner.
2	Section II. "CSO Financial Capability Assessment Approach", Page 10; "Since flexibility is an important component of the CSO Policy, WQS authorities, NPDES authorities, EPA personnel, and permittees should communicate throughout the CSO control planning process to coordinate the development of an effective LTCP. **This guidance document provides all CSO participants with a structured yet flexible approach for evaluating the financial burden CSO controls place on permittees, it also recognizes the importance of this financial burden when establishing a CSO control implementation schedule.** *(emphasis added)* The financial capability information developed in this guidance provides a basis for the permittee and the NPDES authorities to negotiate the implementation schedule for the CSO controls. **However, when a permittee believes that there are unique circumstances that would affect the conclusion of this guidance, the permittee may submit documentation of its unique financial conditions to the appropriate EPA or State NPDES authorities for consideration.** *(emphasis added)*"	• Chester City is the only municipality with a combined sewer system and is the poorest municipality in the service area. • The City of Chester is a financially distressed municipality as defined by the 1987 Financially Distressed Municipalities Act 47 (Act 47). Chester City continues to have budget deficits and remains in the Act 47 program until their financial health improves.

Table 2-1: EPA 1997 CSO FCA Guidance and Example of DELCORA's Unique Financial Circumstances (Continued)

Item	Flexibility from EPA 1997 FCA Guidance	Example of DELCORA's Unique Financial Circumstance
3	Section III. "Phase One: The Residential Indicator", Page 19; "**In situations where a permittee believes that there are unique circumstances that would affect the conclusion of the first phase, the permittee may submit documentation of its unique financial conditions to the appropriate state NPDES and EPA authorities for consideration.** *(emphasis added)*"	• DELCORA has several unique circumstances that would affect the conclusion of the first phase (residential indicator), which include; ○ DELCORA serves 44 municipalities and 14 major industries that require fair and equitable cost allocations based on services provided. ○ DELCORA allocates current costs to retail, wholesale, and industrial customers based on annual wastewater volume for each customer and water consumption. ○ Chester City is the only combined sewer system. ○ Chester City is the poorest community. ○ Chester City is located in the Western Service Area. ○ The bedrock principle of rate setting is COST CAUSATION – assigning costs to those customers who cause the costs. ○ DELCORA only operates a few collection systems. Costs for collection systems not operated by DELCORA are accounted for separately. • **Table 2-3** provides approaches to DELCORA's unique circumstances.

Table 2-1: EPA 1997 CSO FCA Guidance and Example of DELCORA's Unique Financial Circumstances (Continued)

Item	Flexibility from EPA 1997 FCA Guidance	Example of DELCORA's Unique Financial Circumstance
4	Section IV. "Phase Two: Permittee Financial Capability Indicators", Page 20; Even though the financial capability analysis reflects current conditions, pending changes in the service area should be considered in development of the second phase indicators. For example, if the current unemployment rate is high, but there is a new plant opening that will stimulate economic growth, the unemployment indicators for the service area would need to be modified to reflect the projected impact of the new plant. The permittee should submit documentation of such conditions to the appropriate EPA and state NPDES authorities for consideration. **When the permittee is a sanitary district, sewer authority or similar entity, the second phase indicators related to property values and tax revenues may not be applicable. In those circumstances, the permittee may simply use the remaining indicators or submit other related documentation that will help assess its financial capability to implement the CSO controls.** *(emphasis added)*"	• As an authority, DELCORA does not have the ability to generate revenue by increasing tax rates on real estate or personal property to fund CSO improvements.
5	Section IV. "Phase Two: Permittee Financial Capability Indicators", Page 36, **In situations where a permittee believes that there are unique circumstances that would affect the conclusion of the second phase, the permittee may submit documentation of its unique financial conditions to the appropriate EPA and state NPDES authorities for consideration.** *(emphasis added)* The purpose of additional information is to clarify unique circumstances which are not fairly represented by the overall scores of the selected indicators. An example could be where a state or community imposes restrictions on property taxes.	• The City of Chester is a financially distressed municipality as defined by the 1987 Financially Distressed Municipalities Act 47 (Act 47). Chester City continues to have budget deficits and remains in the Act 47 program until their financial health improves.

Table 2-2: EPA 2014 CSO FCA Framework and Example of DELCORA's Unique Financial Circumstances

Item	Flexibility from EPA 2014 FCA Framework	Example of DELCORA's Unique Financial Circumstance
1	"**Purpose**", Page 1; "This financial capability assessment framework is intended to provide additional examples and **greater clarity on the flexibilities built into existing guidance that local governments or authorities can use in assessing their financial capability** *(emphasis added)*, and the relationship between that assessment and consideration of schedules for permit and consent decree implementation. This framework builds on the progress already made in the May 2012 "Integrated Municipal Stormwater and Wastewater Planning Approach Framework," and the **experience gained from talking with communities about their financial capability in actual, on the ground circumstances**. *(emphasis added)* Integrated Planning has been helping in identifying a permittee's relative priorities for projects based on the relative importance of adverse impacts on human health and water quality and the municipality's financial capability."	• The EPA 2014 CSO FCA Framework clarifies the flexibilities that are already included in the EPA 1997 FCA Guidance. Therefore, the approaches to DELCORA's unique financial circumstances, as shown in **Table 2-3**, are consistent with and acceptable under the EPA 1997 CSO FCA Guidance.

Table 2-2: EPA 2014 CSO FCA Framework and Example of DELCORA's Unique Financial Circumstances (Continued)

Item	Flexibility from EPA 2014 FCA Framework	Example of DELCORA's Unique Financial Circumstance
2	**"Financial Capability Assessment"**, key element No. 1, Page 2; **"The 1997 FCA Guidance identifies a valuable assessment that provides a common basis for financial burden discussions between the permittee, EPA and state NPDES authorities. Permittees have the option of submitting additional information that would create a more accurate and complete picture of their financial conditions.** The financial capability assessment described in the 1997 FCA Guidance identifies information that provides a basis for a general comparison of financial conditions between communities across the country and provides a consistent assessment of basic financial indicators as part of the overall analysis. **Additional information that the community provides on its unique financial circumstances will be considered so that schedules take local considerations into account. Where appropriate, this information can result in schedules that are different than the schedules suggested by the baseline analysis suggested in the 1997 FCA Guidance."** *(emphasis added)*	• DELCORA has several unique circumstances that affect the conclusion of the residential indicator phase and require slight modifications to schedules in the EPA 1997 CSO FCA Guidance, which include; ○ DELCORA serves 44 municipalities and 14 major industries that require fair and equitable cost allocations based on services provided ○ DELCORA allocates current costs to retail, wholesale, and industrial customers based on annual wastewater volume for each customer and water consumption. ○ Chester City is the only combined sewer system ○ Chester City is the poorest community ○ Chester City is located in the Western Service Area ○ DELCORA only operates a few collection systems. Costs for collection systems not operated by DELCORA are accounted for separately. • **Table 2-3** provides approaches to DELCORA's unique circumstances, which creates a more accurate and complete picture of DELCORA's financial conditions.

Table 2-2: EPA 2014 CSO FCA Framework and Example of DELCORA's Unique Financial Circumstances (Continued)

Item	Flexibility from EPA 2014 FCA Framework	Example of DELCORA's Unique Financial Circumstance
3	**"The Financial Capability Assessment Guidance and Examples of Additional Information that are Relevant to a Consideration of Financial Capability"**, Pages 5 and 6; "The examples given below are not intended to be a complete list, nor a list of factors that will be relevant in every community. Rather it provides an illustration of information that may prove useful in some instances. Examples of Information Related to Residential Impacts: 1. **Income distribution by quintile, geography or other breakdown, illustrating how income distribution in the service area differs from comparable data on the national level or for similar cities.** *(emphasis added)* 2. Where cities have adopted differential rates for low income customers, the income distribution that led to that rate structure. 3. **Information about service area poverty rates and trends.** *(emphasis added)* 4. Projected, current and historical sewer, and stormwater fees as a percentage of household income, quintile, geography or other breakdown. 5. Information on sewer and water usage for various classes of ratepayers or by type of dwelling unit. Examples of Information Related to Financial Strength: 1. Historical population trends or population projections. 2. Service area unemployment data and trends, or other labor market indicators, including unemployment on an absolute basis. 3. **Rate or revenue models, including dynamic financial planning models showing the projections of impacts over the program period. All revenue sources tied to CWA obligations may be included as appropriate."** *(emphasis added)*	• Chester City is the only municipality with a combined sewer system and is the poorest municipality in the service area. • The City of Chester is a financially distressed municipality as defined by the 1987 Financially Distressed Municipalities Act 47 (Act 47). Chester City continues to have budget deficits and remains in the Act 47 program until their financial health improves. • When comparing the median household income for the Chester City between the decennial censuses, Chester City's median household income is not keeping up with rate of inflation. • DELCORA serves 44 municipalities and 14 major industries that require fair and equitable cost allocations based on services provided. Since the DELCORA FY2016 financial model already includes methodologies to allocate conveyance and dry/wet weather treatment costs in an industry standard fair and equitable manner that is consistent with current rate making practices and includes the timeframe when debt service will retire, DELCORA's approach is to use the FY2016 financial model to calculate the Cost per Household by municipality.

Table 2-3: Unique Financial Circumstances for DELCORA's CSO LTCP FCA

Item	Unique Circumstance	Financial Consideration	DELCORA's FCA Approach	Comments
1	DELCORA serves 44 municipalities and 14 major industries.	Approach required to allocate conveyance and dry/wet weather treatment costs in fair and equitable manner that is consistent with current rate making practices.	• Adapt existing FY2016 financial model to calculate the DELCORA's portion of Cost per Household for each municipality/ authority/ industry. • Calculate equivalent residential households based on 55,000 gallons per year per household.	
2	Chester City is the only municipality with a combined sewer system.	Approach required to allocate CSO LTCP costs in fair and equitable manner that minimizes the risk of losing a municipality/ authority/ industry	• Establish Peak Wet Weather Flow Targets for each municipality/ authority/ industry. • Total annual excess wet weather volume is the summation of annual excess wet weather volumes above flow targets plus the annual volumes discharged from the CSO Outfalls. • Municipalities/ authorities/ industries share of CSO LTCP costs would be based on their annual excess wet weather volume above their flow target divided by the total annual wet weather volume.	ALCOSAN is employing a similar approach for sizing their regional wet weather facilities, which will most likely result in updating wholesale customer cost sharing methodology.
3	Chester City is the poorest municipality in service area.	The Chester City MHI is $27,249 in 2013 dollars and is a distressed community.	• Show columns for both Chester City and Model Area in the FCA calculations • Overall affordability should be based on Chester City	
4	Chester City is located in the Western Service Area and flows to the Western Regional Treatment Plant.	Municipalities/ authorities/ industries in Eastern Service Area flow to PWD's SW WPCP, do not contribute flow to DELCORA's WRTP, and therefore are not included in the Model Area.	Exclude from the FCA municipalities/ authorities/ industries in the Eastern Service Area that do not contribute flow to DELCORA's WRTP.	
5	DELCORA does not own or operate all of the wastewater collection systems in the service areas.	• Wastewater collection systems not operated by DELCORA are billed separately to residential customers. • A few municipalities fund wastewater collection systems through their general fund and exact costs to residential customers are not known.	• Add wastewater collection system costs to the Cost per Household calculation for municipalizes / authorities who own and operate their collection system. • If collection system costs are not known, use the same unit charge for collection system renewal / operation as the DELCORA retail customers.	
6	DELCORA does not own or operate the stormwater system	Most municipalities fund stormwater systems through their general fund and exact costs to residential customers are not known.	Added stormwater system costs to the Cost per Household calculation, which is based on the average fee from a national survey.	

2.3 DELCORA's Approach for Allocating LTCP Costs to Municipalities, Authorities, and Industries

System Configuration

DELCORA has two service areas (Western and Eastern) that are served by two wastewater treatment plants; DELCORA's Western Regional Treatment Plant (WRTP) and PWD's Southwest Water Pollution Control Plant (SW-WPCP) as shown in **Figure 2-1**. All the flows (dry and wet weather) in the Western Service Area flow to DELCORA's WRTP. The Eastern Service Area is comprised of four Authorities – Central Delaware County Authority, Muckinipates Authority, Radnor-Haverford-Marple Authority, and Darby Creek Joint Authority. All the flows (dry and wet weather) from the Muckinipates Authority, Radnor-Haverford-Marple Authority, and Darby Creek Joint Authority flow to PWD's SW-WPCP. The first 20 mgd of flow, which includes all of the dry weather flow and a majority of the wet weather flow, from the Central Delaware County Authority is conveyed to DELCORA's WRTP and the remaining flows (primarily high wet weather flows) are conveyed to PWD's SW-WPCP though a valve operation on the Eastern Force main.

Unique Financial Circumstance

Since DELCORA serves 44 municipalities and 14 major industries, only operates a few of the wastewater collection systems (only in the Western Service Area), and fair and equitable cost allocations for industries and authorities are required, DELCORA has developed a financial model to allocate costs for services provided to retail customers and wholesale customers (industries, municipalities, and authorities). The financial model has been modified to serve as the basis to calculate the Cost per Household required under the EPA's 1997 FCA Guidance and the 2014 FCA Framework. The EPA 2014 FCA Framework specifically recognized that schedules/worksheets that account for the local considerations associated with unique financial circumstances may be different from the schedules/worksheets shown in the EPA 1997 FCA Guidance (See EPA 2014 FCA Framework, **"Financial Capability Assessment"**, Key Element No. 1, at Page 2).

Current debt service, O&M costs, and future renewal costs for the facilities that serve all current permitted Clean Water Act requirements have been allocated to all the DELCOA customers in a fair and equitable manner in the base financial model. **Figure 2-2** shows how the two LTCPs (Chester City LTCP and DELCORA's portion of PWD LTCP) will be assigned to the customers in the FCA financial model.

DELCORA has completed the model calibration and has initial flow results from the calibrated model for the climate period of 1994 through 1996. **Appendix D** shows how the separate sewer system flows were calculated from the model results and includes the hydrographs for the period between 1994 and 1996. The horizontal dashed line on the hydrographs represents the collective wet weather flow target for the WRTP model area. **Table 2-4** summarizes the annual CSO volume and the annual excess wet weather volume from the separate sewer system. The separate sewer system is functionally increasing the CSO volume by 8.2% to 11.6%. Therefore, separate sewer system's share of the Chester City CSO problem should remain about 15% for planning purposes. This evaluation should be updated after future dry weather flow projections are added to the model and the recommended CSO control alternatives are selected.

Figure 2-1
DELCORA's Approach to Allocating LTCPs Costs by Service Area

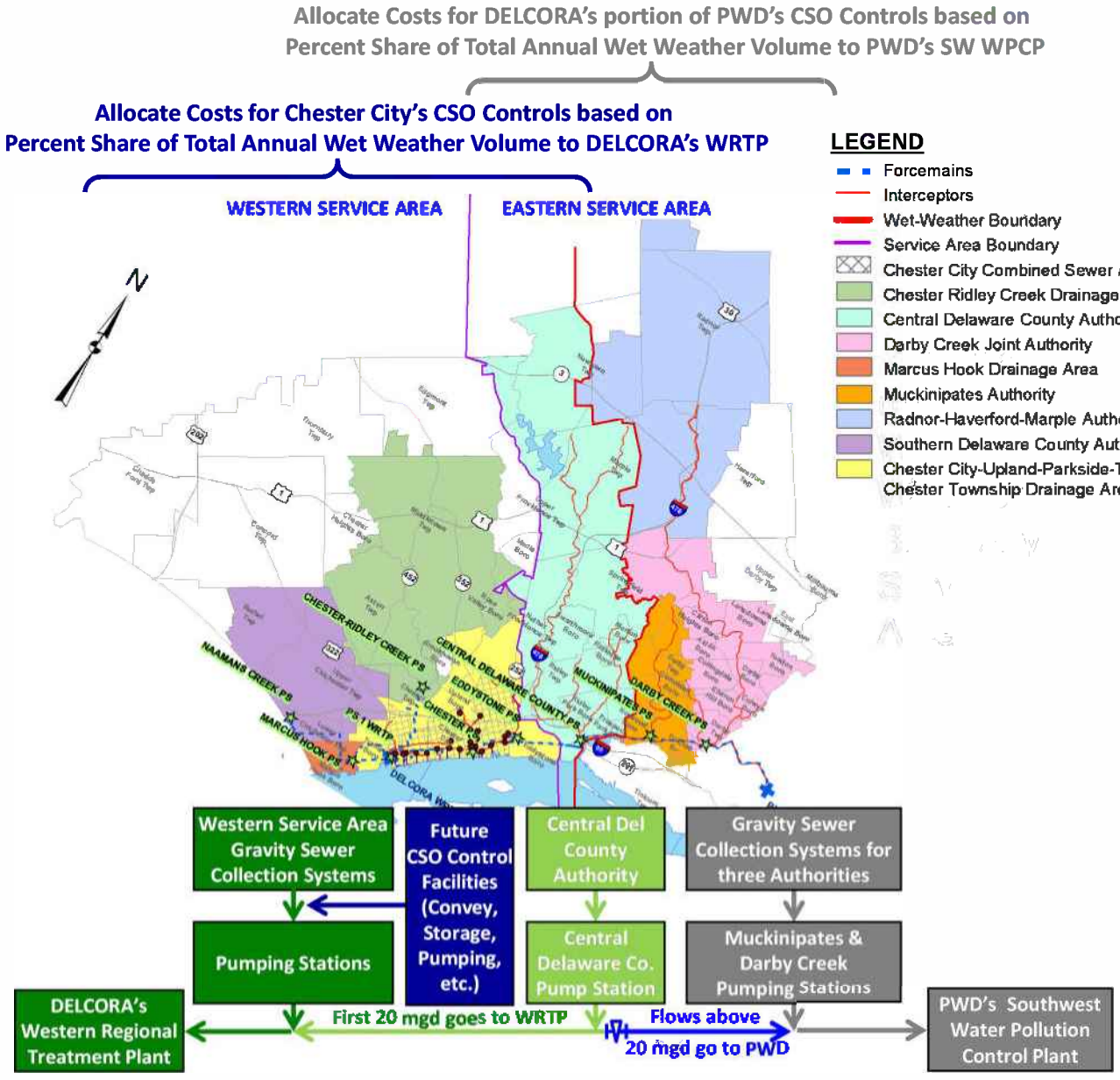


Figure 2-2
DELCORA's Approach to Allocating LTCP Costs by Customer

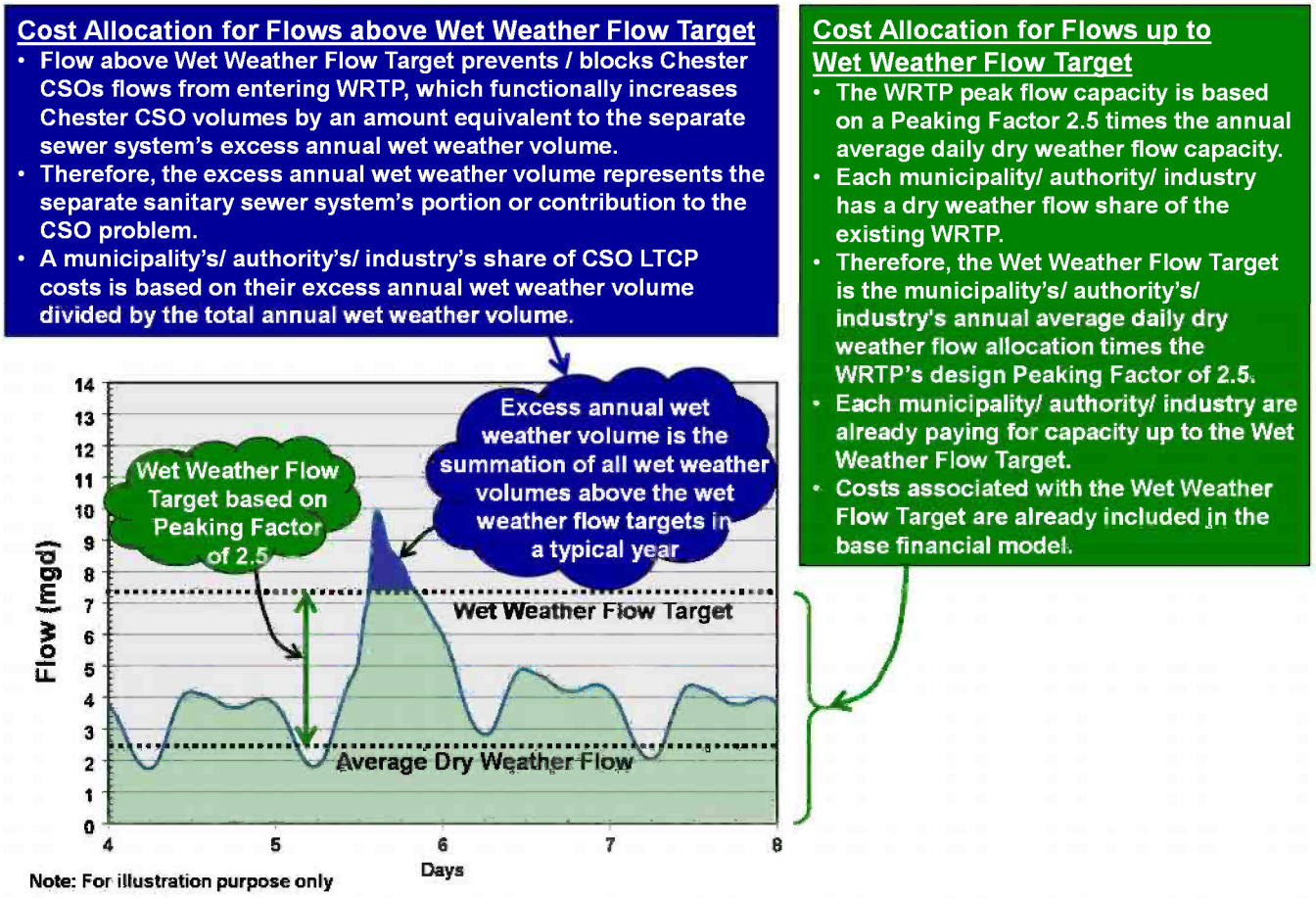


Table 2-4:
Basis for Allocating LTCP Costs for CSOs in Chester City

Year	A Annual CSO Volume (MG)	B Excess Wet Weather Volume from Separate Sewer System (MG)	C = A +B Total Excess Wet Weather Volume (MG)	D = A / C Annual CSO Volume (%)	E = B / C Excess Wet Weather Volume from Separate Sewer System (%)
1994	327	34	361	90.7%	9.3%
1995	201	18	219	91.8%	8.2%
1996	371	49	420	88.4%	11.6%
Average	300	33	333	90.0%	10.0%

Section 3 FCA Case Studies for Precedents and Lessons Learned

The DELCORA FCA has unique financial circumstances requiring local considerations and approaches that require the flexibilities offered in the EPA 1997 FCA Guidance and the EPA 2014 FCA Framework. The two purposes of the case studies are (1) to identify precedents for DELCORA's FCA approaches and (2) provide lessons learned from how Wholesale Customers actually shared in the CSO costs that could be incorporated into the DELCORA FCA, which reflects the true affordability for the communities. CSO Communities were surveyed for the following information:

- Provide CSO Community characteristics
- Summarize the most recent FCA
  - How were Wholesale Customers incorporated into the FCA?
  - Where there any Unique Financial Circumstances or precedent setting approaches that were allowed under the EPA 1997 FCA Guidance or EPA 2014 FCA Framework?
- Describe how the CSO Community paid for the CSO LTCP?
  - Were Municipal Service Agreements re-negotiated?
  - How were CSO LTCP costs allocated to the Wholesale Customers?
  - What was the outcome of allocating CSO costs to the Wholesale Customers?
- Lessons Learned for future FCAs

3.1 Case Study Results

The communities surveyed have advanced CSO control programs with wholesale customers who pay a portion of the CSO LTCP costs. The four CSO case studies have the following relevant features to the DELCORA FCA:

- Case Study #1 – DC Water:
  - Original FCA did not include wholesale customers.
  - Multi-year process to update service agreements where wholesale customers agreed to pay their fair share of the CSO LTCP, which is based on same excess annual wet weather volume approach proposed by DELCORA.
  - 2015 FCA based on financial model that included wholesale customers' cost share.
- Case Study #2 – PWD:
  - PWD's FCA did not include wholesale customers.
  - PWD wholesale customer CSO LTCP cost share is flow based.
  - DELCORA is the major wholesale customer and has direct knowledge of the process to engage a separate sewer community in cost sharing of CSO controls.
- Case Study #3 – Indianapolis:
  - Indianapolis' FCA did not include wholesale customers.
  - Indiana Utility Regulatory Commission required Indianapolis-based Citizens Energy Group to update service agreements such that the Wholesale Customers pay their fair share.

- Case Study #4 – Anderson, Indiana:
  - Anderson FCA rigorously conformed to the EPA 1997 FCA Guidance
  - FCA assigned CSO costs allocated to all residential households, including residential households in wholesale customer service areas.

The CSO case studies are provided in **Appendix A**. A high level summary of the case studies is shown in **Table 3-1**, comparison with DELCORA's FCA approaches are shown in **Table 3-2**, and lessons learned are provided in **Section 3.3**, below.

Table 3-1
Summary of Case Studies

Description	DC Water	PWD	Indiana-polis	Anderson
Combined Sewer System Size in acres	12,400	40,960	35,000	4,700
Total Service Area in acres	464,000	87,040	177,500	10,500
CSO Control Program Capital Costs	$ 2.6 B	$ 3.5 B[1]	$ 2.0 B	$ 161 M
Municipal Service Agreements	8	10	6	2
Industrial Customers	52 SIUs			9
When was FCA prepared?	2002 & 2015	2009	2006	2010
Were Wholesale Customers included latest FCA?	Yes	No	No	Yes
Are Wholesale Customers paying for a portion of the CSO LTCP costs?	Yes	Yes	Yes	Yes
What percentage of CSO LTCP costs are being paid by Wholesale Customers?	7.1%	14.57%	7.95%	Unknown/ Not Calculated
What is the basis for Wholesale Customers share of CSO LTCP costs?	Excess Annual Wet Weather Volume	Peak Flow	Cost of Service based Peak Flow	Number of Households
Have any Wholesale Customers withdrawn from the service area and built their own wastewater treatment plant as result of the request to fund a portion of the CSO LTCP?	No	No[2]	No	Yes

Notes:
1. PWD's 2017 Bond Issue indicated that "As of the most recent projections, the total of the 25-year program is approximately $ 4.5 billion, of which approximately $ 3.5 billion are capital related costs and $ 1 billon are operation and maintenance costs."
2. DELCORA is PWD's largest wholesale customer. Based on the recent $ 4.5 billion estimate, DELCORA is considering other options, including the potential withdrawal from the PWD system and construction of a DELCORA Eastern Service Area Wastewater Treatment Plant.

3.2 Precedent for DELCORA's FCA Approaches

Many of the approaches employed to address the unique circumstances in the DELCORA FCA have been used by other CSO communities. **Table 3-2** shows the precedent of where the approach was used in other FCAs. There are a few circumstances, such as Items 4 and 5 in **Table 3-2**, which are only applicable to DELCORA's FCA and no precedents have been identified.

Table 3-2
Comparison of DELCORA's FCA Approach to other CSO Communities

Item	Unique Circumstance	DELCORA's FCA Approach	DC Water 2015 FCA	PWD 2009 FCA	Indianapolis 2006 FCA	Anderson 2010 FCA
1	DELCORA serves 44 municipalities and 14 major industries	Use Financial Model as basis for FCA calculations (future dollars, inflate MHI differently from O&M/Capital)	Financial Model (future dollars)	Financial Model (future dollars, inflate MHI differently from O&M/ Capital)	Financial Model (future dollars)	Did not use financial model
		Calculate equivalent residential households based on 55,000 gallons per year per household.			Used 65,000 gal per year	
2	Chester City is the only municipality with a combined sewer system.	Assign CSO Costs to Wholesale Customers base on annual wet weather volume above flow targets	Same approach as DELCORA FCA; Included in DC Water's Financial Model for 2015 FCA	Excluded Wholesale Customers from FCA	Excluded Wholesale Customers from FCA	Assigned CSO costs to all residential households
3	Chester City is the poorest municipality in service area.	Show impact on residential customers in most distressed community and overall WWTP service area	Yes	Yes	Yes	No (Only one burden level shown)
4	Chester City is located in the Western Service Area and flows to the Western Regional Treatment Plant.	Exclude municipalities/ authorities/ industries not tributary to Western Regional Treatment Plant	NA	NA	NA	NA
5	DELCORA does not own or operate all of the wastewater collection systems in the service areas.	Add wastewater collection system costs to the Cost per Household calculation for municipalizes / authorities who own and operate their collection system.	NA	NA	NA	NA
6	DELCORA does not own or operate the stormwater system	Add stormwater system costs to the Cost per Household calculation	Included DC specific stormwater fee	No	No	No

3.3 Lessons Learned

To understand the true affordability of the community the FCA should be based on how the LTCP will be financed, which means that all customers in the wastewater service area pay their fair share of all the services provided by the authority, including the wholesale customers. Most communities develop rates based on a cost of service to achieve approval from the community and their wholesale customers, especially when significant rate increases are required and customers want to understand why their wastewater bill double or tripled. Most FCA's have not used cost of service approaches because there was either insufficient information available at the time of the FCA or there was not enough time to discuss cost sharing options with wholesale customers. However, more recently, cost of service approaches have been developed by CSO communities with advanced LTCPs that serve as a "lessons learned" for the development of future FCAs.

3.3.1 Include Wholesale Customers in FCA with Clear / Defensible CSO Cost Share Basis

The Clean Water Act enforcement of EPA's 1994 CSO Control Policy required the larger CSO communities to develop LTCPs with FCAs and these CSO communities either did not have the information or the time to develop an approach for the CSO LTCP cost share with the wholesale customers. Therefore, most of these communities simply excluded the wholesale customers from the FCA, which was the case for DC Water's FCA prepared in 2002 and Indianapolis' FCA prepared in 2006. PWDs 2009 FCA also excluded the wholesale customers from the residential indicator calculation.

In the Indianapolis case, Indianapolis-based Citizens Energy Group (CEG) owns and operates the wastewater collection system, combined sewer system, and the wastewater treatment facilities. CEG sets wastewater rates that are regulated by the Indiana Utility Regulatory Commission. Currently, only Indianapolis City customers are paying for the LTCP. In 2013, CEG updated the cost of service assumptions to include the wholesale customer's share of the CSO LTCP. In the 2013 rate hearings the Indiana Utility Regulatory Commission required CEG to update the service agreements to eliminate the subsidy identified in the 2013 cost of service. In June 2017, CEG successfully re-negotiated new municipal service agreements that incorporated wholesale customer's share of the Indianapolis CSO LTCP costs. It should be noted that updating municipal service agreements was a contentious process, which required significant testimony from all parties involved before the Indiana Utility Regulatory Commission over the four year negotiations. Ultimately, CEG's success was due to transparent cost of service based approaches that allowed for wholesale customer buy-in and regulatory approval. CEG indicated that future FCAs (required by CEG's NDPES permit and Consent Decree) would include wholesale customers 7.98% share of the Indianapolis LTCP costs, which is based on cost of service.

In the DC Water case, the Inter-Municipal Agreement was updated in 2012 and became effective in 2013, which more clearly documented the wholesale customer's share of LTCP. The process to update Inter-Municipal Agreement started in 2008 and required several stakeholder meetings to document to the wholesale customers why and how they contributed to the CSO problem. Ultimately, DC Water was able to convince the wholesale customers that they needed to pay their fair share of the LTCP based on the flow data used to calibrate the hydrologic and hydraulic model and that the wholesale customers were exceeding their contract peak flow requirements (i.e. wet weather flow targets). DC Water recently modified their Consent Decree with EPA/DOJ to include a Green Infrastructure component using the 2012 Integrated Planning Framework. The FCA in DC Water's 2015 "Long Term Control Plan Modification for Green

Infrastructure" was based on the EPA 2014 FCA Framework, which allowed DC Water to show the affordability of the LTCP using methods that are different from EPA 1997 FCA Guidance. DC Water's 2015 FCA was based on a financial model that include the wholesale customer's 7.1% cost share of the LTCP. The approached DC Water used to allocate LTCP costs to the wholesale customers is the same approach proposed by DELCORA.

The lessons learned include:

- FCAs should be based on how the CSO LTCP will be funded and financed.
- Wholesale customers should be included in the FCA based on their share of the CSO problem.
- Industry standard cost of service based approaches are required to achieve wholesale customer buy-in and to understand the true affordability of the community.

3.3.2 Risk Management

Wholesale (industrial and municipal) service agreements are a two way street with benefits to both parties. Each party understands that operating one system results in lower costs for all parties due to economies of scale (i.e. fewer operation staff required to operate a single WWTP, only one WWTP laboratory and administration building is required, etc.). As long as costs for services are shared in a fair and equitable manner all the parities share in the cost savings. However, there are risks associated with not sharing costs in a fair and equitable manner, which are summarized as follows:

- Loss of an industrial customer
  - An industry leaving the community would be an economic loss on multiple fronts.
    - Loss of tax revenue from industry for the local government that fund schools, roads, police, firefighters, etc., would increase taxes on citizens to provide same services.
    - Loss of local jobs may result in people leaving the community, which places further burden on the remaining citizens.
  - Increase wastewater rates due to reduction in wastewater flows.
    - Debt service and the majority of operation and maintenance costs (labor and equipment maintenance, etc.) are fixed costs, and higher wastewater rates would be required to produce the same revenue needed to renew, operate and maintain the constructed facilities.

- Law suits from wholesale and industrial customers regarding unfair or unequitable rate making practices.
  - If wholesale and industrial customers determine that CSO costs are not being allocated in fair and equitable manner, the wholesale and industrial customers could challenge the cost allocations / rates in court.
  - If the court finds that CSO LTCP cost share were unfair or unequitable, then:
    - The CSO LTCP costs would have to be allocated to the remaining customers.
    - The CSO LTCP FCA would have not been a true reflection of community's affordability.

- Withdrawal of municipal wholesale customer
  - A municipality or authority may determine that it is cheaper to construct new WWTP than to continue to participate in the larger system. Similar to loss of industrial customer, higher wastewater rates would be required to produce the same revenue needed to renew, operate and maintain the constructed facilities.
  - Overall impact is that entire community would pay more for wastewater service due to the loss of the economy of scale.

In the case of Philadelphia Water Department (PWD), the 2009 FCA indicated that "residential indicator is based on the retail cost of wastewater service for households in the City of Philadelphia served directly by PWD". However, Table 4 in the City of Philadelphia, Water and Wastewater Revenue Bonds, Series 2017A indicates that wholesale customer share of the PWD's CSO LTCP costs is 14.57%. Table 4 also shows that DELCORA's share is 9.44% of the PWD CSO LTCP costs. PWD is allocating costs to the wholesale customers based on peak flow. DELCORA is currently evaluating if the 9.44% share of the PWD CSO LTCP costs is fair and equitable or if it cheaper to build a new DELCORA owned eastern service area wastewater treatment plant.

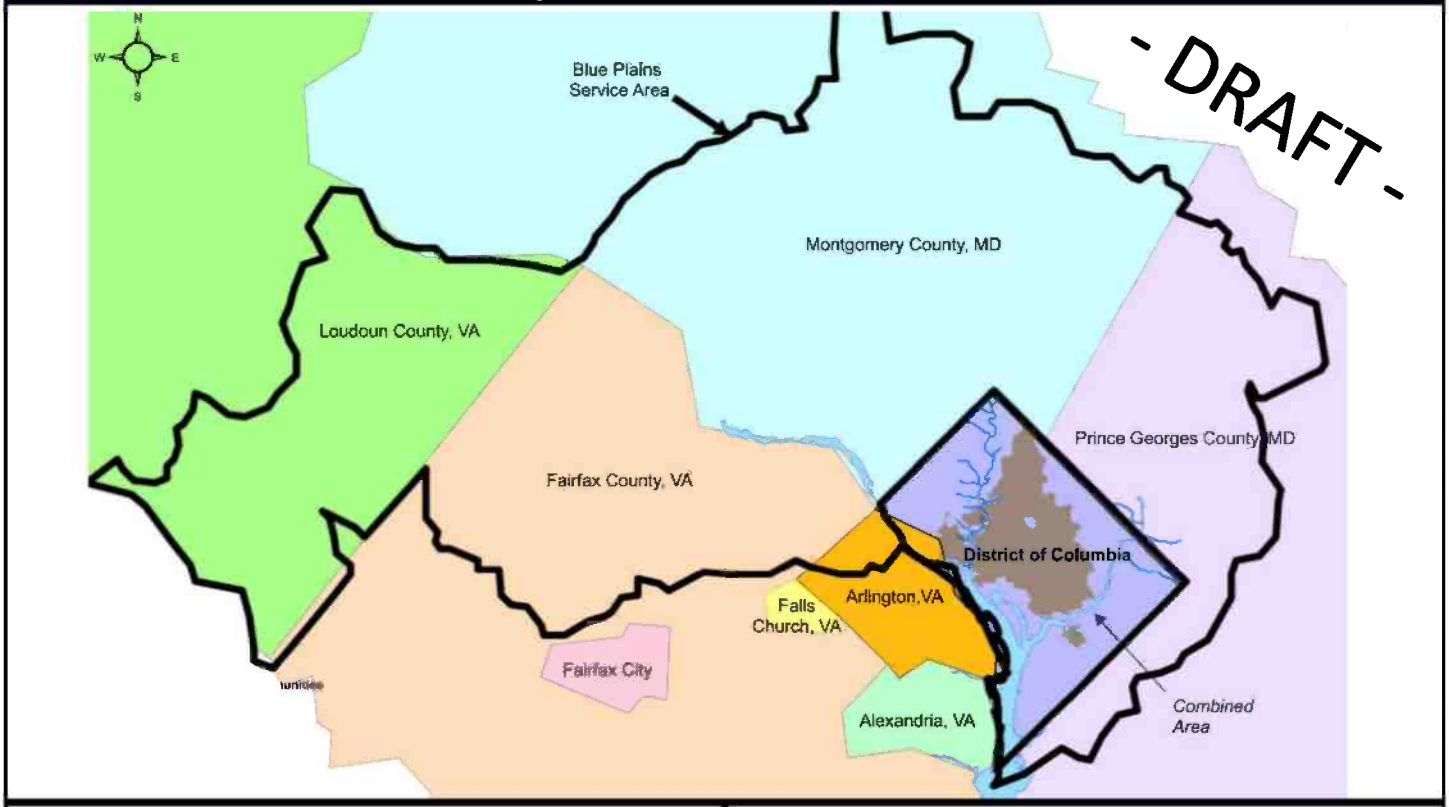
In the case of Anderson, Indiana, the 2010 FCA allocated LTCP costs to all households in the entire service area, including residential households in the wholesale customer service areas. Anderson attempted to incorporate the FCA assumptions into new wholesale customer service agreements. As a result of the re-negotiation process, the Town of Chesterfield decided that it was cheaper to build its own wastewater treatment facility. The decision resulted in higher costs for the remaining City of Anderson customers, because there were fewer households to share the dry weather flow treatment costs (i.e. WWTP facilities are the same size, but Capital, and O&M costs are allocated to fewer customers). Also, there was an increased financial burden on all customers (including Chesterfield) due to loss of economy of scale.

The lessons learned include:

- LTCP costs should be allocated in a fair and equitable manner. Otherwise, Wholesale Customers will consider withdrawal from the CSO community's system to control cost impacts on their customers.
- Cost share decisions need to be incorporated into FCA that minimize long term risks to CSO community.

In closing, the lessons learned from the FCA Case Studies further support DELCORA's approach to allocate LTCP costs in a fair and equitable manner based on current rate making practices that minimizes the risks associated with losing wholesale customer.

Case Study #1: DC Water CSO LTCP



Characteristics

Description	Value
Combined Sewer System	12,400 acres
Totals Service Area	464,000 acres
CSO Control Program Cost	$2.6 billion
Municipal Service Agreements	8
Industrial Customers	52 SIUs
Residential Population in CSS	300,000
Residential Population in Service Area	1.6 million

Financial Capability Analyses

- 2002 FCA for CSO LTCP (Attachment 1-1)
  - ✓ Provided in Section 12 of 2002 CSO LTCP
  - ✓ Consistent with EPA's 1997 financial guidance
  - ✓ Wholesale Customers NOT included in FCA
- 2015 FCA for CD Modification (Attachment 1-2)
  - ✓ Based on EPA's "Financial Capability Assessment Framework for Municipal CWA Requirements"
  - ✓ Used 40th Percentile household income instead of median household income
  - ✓ Wholesale Customers pay 7.1% of DC Water's CSO LTCP due to extra CSO generated due to flows that exceeded their contract amounts.

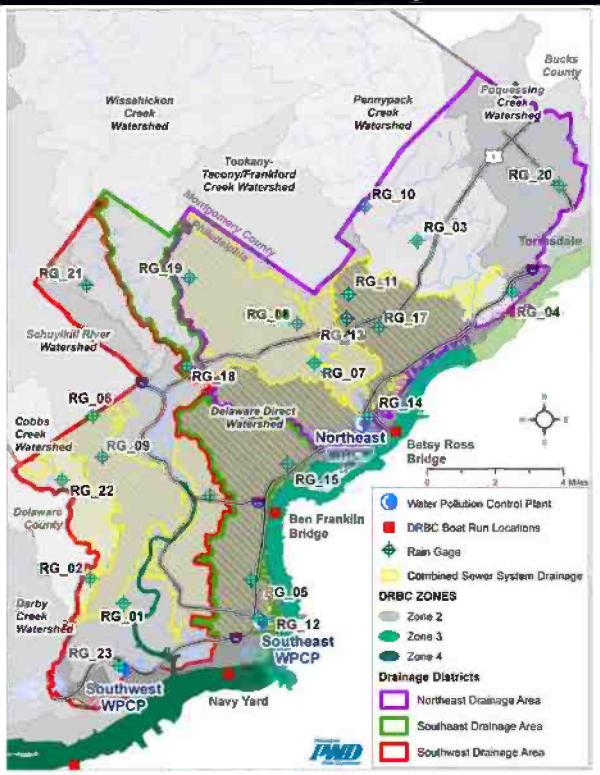
How CSO Community Paid for LTCP?

- In 2012 DC Water re-negotiated Inter-Municipal Agreements (Attachment 1-3)
  - ✓ Made it clear that communities will only pay based on what they use.
  - ✓ Suburbs agreed to pay for some of the LTCP costs only because it was possible to demonstrate they were sending flows greater than their contract allocations to the Blue Plains Wastewater Treatment Plant.

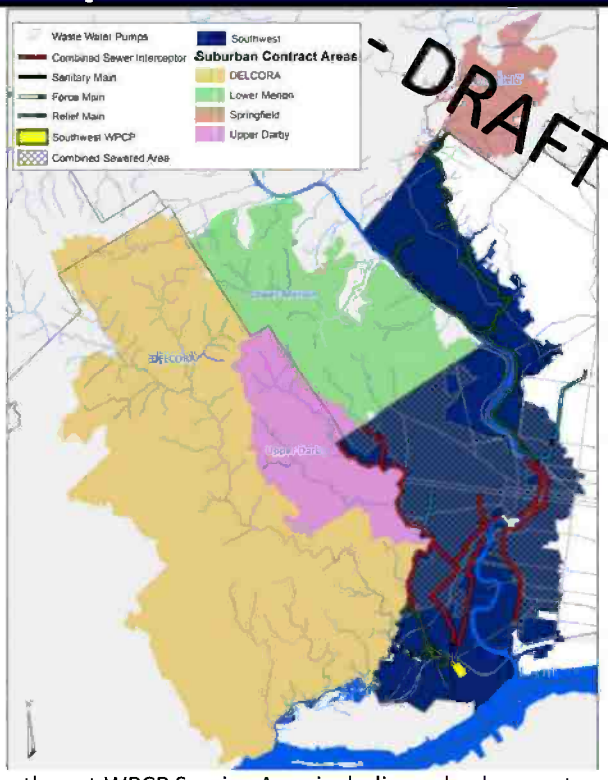
Lessons Learned

- FCA should be based on how the CSO LTCP will be actually financed.
- Demonstrating impact of Separate Sewer System on Combined Sewer Overflows provided evidence required to obtain buy-in from Wholesale Customers.
  - ✓ Required long-term flow monitoring of separate communities
  - ✓ Required updating service agreement to make it clear that community is only paying their fair share
- EPA's 2014 Financial Capability Assessment Framework provided increased flexibility over 1997 FCA guidance

Case Study #2: Philadelphia CSO LTCP



Northeast, Southeast and Southwest WPCP Service Areas



Southwest WPCP Service Area including suburban customers

Characteristics

Description	Value
Combined Sewer System	40,960 acres
Totals Service Area	87,040 acres
CSO Control Program Cost	$3.5 Billion
Municipal Service Agreements	10
Industrial Customers	
Residential Population in CSS	
Residential Population in Service Area	2.2 Million

Financial Capability Analysis

- FCA for CSO LTCP (Attachment 2-1)
  - ✓ Provided in Section 11 of 2009 CSO LTCP Update
  - ✓ Consistent with EPA's 1997 financial guidance
  - ✓ MHI inflated at 2.29%; O&M inflated at 4.7%; Capital inflated at 3.87%
  - ✓ Revenue projections based on PWD's existing cost-of-service based rate structure (future dollars).
  - ✓ Wholesale Customers NOT included in FCA cost share of CSO LTCP Update

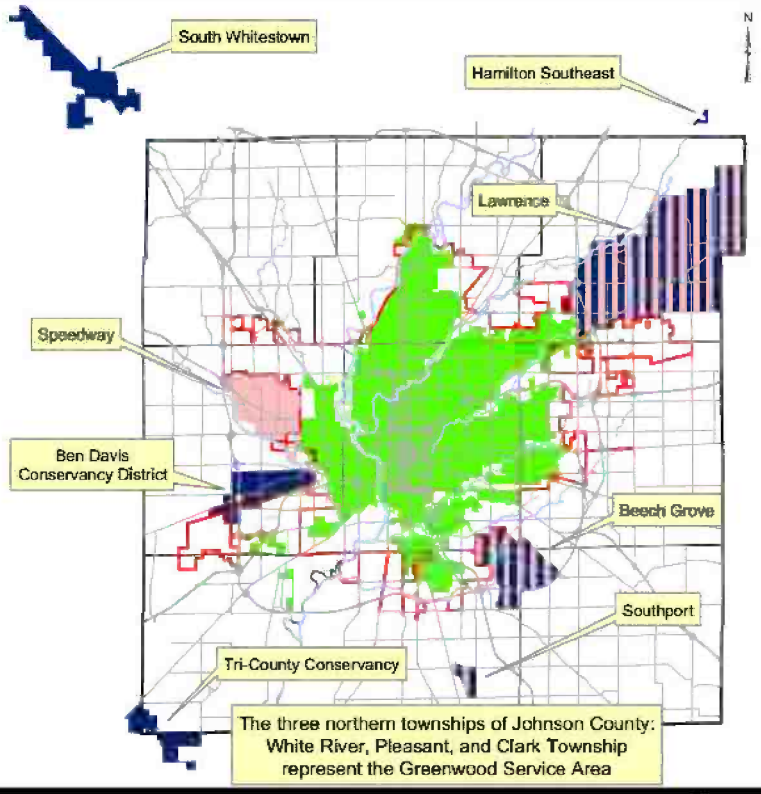
How CSO Community Paid for LTCP?

- Subsequent to 2009 FCA, PWD assigned about 9.44% of PWD's CSO LTCP costs to DELCORA. As a result DELCORA is considering options to control costs:
  - ✓ Option 1: Construct storage facility to reduce peak flow to PWD's Southwest plant
  - ✓ Option 2: Construct new DELCORA WWTP for Eastern Service Area and withdraw from PWD
  - ✓ Option 3: Re-negotiate agreement with PWD for a fair and equitable cost share of PWD's CSO LTCP
- PWD is using a peak wet weather flow as a basis to assess CSO LTCPs to DELCORA.

Lessons Learned

- To determine future impact on residential customers, FCA should be based on how the rates are made and costs are assessed
  - ✓ Inflated MHI, O&M costs, and capital costs at different rates
  - ✓ Revenue projections based on cost-of-service and future dollars
- CSO LTCP costs should be allocated in a fair and equitable manner. Otherwise, Wholesale Customers will consider withdrawal from the CSO community's system to control cost impacts on their customers.

Case Study #3: Indianapolis CSO LTCP



- DRAFT -

Legend

- Wholesale Customers
- Speedway - Not Served by City of Indianapolis
- Wholesale Customers that are Excluded Cities
- Marion County Boundary
- Township Boundary
- Old Indianapolis City Limits
- CSO Area

Characteristics

Description	Value
Combined Sewer System	35,000 acres
Totals Service Area	177,500 acres
CSO Control Program Cost	$ 2.0 billion
Municipal Service Agreements	6
Industrial Customers	
Residential Population in CSS	
Residential Population in Service Area	740,000

Financial Capability Analysis

- FCA for CSO LTCP (Attachment 3-1)
  - ✓ Provided in Section 6 of the 2006 CSO LTCP
  - ✓ Consistent with EPA's 1997 financial guidance
  - ✓ Wholesale Customers NOT included in FCA
  - ✓ Residential share (Cost per Household) was developed using a rate-based methodology.
    - City projects total revenue required,
    - City then estimates future rates,
    - City then estimates Cost per Household based on per-dwelling unit annual water consumption of 65,000 gallons per year (derived from records)

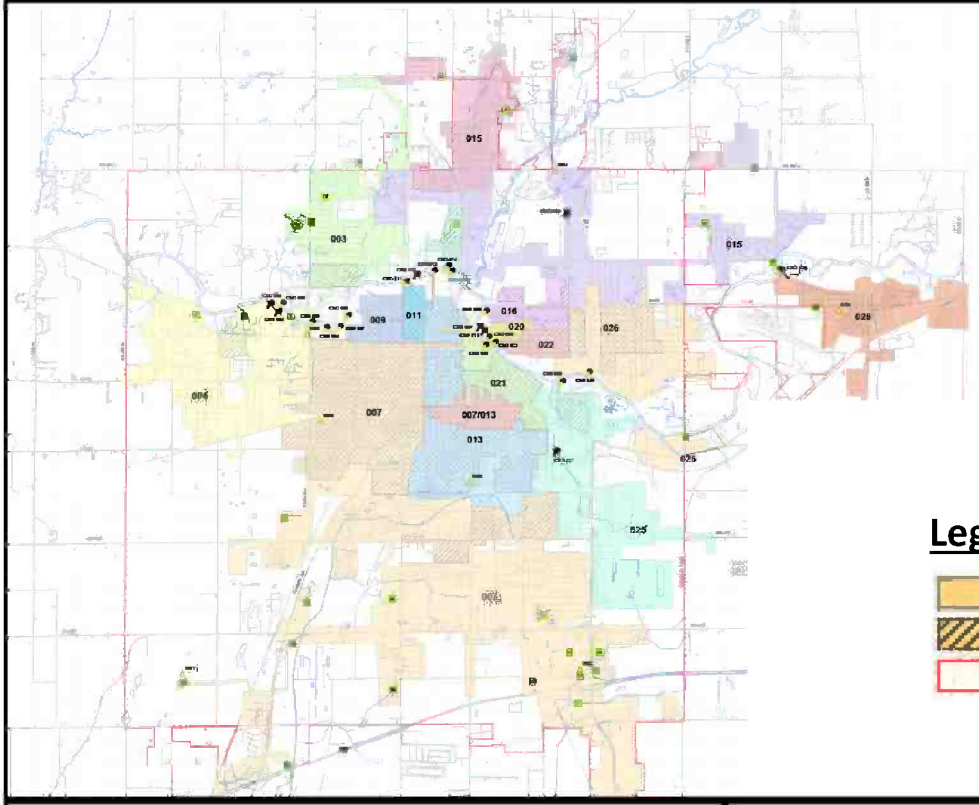
How CSO Community Paid for LTCP?

- Currently, only the Indianapolis City customers were paying for the CSO LTCP.
- In 2013 Indianapolis-based Citizens Energy Group (CEG) updated cost of service assumptions to include Wholesale Customers' share of CSO LTCP
- In 2017, Indiana Utility Regulatory Commission required CEG to update service agreements.
  - ✓ Wholesale Customers' share of CSO LTCP is 7.96%, which was based on the Wholesale Customer's Permitted Capacity for peak wet weather flow.
  - ✓ Surcharge rates if flows above Permitted Capacity

Lessons Learned

- FCA should consider
  - ✓ Wholesale Customers should pay their fair share of CSO LTCP based on cost of service assumptions consistent with Wholesale Customers' share of facilities providing service.
  - ✓ True burden on lower income population of CSO LTCP costs.

Case Study #4: Anderson, Indiana CSO LTCP



Characteristics

Description	Value
Combined Sewer System	4,700 acres
Totals Service Area	10,500 acres
CSO Control Program Cost	$161 million
Municipal Service Agreements	2 (2010)
Industrial Customers	9 (2010)
Residential Population in CSS	
Residential Population in Service Area	63,505

Financial Capability Analysis

- FCA for CSO LTCP (Attachment 4-1)
  - ✓ Provided in Section 7 of 2010 CSO LTCP
  - ✓ Consistent with EPA's 1997 financial guidance
  - ✓ Residential households in Wholesale Customers' service area included in FCA

How CSO Community Paid for LTCP?

- Anderson re-negotiated agreements with wholesale communities to increase rates for Anderson's CSO control and operational requirements.
- Subsequently, the Town of Chesterfield decided to build its own WWTP. Chesterfield cited that it was "cheaper" to build its own treatment facility than to send flows to the Anderson facilities (See Attachment 4-2)

Lessons Learned

- CSO LTCP costs should be allocated to Wholesale Customers equitably or risk losing the Wholesale Customer the system, which results in the following:
  - ✓ Fewer customers to share the dry weather flow treatment costs (i.e. WWTP facilities are the same size, but Capital, and O&M costs are allocated to fewer customers)
  - ✓ Increase financial burden on all customers (including Chesterfield) due to loss of economy of scale
- Cost share decisions need to be incorporated into FCA that minimize long term risks to CSO community.

Case Study #1: DC Water CSO LTCP
Attachment 1-1
DC Water's 2002 FCA

DISTRICT OF COLUMBIA
WATER AND SEWER AUTHORITY

Serving the Public • Protecting the Environment

Anacostia River

Potomac River

Rock Creek

Combined Sewer System Long Term Control Plan

Final Report

July 2002

DISTRICT OF COLUMBIA
WATER AND SEWER AUTHORITY

Combined Sewer System Long Term Control Plan

Submitted by:

District of Columbia
Water and Sewer Authority

Prepared by:

Greeley and Hansen LLC

July 2002

DISTRICT OF COLUMBIA
WATER AND SEWER AUTHORITY
Washington, D.C.

Combined Sewer System Long Term Control Plan

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Engineering Program Management Consultant - III
Program Manager - Greeley and Hansen LLC
July 2002

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Section 12
Financial Capability

12.1 INTRODUCTION

Financing CSO programs in a fair and equitable manner without placing an unreasonable burden on ratepayers is one of the most challenging aspects facing CSO communities. CSO control costs can be one of the largest single expenditures made on a public works project for many communities. No dedicated grant programs currently exist to fund CSO control programs. As a result, a detailed affordability analysis is necessary to assess the impact of CSO control costs on the fiscal health of a community. A procedure for assessing financial capability is described in EPA's Guidance Document, *Guidance for Financial Capability Assessment and Schedule Development* (EPA, 1997). This procedure was used to perform the financial capability assessment for WASA.

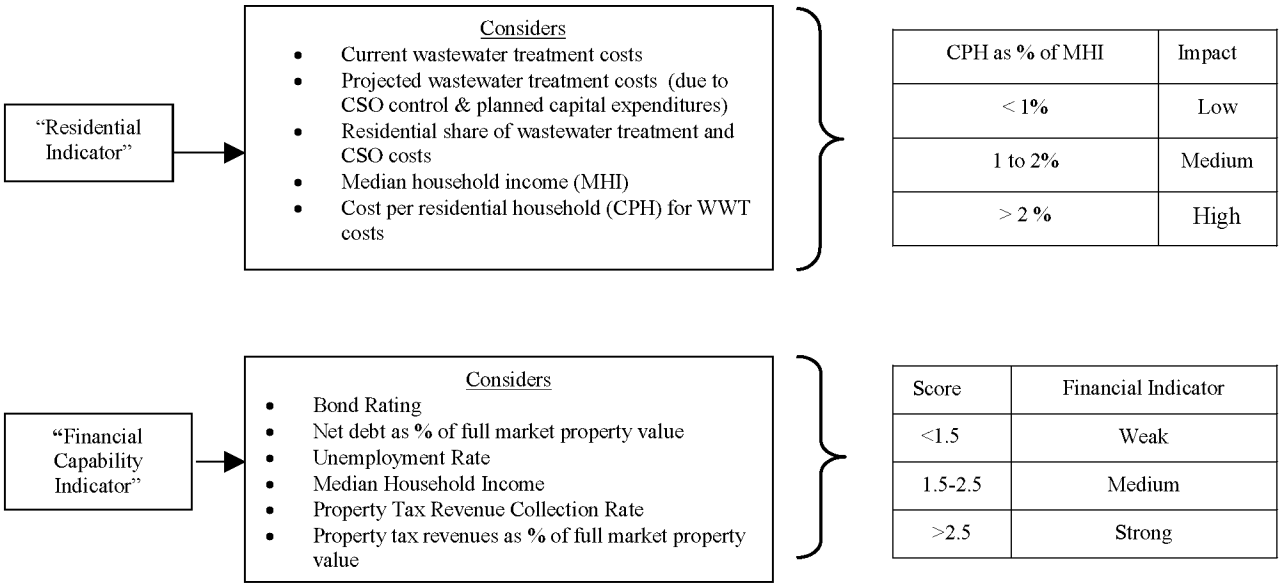
Regulatory agencies are allowed to consider other factors that will have an impact on the ability of a community to finance CSO controls. As a result, this evaluation also considers the District's income distribution, the ability of the District to remain competitive in the greater Washington area, and the effect of WASA's existing capital improvement program on the ability to finance CSO controls.

12.2 METHODOLOGY

In EPA's guidance document, assessment of financial capability entails a two-phase approach. The first phase consists of the calculation of a "Residential Indicator", which measures the financial impact of current and proposed CSO controls on residential users. The residential indicator is calculated by estimating the cost per household (CPH) for current and proposed wastewater treatment and CSO control costs. The CPH is used in conjunction with the median household income (MHI) to estimate residential impacts. Residential impacts are considered by EPA to be 'low' if the CPH is less than 1% of the MHI, 'medium' if the CPH is between 1% and 2% of the MHI, and 'high' if the CPH is greater than 2% of the MHI. Note that the CPH is not strictly equivalent to a monthly or annual sewer user fee. The CPH does not take into account all factors that are included when developing a sewer bill such as project scheduling, industrial vs. residential rates and other factors.

The second phase of the assessment involves calculation of a "Financial Capability Indicator", which assesses the overall financial health of the community. This indicator examines bond rating, debt burden, unemployment rate, property tax collection rates, MHI and other factors to develop a numerical score. The financial capability is considered by EPA to be low if the score is less than 1.5, medium if the score is between 1.5 and 2.5, and strong if the score is greater than 2.5. Figure 12-1 summarizes the development and scoring of the residential and financial capability indicators.

Figure 12-1
EPA's Residential and Financial Capability Indicators



Once the residential and financial capability indicators are calculated, they are combined into a financial capability matrix. The matrix provides EPA's assessment of the overall burden associated with funding CSO controls. This is summarized in Table 12-1.

Table 12-1
EPA's Financial Capability Matrix

Financial Capability Indicator	Residential Indicator (Cost per Household as % of Median Household Income)		
	Low (Below 1.0%)	Medium (Between 1.0% and 2.0%)	High (Above 2.0%)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Medium (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

12.3 RESIDENTIAL INDICATOR

12.3.1 Median Incomes

The CPH for wastewater treatment (WWT) and CSO controls was developed using a three-step process. First, WASA's total WWT and CSO costs were calculated by adding current costs for existing wastewater treatment operations and projected costs for proposed WWT facilities and CSO

controls. Next, the residential share of total WWT and CSO costs was calculated. The final step consists of calculating the CPH by dividing the residential share of total WWT and CSO costs by the number of households in the District.

Current WWT costs consist of current annual wastewater operating and maintenance (O & M) expenses, plus current annual debt service (principal and interest). Planned WWT capital costs were obtained from WASA's ten year Capital Improvement Program (CIP) (WASA, 2000b). The CIP amounts to $1.6 billion for the ten-year period FY2000 through FY2009, of which about $564 million are attributable to wastewater treatment for WASA customers within the District. The remainder of the CIP is attributable to water system improvements or to expenditures to be borne by others such as the surrounding counties whose wastewater is treated at Blue Plains.

The affordability analysis was conducted for a range of CSO control plan capital costs between $100 million and $2 billion in year 2001 dollars. Five cost levels were selected to compute the CPH: $0 million, $100 million; $500 million; $1 billion; and $2 billion. Each of the foregoing CSO control cost levels was assumed to occur in FY2001 to establish a common implementation year for all assumed CSO control cost scenarios as a benchmark for their comparison.

WASA's Board of Directors has adopted financial policies that require maintenance of 140 percent debt service coverage, and maintenance of cash reserves of 180 days O&M expenses, currently approximately $91 million. The present analysis factored in WASA's debt service coverage requirement. CSO control O&M costs will add substantially to the reserve requirement. An interest rate of 7% and a term of 30 years were used in the analysis to determine the capital recovery factor, which are consistent with WASA's assumptions for debt issuance for the CIP (WASA, 2002a). An interest rate of 2.6% was used as a present value adjustment factor based on the past 5 year average annual increase in the Consumer Price Index (CPI) from the Bureau of Labor Statistics (U.S. Bureau of Labor, 2000).

The residential share of total annual WWT and CSO costs is computed by multiplying the percent of total wastewater flow attributable to residential users by the total costs. For FY 1999, the residential share of wastewater flow within the District boundaries was 50% (WASA, 2000c).

The latest median household income (MHI) for the District estimated by the Census Bureau for 2000 is $38,752 (U.S. Census Bureau, 2002). This was adjusted upward to year 2001 using an inflation adjustment factor resulting in an adjusted MHI of $39,760. Dividing this amount by total annual WWT and CSO control costs per household (CPH) yields the Residential Indicator and the financial impact on residential customers.

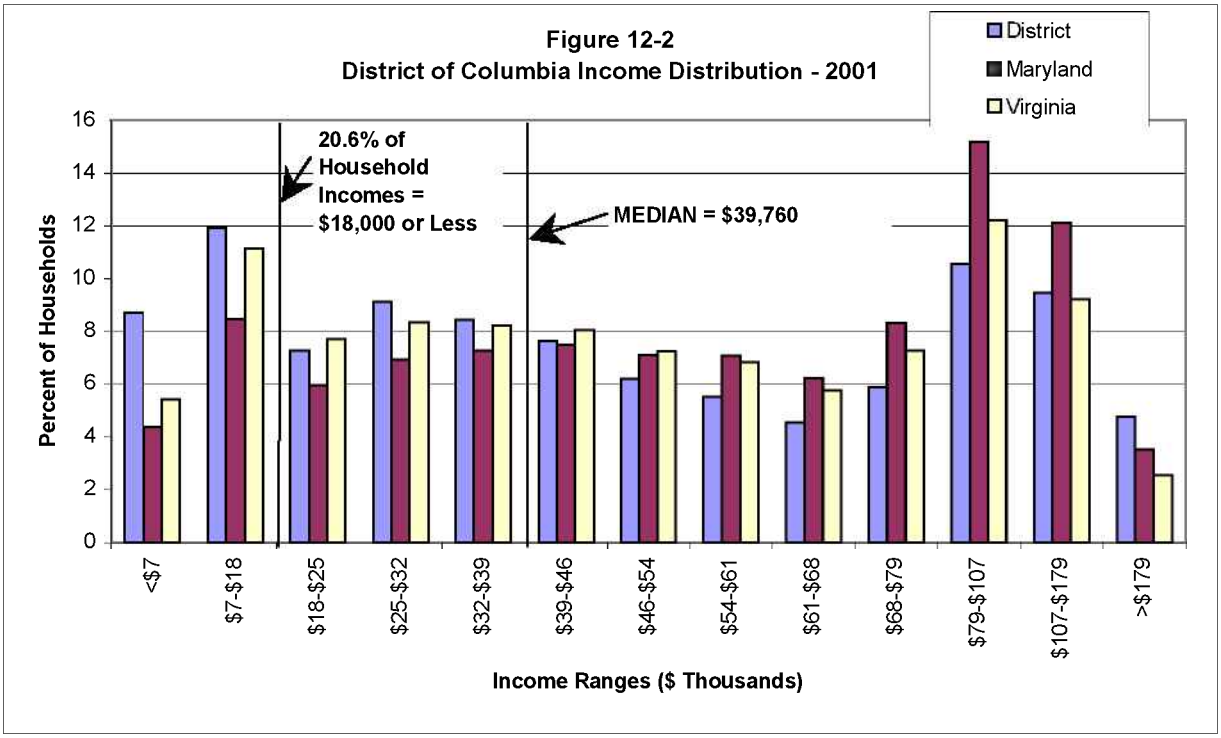
The annual cost per household and the residential indicator are summarized in Table 12-2.

Table 12-2
Projected Cost Per Household and Residential Indicator
Median Income Households

Category	*CSO Control Costs in Year 2001 (ENR=6383)*					*Line No. from EPA Worksheet*
	$0	*$100 Million*	*$500 Million*	*$1,000 Million*	*$2,000 Million*	
Current WWT Costs:						
Annual O&M Expenses	$88,059,582	$88,059,582	$88,059,582	$88,059,582	$88,059,582	100
Annual Debt Service (P&I)	$17,111,944	$17,111,944	$17,111,944	$17,111,944	$17,111,944	101
Subtotal (Line 100 + Line 101)	$105,171,526	$105,171,526	$105,171,526	$105,171,526	$105,171,526	102
Projected WWT Costs: Annual O & M Expense	$0	$0	$0	$0	$0	103a
Projected CSO Costs: Annual O & M Expense	$0	$1,500,000	$7,500,000	$15,000,000	$30,000,000	103b
Projected WWT & CSO Costs: Annual Debt Service (P&I)	$58,110,933	$69,107,129	$113,091,910	$168,072,887	$278,034,842	104
Subtotal (Lines 103a + 103b+ 104)	$58,110,933	$70,607,129	$120,591,910	$183,072,887	$308,034,842	105
Total Current & Projected WWT & CSO Costs (Line 102 + Line 105):	$163,282,459	$175,778,655	$225,763,436	$288,244,413	$413,206,368	106
Residential Share of Total WWT & CSO Costs:	$81,641,230	$87,889,327	$112,881,718	$144,122,207	$206,603,184	107
Total No. of Households in District:	248,338	248,338	248,338	248,338	248,338	108
Annual Cost per Household (Line 107 / Line 108):	**$329**	**$354**	**$455**	**$580**	**$832**	**109**
Median Household Income (MHI) for Census Year 2000	$38,752	$38,752	$38,752	$38,752	$38,752	201
MHI Adjustment to Year 2001	1.026	1.026	1.026	1.026	1.026	202
Adjusted MHI (Line 201 x Line 202)	$39,760	$39,760	$39,760	$39,760	$39,760	203
Annual WWT & CSO Control Costs per Household (CPH) (Line 109)	$329	$354	$455	$580	$832	204
Residential Indicator: CPH as % MHI) (Line 204 / Line 203 x 100)	**0.83%**	**0.89%**	**1.14%**	**1.46%**	**2.09%**	**205**
Financial Impact:	**Low**	**Low**	**Mid-Range**	**Mid-Range**	**High**	

12.3.2 Lower Incomes

The financial impact of wastewater treatment and CSO control costs on residential customers in the District is not fully measured by the foregoing method. Because of the demographics of the District, income does not follow a normal statistical distribution, or bell curve, among households across the full range of incomes. In the District, there is a distinct clustering of household incomes at the lower and upper extremes of the income spectrum. This creates a 'u' shaped or upside down income distribution which is shown on Figure 11-2.



Because of the disproportionate number of low income households in the District, the impact of wastewater treatment and CSO control costs on the most well off households in the lowest 20% of income distribution in the District was calculated. The most well off households in this category have incomes of approximately $18,000 per year. The results are presented in Table 12-3, which shows a high impact on this segment of the population for all assumed levels of CSO control costs.

Table 12-3
Projected Cost Per Household and Residential Indicator
Lower 20% of Household Incomes

Category	*CSO Control Costs Year 2001 (ENR=6383)*					*Line No. from EPA Worksheet*
	$0	*$100 Million*	*$500 Million*	*$1,000 Million*	*$2,000 Million*	
Highest Household Income of Lower 20% of Income Range:	$18,000	$18,000	$18,000	$18,000	$18,000	201a
Annual WWT & CSO Control Costs per Household (CPH) (Line 109)	$329	$354	$455	$580	$832	204
Residential Indicator: CPH as % MHI) (Line 204 / Line 203 x 100)	**1.83%**	**1.97%**	**2.53%**	**3.22%**	**4.62%**	**205a**
Financial Impact:	**Mid-Range**	**Mid-Range**	**High**	**High**	**High**	

12.4 FINANCIAL CAPABILITY INDICATORS

12.4.1 General

The permittee's financial indicator score was determined by evaluation of selected factors that portray WASA's and the District's debt burden, socioeconomic conditions, and financial operations. WASA's current debt burden was assessed as well as its ability to issue new debt to finance CSO controls by determining bond ratings and overall debt as a percentage of full market property value in the District. Socioeconomic conditions in the District were evaluated by assessing its unemployment rate and median household income (MHI). The District's ability to manage financial operations were evaluated by determining the property tax collection rate and property tax revenues as a percentage of full market property value. A value range for each of these indicators characterizes whether WASA's residential users are in a "Weak", "Mid-Range" or "Strong" position to bear WASA's WWT and CSO control costs relative to national benchmarks according to the EPA guidance document.

12.4.2 Bond Ratings

Ratings of WASA's Public Utility Revenue Bonds, Series 1998, have been upgraded since their issuance by Moody's, Standard & Poors and Fitch IBCA to A1, A, and A+, respectively. Continued compliance with the Board of Directors' 140 percent debt service coverage and 180 day O&M expense cash reserves policies has been critical to these bond rating upgrades. This will ultimately result in lower interest rates on future WASA debt issuance.

When WASA was first created in 1996, it was an unrated utility. WASA started operations with the negative cash position left by its predecessor agency, the Water and Sewer Utility Administration (WASUA). In barely two years WASA reached its 180 day O & M cash reserve goal, 11 months ahead of schedule. Without strong cash reserves and debt service coverage policies, WASA's bond ratings would be significantly lower and its cost of capital significantly higher. WASA has worked hard to implement these policies and achieve their goals. They must be maintained in order to ensure WASA's long-term financial viability and not be compromised by unaffordable new projects.

According to criteria in the guidance document, the rating of the most recent bonds to be issued either by the District or WASA is to be used to determine a bond rating indicator for WASA. Consequently, a rating of Baa1 for the District's General Obligation Bonds (Series 1999A) and General Obligation Bonds (Series 1999B) by Moody's Investor Service has been used, corresponding to a "Mid-Range" indicator rating (WASA 2002a).

12.4.3 Summary of Financial Capability Indicators

An average score for the indicators determined in this phase of the financial capability assessment was calculated. The indicators are compared to national benchmarks to form an overall assessment

of the financial capability and its effect on implementation schedules in the long-term CSO control plan. Each indicator is scored using the following rating scale:

Indicator Ratings	Score
Weak	1
Mid-Range	2
Strong	3

The average score for the indicators was calculated by dividing the sum of the scores by the number of entries. The average score is given on line 907 of Table 12-4 and the overall financial capability rating is given at the bottom of the table. According to this procedure, WASA's overall financial capability corresponds to a "Mid-Range" rating. However, because of the disproportionate number of lower income households in the District previously described, an alternative score is presented using the income of the most well off households in the lowest 20% of income distribution in the District instead of the MHI. This score results in a "Low" overall financial capability rating.

Table 12-4
Financial Capability Indicators

Indicator(Line No. from EPA Worksheet)	*Value*	*Indicator Rating*	*Score Using Median Household Incomes*	*Score Using Lower 24% of Household Incomes*	*Line No. from EPA Worksheet*
Bond Rating (Line 303):	Baa1	Mid-Range	2	2	901
Overall Net Debt as a Percent of Full Market Property Value (Line 405):	7.30%	Weak	1	1	902
Unemployment Rate (Line 501):	5.1	Weak	1	1	903
Median Household Income (Line 601):	$39,760	Mid-Range	2	0	904
Highest Household Income of Lower 20% of Income Range (Line 601a):	$18,000	Weak	0	1	904a
Property Tax Revenues as a Percent of Full Market Property Value (Line 703):	1.31%	Strong	3	3	905
Property Tax Revenue Collection Rate (Line 803):	86.89%	Weak	1	1	906
Permittee Indicators Score (Sum of Scores/ Number of Entries):			1.67	1.50	907
Financial Capability:			**Mid-Range**	**Low**	

12.5 COMBINED RESIDENTIAL AND FINANCIAL INDICATORS

The Residential Indicator and the Financial Capability Indicators were combined in the Financial Capability Matrix to evaluate the level of financial burden that CSO controls might impose on WASA. The Residential Indicator score is given on line 1001 and the Financial Capability Indicator score is given on line 1002 of Table 12-5.

Table 12-5
Financial Capability Matrix Overall Score

	CSO Control Costs in Year 2001 (ENR-6383)					*Line No. from EPA Worksheet*
	$0	*$100 Million*	*$500 Million*	*$1,000 Million*	*$2,000 Million*	
For Median Incomes						
Residential Indicator Score (Line 205):	0.83%	0.89%	1.14%	1.46%	2.09%	1001
Financial Capability Indicators Score (Line 907 Column B):	1.67	1.67	1.67	1.67	1.67	1002
Financial Capability Matrix Category:	**Low Burden**	**Low Burden**	**Medium Burden**	**Medium Burden**	**High Burden**	**1003**
Lower 20% of Household Incomes						
Residential Indicator Score (Line 205a):	1.83%	1.97%	2.53%	3.22%	4.62%	1001a
Financial Capability Indicators Score (Line 907 Column C):	1.50	1.50	1.50	1.50	1.50	1002a
Financial Capability Matrix Category:	**Medium Burden**	**Medium Burden**	**High Burden**	**High Burden**	**High Burden**	**1003a**

Based on EPA's approach, it would appear that CSO control programs costing between $500 million and $1 billion would impose a "Medium Burden" and a CSO control program costing $2 billion would impose a "High Burden" on WASA and its residential customers.

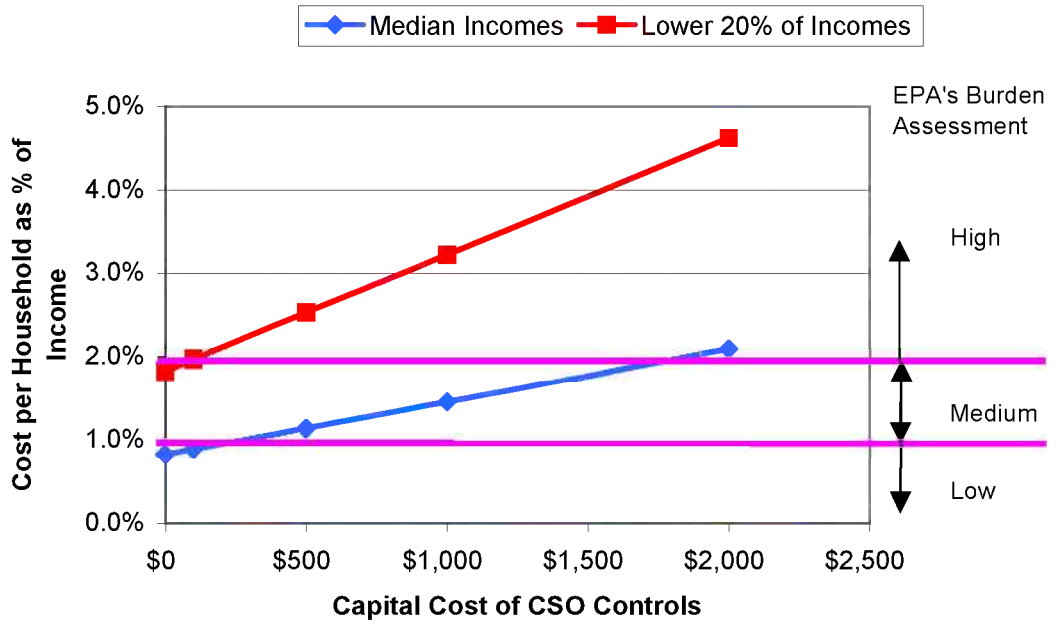
This method of determining a Financial Capability Matrix category for WASA understates the impact of CSO controls on the disproportionately large number of low income households in the District. Therefore, the Financial Capability Matrix Score was also calculated for the most well off households in the lowest 20% of income distribution. This score presents a very different picture of the impact of CSO control costs, indicating that any program above approximately $100 million would impose a "High Burden" on this segment of the population.

Additional analyses were performed to determine the CSO control cost levels that would trigger each of the financial burden categories established by EPA. The results suggest that for median income households, the threshold CSO capital cost for rising into EPA's 'high' burden level is about $1.85 billion. For the upper end of the lower 20% income range, this threshold is only $125 million. These results are summarized in Table 12-6 and on Figure 12-3.

Table 12-6
Summary of CSO Control Cost Impacts on Residential Customers
(Year 2001 Dollars)

EPA's Burden Assessment	*Median Income Households*			*Low Income Households (Income of 18,000)*		
	CPH as a % of MHI	*Wastewater & CSO CPH*	*CSO Control Plan Cost*	*CPH as a % of Income*	*Wastewater & CSO CPH*	*CSO Control Plan Cost*
No Additional CSO Controls (Baseline Condition)	0.83%	$329	$0	1.83%	$329	$0
Medium Burden Threshold	1.0%	$399	$280 million	1.0%	$180	$0
High Burden Threshold	2.0%	$794	$1.85 billion	2.0%	$360	$125 million

Figure 12-3
Impact of CSO Controls on Cost Per Household



12.6 OTHER FACTORS

12.6.1 Baseline Rate Impacts Facing WASA's Rate Payers

The financial assessment and affordability analysis presented in the previous sections uses EPA's standard methodology to assess the financial capability of the Authority and its customers relative to the proposed LTCP. The assessment using EPA's approach results in a finding of an overall "medium impact" on the Authority and its customers; the impact is high when applied to the over 51,000 households that have incomes of less than $18,000. These households approach the medium impact with WASA's existing capital program and financial plan; including CSO costs, their wastewater costs will fall in the very high range. A more accurate and complete picture of the financial capability of the Authority and its customers to fund the proposed LTCP must take into consideration the total cost of wastewater treatment and CSO controls, the rising cost of drinking water services, and, as pointed out earlier, the disparate impact on low income residents of the District of Columbia.

This analysis reflects several important analytical conventions that differ from the analysis presented in earlier sections.

- This rate impact analysis focuses on a typical residential customer with metered water consumption of 100 ccf per year. The EPA approach documented in earlier sections uses the number of households and cost per household (CPH) to evaluate financial capability. Note the two methods are not strictly equivalent. The CPH does not take into account all factors that are included in retail rate making such as project scheduling, varying consumption levels, etc.

- The EPA approach uses cost estimates in current dollars. The plan reflects 2001 values for all cost estimates. This analysis of rate impacts uses "year-of-expenditure" values which reflect the inflationary impact of time on costs and rates.

In January 2002, the Authority adopted a 10-year financial plan that provides for operations, maintenance and capital expenditures for the period of FY 2001 to FY 2010. This 10-year plan continues the Authority's current $1.6 billion water and wastewater capital improvement program (CIP).

Approximately 24 percent of the CIP is for mandated improvements that will enable the Authority to meet its current regulatory requirements. The balance of the program reflects the age and condition of the system and historical disinvestment in the system's infrastructure by predecessor agencies.

- Over half of WASA's pumping stations were constructed before 1940 and are not operating at optimal capacity.
- Half of WASA's pipes were built prior to 1930.
- Preventive maintenance expenditures were extremely low from 1980 to 1996.
- Virtually no technology existed in the Authority's operations prior to 1997.
- Prior to WASA's creation in 1997, annual capital spending averaged less than $40 million per year on total plant in service of over $1.3 billion.

Between FY 2003 and FY 2007, in the peak years of this capital program, WASA's annual capital investments in water and wastewater infrastructure (before consideration of the LTCP) exceed $200 million, a fivefold increase from the average investment only five years ago.

Even with significant capital funding from wholesale customers and grants – about 13% of the CIP's funding will come from EPA grants and 28% from wholesale customers – WASA will need to issue approximately $775 million in new debt between FY 2001 and FY 2010 to finance 47% percent of the program. As a result debt service costs will increase by more than $50 million per year by 2010 over current levels. This rising trend is equivalent to average annual increases of 11% in annual debt service costs.

The majority of the burden of this capital investment falls on the District's retail rate payers. Annual increases in retail rates of approximately 6.5% to 7.0% through FY 2008 followed by 6% annual increases from FY 2009 through FY 2012 will be required to finance the Authority's existing capital program. This projection is consistent with the policy adopted by WASA's Board of Directors to use steady rate increases as a way to mitigate the impacts of rising and mandated costs to customers. The Board established this policy after implementing a critically-needed 42% rate increase in 1997.

Over the long-term, the Authority is projecting that future necessary infrastructure investment will continue to require steady rate increases of at least 5% per year. This longer-term outlook is consistent with national infrastructure studies that document the need for doubling of rates over 20 years for infrastructure investment (see Clean and Safe Water for the 21st Century, Water Infrastructure Network, Washington, D.C.).

Under this "baseline" scenario, in which customer rates are affected by the water and wastewater capital program and routine inflationary increases in the cost of doing business, the annual cost for water and wastewater costs for a typical residential customer with metered consumption of 100 CCF per year prior to consideration of the CSO LTCP will increase from $290 to $617, a 113% increase, in fifteen years.

12.6.2 Substantial Rate Increases Required to Fund LTCP

Implementation of the LTCP will result in substantial additional rate increases and higher costs to the Authority's customers over and above the increases needed to fund the baseline capital program. Through analysis of a range of LTCP implementation schedules WASA has determined that the only rates impacts that are feasible (without substantial outside funding) are those associated with the longest possible implementation schedules. Shorter implementation schedules create too high a burden on the Authority's rate payers in terms of rapid escalation of the cost of wastewater services.

If WASA implemented the proposed LTCP over a 40-year period, a typical residential customer with annual metered water consumption of 100 CCF will see their annual wastewater costs rise from $290 to $722 in 15-years; an increase of 150%. This figure is $105 per year more than the annual bill in the baseline case without any CSO program.

Any shortening of the implementation schedule to less than 40 years will significantly increase the impacts on WASA's rate payers of the CSO controls. A fifteen-year LTCP implementation schedule would result in a more than tripling of wastewater bills to $1002 in fifteen years, and would require multiple peak increases within the next 5 to 10 years exceeding 15%, as described further below. A twenty-year program also has similar peaking impacts during the first 10 years.

Table 12-7 displays the impacts for a 100 CCF customer over 15 years for the baseline and for several LTCP implementation schedules.

Table 12-7
Summary of Rate Impacts of the CSO LTCP on 100 CCF Residential Customer

	FY 2003 Annual Bill	*Annual Bill in 15 Years*	*Average Annual Rate Increases Over 15 Years*
Baseline – No LTCP	$290	$617	6.0%
Baseline Plus LTCP – 40 Years	$290	$722	7.2%
Baseline Plus LTCP – 30 Years	$290	$795	8.0%
Baseline Plus LTCP – 20 Years	$290	$942	9.4%
Baseline Plus LTCP – 15 Years	$290	$1,002	9.9%

12.6.3 True Affordability Measure -- Impacts on Annual Household Budgets

A key indicator of the affordability of the proposed LTCP is the impact on the annual household budgets for District ratepayers as measured by the timing and extent of the required annual rate increases.

The 15 and 20-year LTCP implementation schedules would require a large number of consecutive "double-digit" rate increases when the costs of those programs are added to the demands imposed by the baseline investment in water and wastewater infrastructure. The 15-year program is projected to require 8 consecutive increases over 10% per year. Such rate increases would outpace expected growth in household incomes by two to three times, therefore eroding household resources for other items .

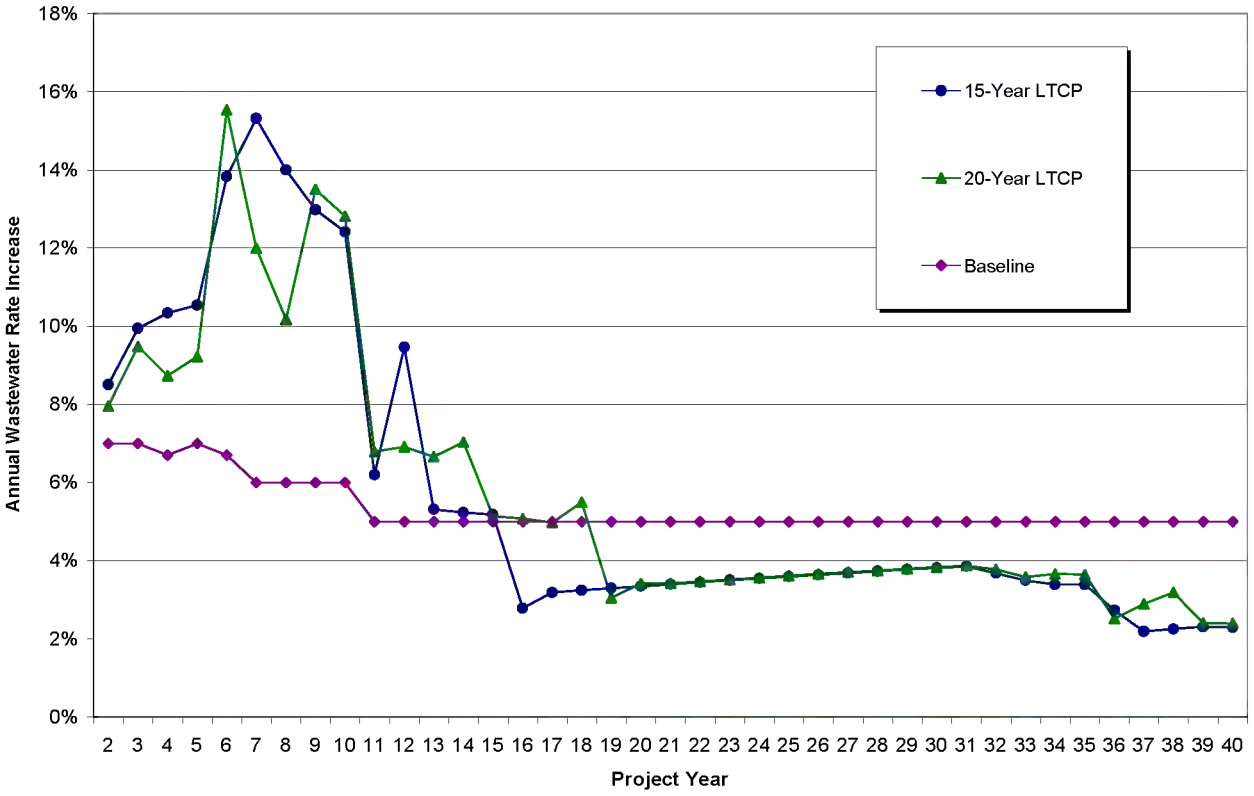
In addition to the extreme peaking of rate increases, the disparity between the rising costs that would be borne by District of Columbia residents and national experience is illustrated by the difference between 9.9% average annual increases associated with the 15-year program and the 3.6% annual rate of growth in consumer expenditures for water and sewer maintenance reported by the Bureau of Labor Statistics (BLS from January 1992 to January 2002.

These burdens will make it increasingly difficult for the District to remain competitive on a "cost of living" or "cost of doing business basis" compared to neighboring jurisdictions or other major cities that are not faced with the same capital investment burden. Currently the Authority's rates are generally competitive with the wastewater rates paid in neighboring jurisdictions in Maryland and Virginia but none of these jurisdictions is faced with the burden of an expensive CSO LTCP. The impact of this program will reduce the ability of the District to attract and retain residents and businesses relative to other locations in the area.

Nationally, a survey conducted by Memphis Gas, Light and Water Division of residential wastewater bills for rates in effect in 2001 found the monthly wastewater bills for residential customers in the District were the sixth highest out of 28 cities surveyed. All of the future rate increases associated with the baseline infrastructure investment needs and the CSO will likely further reduce the District's competitiveness on a cost of living and cost of doing business basis relative to other major cities that do not have the same burdens.

Figure 12-4 shows the annual increase in wastewater rates required for the 15 and 20-year programs as well as the baseline case.

Figure 12–4
Annual Rate Increases Required for 15 and 20-Year LTCP Plans



Another important measure is the total increase in revenue requirement added in each fiscal year, as shown in Figure 12-5. This measure demonstrates the intense peaking requirements of the CSO program as well. A 15-year program would require approximately $20 million of annual rate increases solely for CSO in five out of six years at the height of the program. The highest annual increase in revenue requirement would be approximately $33 million when the total needs of the baseline infrastructure program and the CSO are taken together.

Longer implementation schedules that range from 30 to 40 years greatly minimize peak rate increases: the 15-year schedule required eight consecutive annual increases in excess of 10 percent, while a 40 year schedule will only require one increase that is greater than 10 percent. Fewer peak increases under longer-term implementation schedules minimize the near-term impact on customers, particularly the 51,000 households with incomes less than $18,000 per year, allowing them to plan for more gradual rate increases that are in line with projected salary and other income increases. Figure 12-6 displays the annual rate increases required for 30- and 40-year implementation programs.

Figure 12-5
Annual Increase in Revenue Requirement for 15-Year LTCP and Baseline Needs

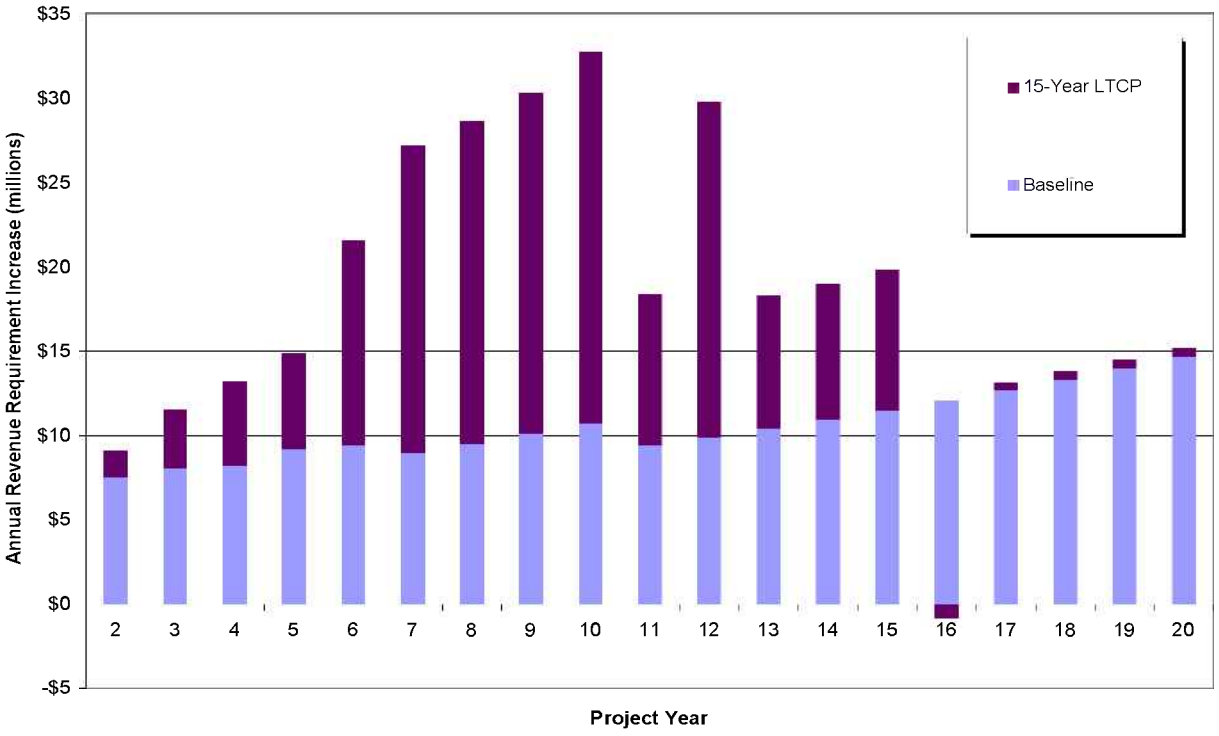
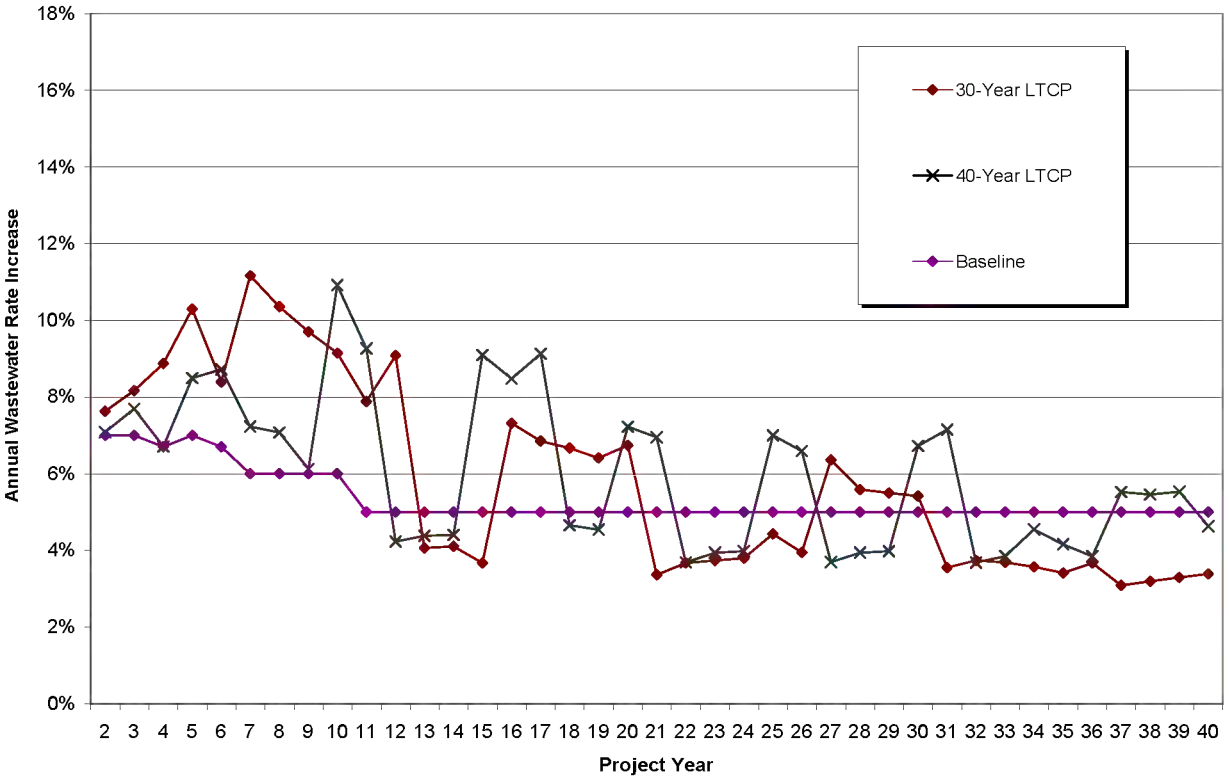
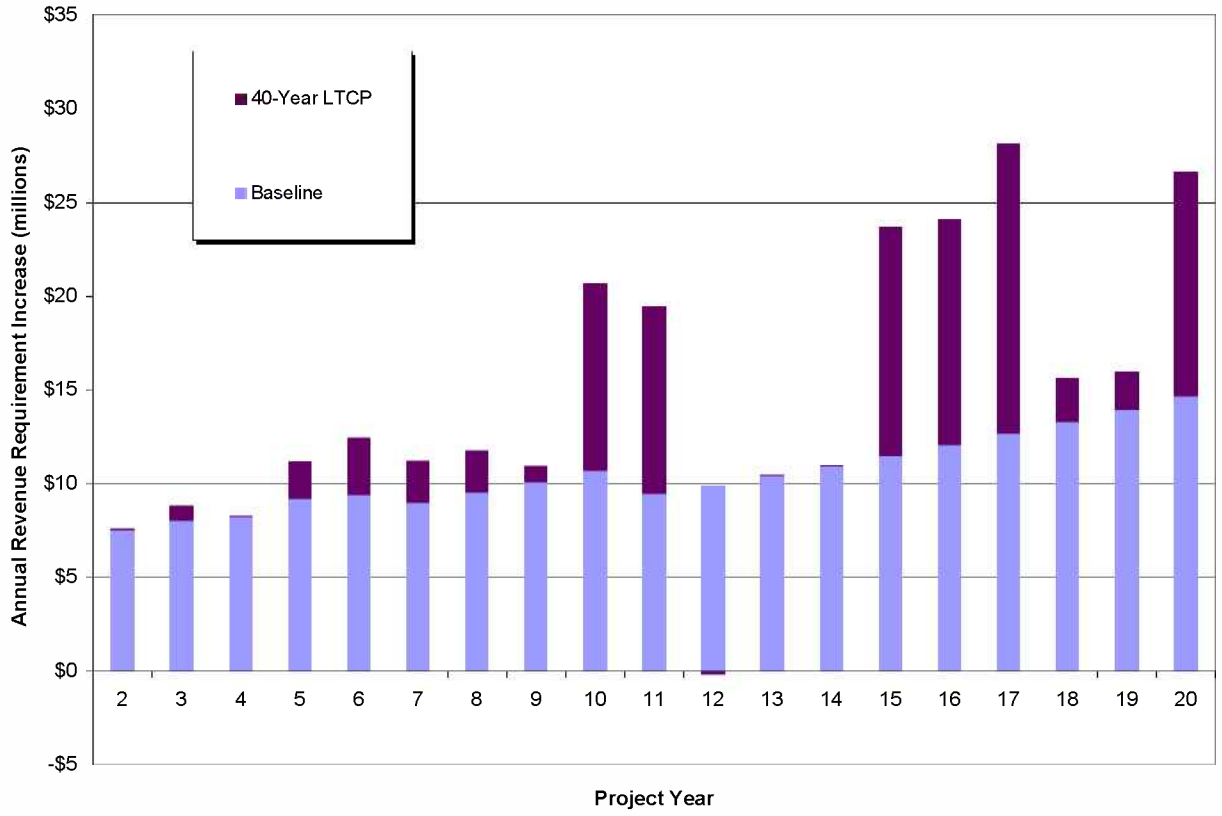


Figure 12-6
Annual Rate Increases Required for 30 and 40-Year LTCP Plans



Although there are still burdensome peaks, in general the 40-year program requires less annual increases in rate revenues for CSO. As shown in Figure 12-5, a 15-year program will require annual rate revenue increases in excess of $20 million for five out of fifteen years. Figure 12-7 shows that a 40-year schedule will require only one increase in excess of $20 million during the first fifteen years of implementation. This illustrates the minimizing effect of a longer term program on WASA's customers, particularly low income customers.

Figure 12-7
Annual Increases in Revenue Requirements for 40-Year Program



12.6.4 High Degree of Uncertainty in Rate Impacts Should Be Considered

In formulating its rate impact analysis WASA focused on a "most probable" approach to key assumptions that represent the economic and demographic conditions during the foreseeable future in a manner appropriate for this planning document. Nevertheless, the economic and demographic conditions that actually materialize on a year-to-year basis may differ from those associated with the forecast. Some of these considerations are described below:

- Water Consumption - The analysis of rate impacts has assumed that metered water consumption is maintained at current levels over the long-term. Water consumption has declined over the past 2 decades due to technological improvements and shifts in consumer

behavior. Although WASA has taken steps to maintain a high level of meter accuracy and to reduce unbilled water, it is possible that water consumption will continue to decrease over the long-term, particularly in response to increasing rates. It is not unreasonable to expect that the 150% increase in rates over 15 years associated with the 40-year LTCP program will result in some level of reduced consumption. Any reduction in consumption will result in higher impacts have to be offset with further rate increases on the balance of the water sold by the Authority. There exists the potential to initiate a vicious cycle that would be particularly hard on low income households.

- Cost Estimates -The rate impact analysis reflects the cost estimates prepared for this planning document. These costs estimates have a level of confidence of minus-15% to plus-40%. It would be equally likely that the final cost estimates in today's dollars are 40% greater or 15% less than the cost estimates included in this plan. These estimates reflect the level of planning and engineering completed to date on each alternative which is only a portion of the work needed to complete the project. It is very likely that the costs will be higher due to the complexity of the project and the unique risks involved with a mega-project. In recent months many high-profile mega-projects of this type have seen bid amounts far exceed preliminary estimates. Several examples within the Washington region are the Woodrow Wilson Bridge replacement and the I-495/I-395 interchange (the "Mixing Bowl") project. Unlike those projects however, any cost increases or contract overruns would be borne by a relatively small population of wastewater rate payers in the District of Columbia. These are very real risks that should be considered as part of the financial capability assessment.

- Interest Rates - This rate impact analysis assumes that the Authority will be able to borrow for future CSO costs at the same interest rates as it currently pays for its utility revenue debt. Any increase in interest rates due to market conditions will need to be absorbed by WASA's retail customers and will increase the financial burden of all LTCP schedule options. The Authority's future credit rating and the structure of future bond issues could also have negative impacts on the revenue requirements. These risks should also be considered in the financial capability analysis.

- Future Regulatory Requirements - The rates impact analysis reflects the current regulatory horizon that the Authority has used to develop its current capital improvement program and the LTCP for its combined sewer system. The analysis does not provide for additional costs that may be mandated to cover future regulations such as Total Maximum Daily Loads (TMDLs) or additional nitrogen removal requirements at Blue Plains. While the baseline analysis provides substantial capital funding for future reinvestment in infrastructure, any extraordinary capital costs related to future regulation (e.g., disinfection by-products) or

critical infrastructure replacement needs would further increase rates for the Authority's rate payers.

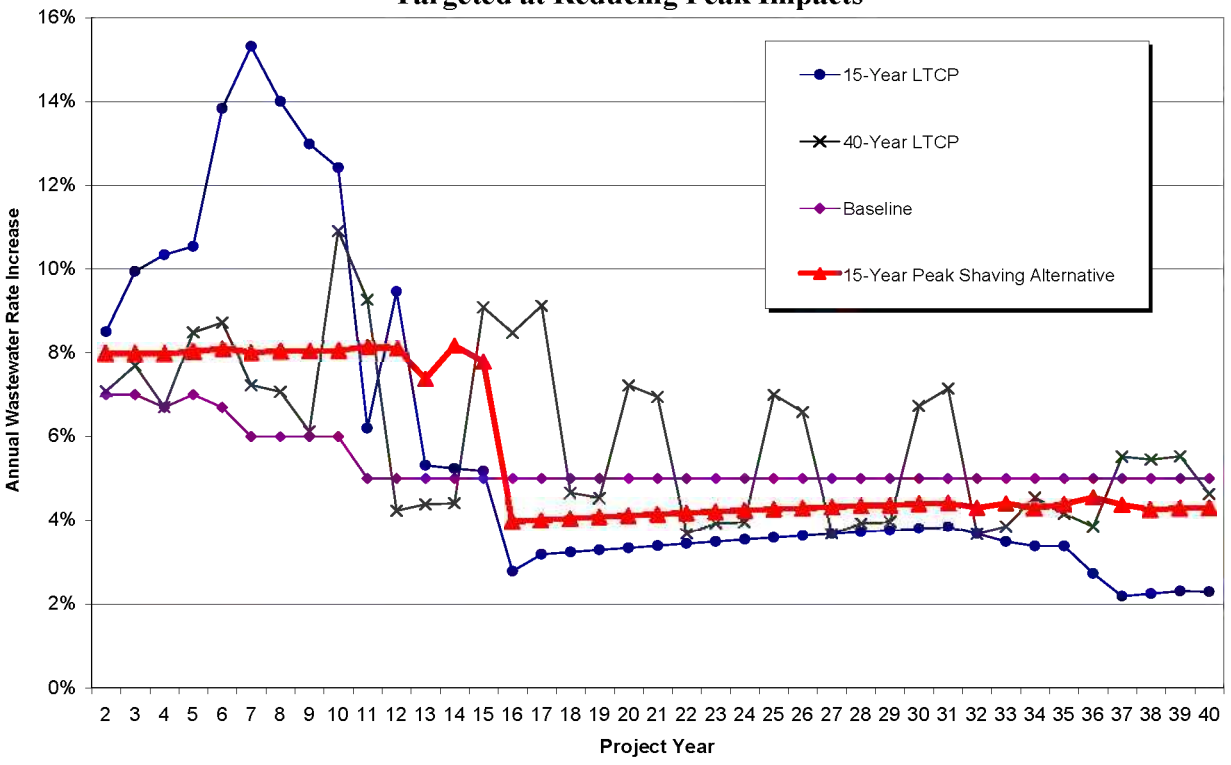
12.6.5 Effect of Federal Funding on Rate Increases

There are two ways to reduce the rate impacts of a shorter LTCP implementation schedule, external funding assistance and deferral of other water and wastewater capital expenditures.

External assistance targeted at limiting peak rate increases can reduce the severe impacts of high annual rate increases associated with the shorter programs. External assistance of 62% of the capital cost of the program could keep rate increases to 8% per year as shown in the following chart. The additional annual revenue required would gradually increase to $11.2 million by year 15.

Total external capital assistance under this scenario would be $960 million over 15 years. The external assistance in this case is targeted at the peaking impacts on wastewater rates and varies from year to year as necessary to limit rate increases to 8% or less. In any case, it is important for external assistance to reflect year-of-expenditure values or the actual "cost to complete" the project. If external assistance is determined on current dollars or on an amount per year, the cost to complete and inflation risks are shifted to ratepayers.

Figure 12-8
Rate Increases for a 15-Year LTCP Plan with External Assistance Targeted at Reducing Peak Impacts



Case Study #1: DC Water CSO LTCP
Attachment 1-2
DC Water's 2015 FCA for CD Modification

Long Term Control Plan Modification for Green Infrastructure

May 2015

prepared by

dc water is life

District of Columbia
Water and Sewer Authority
Washington, DC

dc clean RIVERS PROJECT
RESTORING OUR RIVERS
PROTECTING OUR DISTRICT

DISTRICT OF COLUMBIA
WATER AND SEWER AUTHORITY

DC CLEAN RIVERS PROJECT

LONG TERM CONTROL PLAN MODIFICATION FOR GREEN INFRASTRUCTURE

May 2015

FINAL

Prepared for:

dc water is life

Prepared by:

dc clean RIVERS PROJECT
RESTORING OUR RIVERS
PROTECTING OUR DISTRICT

Program Consultants Organization
Blue Plains Advanced Wastewater Treatment Plant
5000 Overlook Avenue, SW
Washington, DC 200321

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General Manager's Message

I am pleased to announce the completion of the process to modify DC Water's Long Term Control Plan to enable a significant investment in Green Infrastructure. This plan represents an enormous body of work and painstaking analysis performed by DC Water and its contractors. Exploring Green Infrastructure to reduce combined sewer overflows to the Potomac River and Rock Creek was a personal priority for me when I accepted the position of General Manager at DC Water in 2009. Since then, DC Water has invested $14 million in ratepayer funds to further our understanding of this innovative solution to stormwater control that will bring environmental, social, and economic benefits to the residents of the District of Columbia.

DC Water CEO & General Manager
George S. Hawkins

This document is a product of methodical outreach and collaboration with our regulatory, environmental, and community stakeholders. DC Water solicited feedback on its plans for Green Infrastructure by holding multiple summits, more than 14 public meetings, and notifying District residents through a proactive ad campaign. The updated proposal reflects the nearly 500 comments we received from the public, and I am confident will position DC Water as a leader in the responsible use of Green Infrastructure for combined sewer overflows. We are grateful for the comments we received, and we strongly believe that our proposal is much better for it.

The release of this document marks an important moment in DC Water's history. Some argue about the role of Green Infrastructure in comparison to gray. We have learned over this process that embracing both techniques in a complementary manner builds on their relative strengths and yields an outcome that is better than either alone. I want to thank all who have engaged DC Water on this herculean effort, and I look forward to collaborating with the public and our stakeholders as DC Water begins to make this plan a reality in the District of Columbia.

George S. Hawkins

What is the Purpose of this Initiative?

DC Water is proposing to implement **Green Infrastructure** or **GI** as part of our plan to control Combined Sewer Overflows (CSOs). CSOs are one of the sources of pollution

Bioretention in the Public Right of Way

impairing the quality of the District's waterways. The current plan to control overflows in the District's Potomac River and Rock Creek sewersheds relies largely on the construction of large tunnels ("gray" infrastructure) designed to capture CSO during heavy rains and transport it to the Blue Plains Advanced Wastewater Treatment Plant (Blue Plains) for treatment. GI reduces the scope of gray infrastructure needed to control stormwater runoff that contributes to CSOs, and has the potential to provide many environmental, social, and economic benefits to the community. While additional time is needed to effectively implement GI, it will deliver earlier pollutant reductions through phased construction when compared to gray infrastructure. This report explains the basis for this initiative and why a modification to DC Water's plan for controlling CSOs (called the Long Term Control Plan, LTCP or DC Clean Rivers Project) is required to implement it.

What is the Consent Decree?

The Consent Decree is the 2005 agreement among DC Water, the District, the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Justice (DOJ) that establishes schedules for construction of the tunnels and related CSO control facilities, including a 2025 deadline to construct and place the tunnels in operation.

What is Green Infrastructure?

GI, also known as Low Impact Development (LID), uses plants, trees and other measures to mimic natural processes to control stormwater, resulting in cleaned, cooled, and slowed stormwater runoff. These systems promote rainwater detention and infiltration into the soil and include techniques such as rain gardens, porous pavements, green roofs and other technologies.

Typical Green Infrastructure Measures
• Rain Gardens (Bioretention)
• Porous Pavements
• Green Roofs
• Rain Barrels and Downspout Disconnections

By integrating natural processes into the urban environment, GI provides not only stormwater management, but also can support additional benefits such as local job creation, improved air quality, a cooler city, greener public and private spaces, added wildlife habitat, increased property values, and greenhouse gas mitigation.

DC Water's recommended plan is to construct a hybrid green-gray solution to control CSOs while improving the quality of life in the District.

What is a Combined Sewer Overflow?

Like many older cities in the United States, the sewer system in the District is comprised of both combined sewers and separate sanitary sewers. While sanitary sewers carry only sewage, combined sewers carry both sewage and runoff from storms.

Modern practice is to build separate sewers for sewage and stormwater. No new combined sewers have been built in the District since the early 1900's. Approximately one-third of the District is served by combined sewers, the majority of which are in the older, developed sections of the District.

CSO Facts

- "CSO" stands for Combined Sewer Overflow
- About 1/3 of the District is served by combined sewers
- Combined sewers have not been built in the District since the early 1900's
- Combined sewers overflow when stormwater runoff exceeds the sewer capacity

In a combined sewer system, sewage from homes and businesses during dry weather conditions is conveyed to DC Water's Advanced Wastewater Treatment Plant at Blue Plains, located in the southwestern part of the District on the east bank of the Potomac River. There, the wastewater is treated to remove pollutants before being discharged to the Potomac River. When the capacity of a combined sewer is exceeded during storms, the excess flow, which is a mixture of sewage and stormwater runoff, is discharged to the Anacostia and Potomac Rivers, Rock Creek and tributary waters. This excess flow is called Combined Sewer Overflow (CSO). There are 47 active CSO outfalls in the District's combined sewer system.

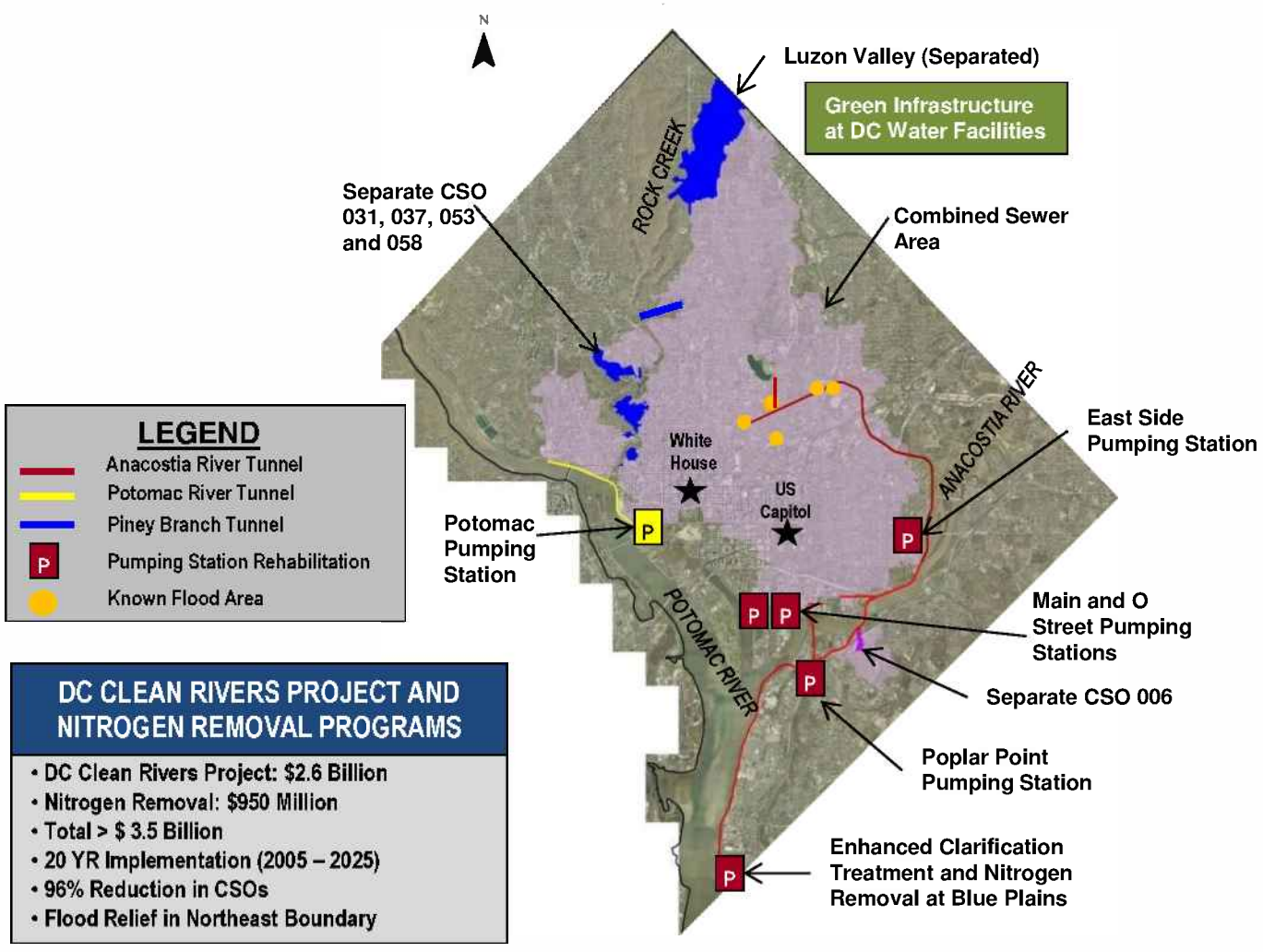
"Lady Bird" Tunnel Boring Machine for the Blue Plains Tunnel

What is the DC Clean Rivers Project?

The DC Clean Rivers Project (DCCR) is DC Water's massive infrastructure program to reduce combined sewer overflows into the District's waterways - the Anacostia and Potomac Rivers and Rock Creek. It includes more than 13 miles of tunnels that are larger than the Metro tunnels and are constructed more than 100 feet below the ground. The tunnels are designed to capture CSO during heavy rains and transport it to Blue Plains for treatment. The tunnels to control CSOs on the Anacostia River are currently under construction.

With the DC Clean Rivers Project, DC Water will improve our waterways by reducing CSOs system-wide by 96% in the average year. The DC Clean Rivers Project will also provide flood relief to neighborhoods in the Northeast Boundary section of the city, such as Bloomingdale, LeDroit Park, Trinidad and Ivy City.

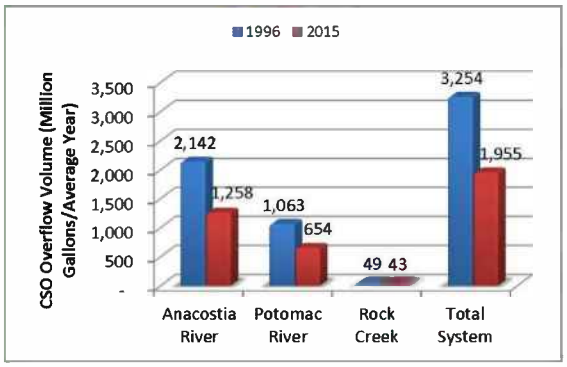
DC Water has reduced CSO overflow volume by approximately 40% since 1996 and has issued more than $1.3 billion in engineering and construction contracts.



Existing Plan

What Progress has already been made in CSO Control?

DC Water has made great strides toward reducing CSOs since the Authority was created in 1996. Since 1996, CSO overflow volume has been reduced by about 40% on a system-wide basis in an average year of rain. DC Water has done this by replacing and upgrading pumping stations and control structures and separating combined sewers in selected sewersheds. The investments have already improved water quality and reduced trash in our waterways.



DC Water has Reduced CSO Overflow Volume by 40% Between 1996 and 2013

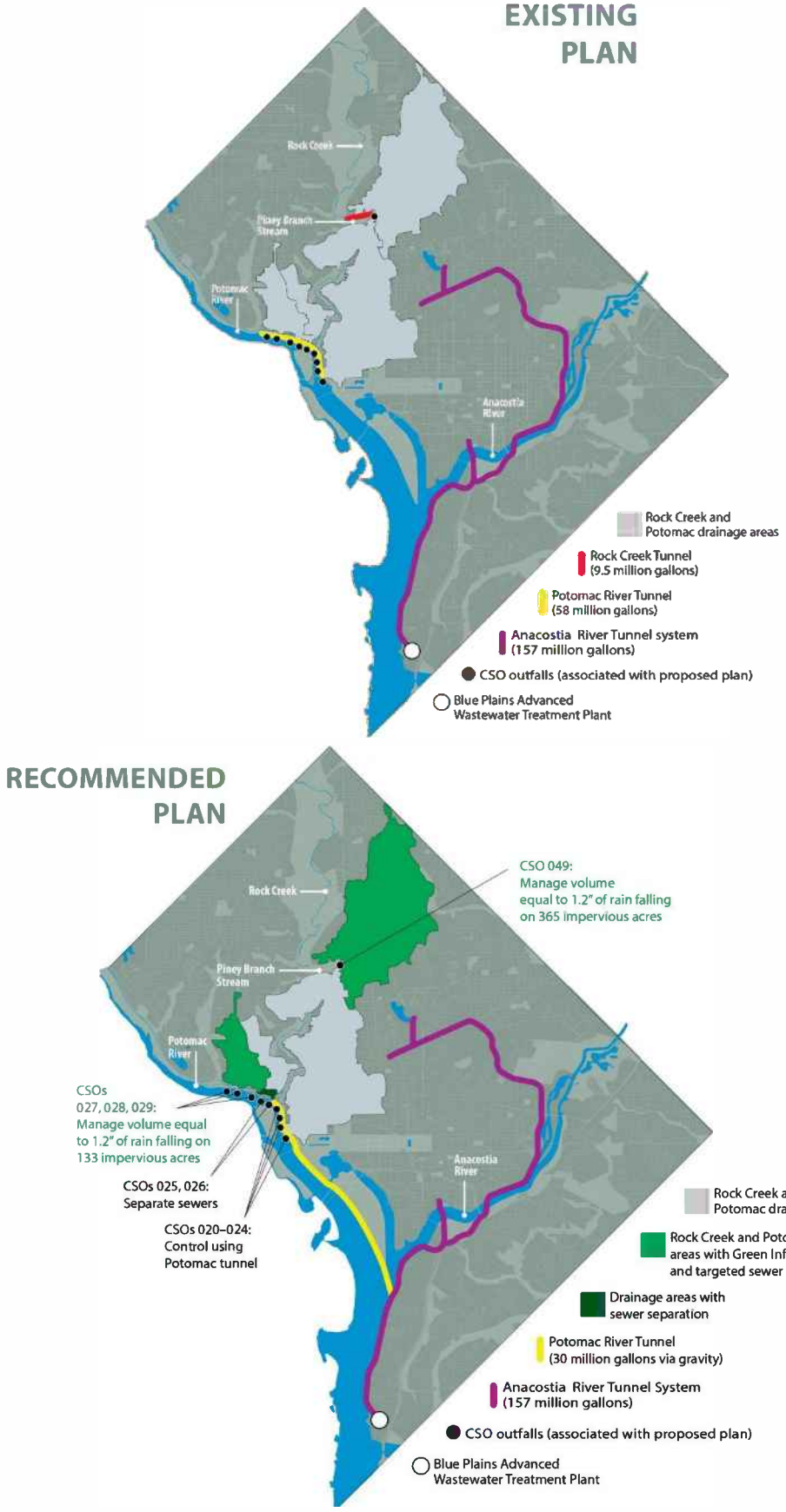
DC Water is currently constructing the tunnel system for the Anacostia River. This will achieve an 81% reduction in CSO volume on the Anacostia by 2018 when the tunnel from Blue Plains to RFK Stadium is placed into operation and a 98% reduction in volume when all Anacostia River controls are placed into service. While the Consent Decree deadline for completion of the Anacostia River Tunnel system is 2025, DC Water is accelerating the work to achieve a completion date of 2022 to provide early flood relief to Bloomingdale and LeDroit Park per the Mayor's Task Force Recommendations.

What is DC Water's Recommended Plan?

On the Anacostia River, DC Water will complete construction of the tunnel system and will meet the existing aggressive schedules. For the Potomac River and Rock Creek, DC Water will implement a hybrid plan of green and gray infrastructure, where each technology will be applied in areas selected to maximize their effectiveness.

For Rock Creek, DC Water will construct GI and targeted sewer separation to manage the volume of runoff produced by 1.2" of rain falling on 365 impervious acres instead of the Rock Creek Tunnel to control the Piney Branch CSO Outfall. This approach is feasible in this sewershed because of its low CSO overflow volumes and because of the lower density of

Receiving Water	Existing Plan	Recommended Plan
Rock Creek	• Construct Rock Creek Tunnel by 2025	• Raise the diversion weir at CSO 049 (Piney Branch) by 2020 • Construct GI and targeted sewer separation to manage the volume of runoff produced by 1.2" of rain falling on 365 impervious acres to control CSO 049 (Piney Branch) by 2030
Potomac River	• Construct Potomac Tunnel by 2025	• For CSOs 027, 028 and 029, construct GI and targeted sewer separation to manage the volume of runoff produced by 1.2" of rain falling on 133 impervious acres by 2027 • For CSO 025 and 026, separate these sewersheds by 2023 • For CSOs 020, 021, 022 and 024, construct a 30 million gallon Potomac Tunnel by 2030. Configure the tunnel to drain by gravity to the Blue Plains Tunnel


EXISTING PLAN
Rock Creek
Piney Branch Stream
Potomac River
Anacostia River
Rock Creek and Potomac drainage areas
Rock Creek Tunnel (9.5 million gallons)
Potomac River Tunnel (58 million gallons)
Anacostia River Tunnel system (157 million gallons)
CSO outfalls (associated with proposed plan)
Blue Plains Advanced Wastewater Treatment Plant
RECOMMENDED PLAN
CSO 049: Manage volume equal to 1.2" of rain falling on 365 impervious acres
CSOs 027, 028, 029: Manage volume equal to 1.2" of rain falling on 133 impervious acres
CSOs 025, 026: Separate sewers
CSOs 020–024: Control using Potomac tunnel
Rock Creek and Potomac drainage areas
Rock Creek and Potomac drainage areas with Green Infrastructure and targeted sewer separation
Drainage areas with sewer separation
Potomac River Tunnel (30 million gallons via gravity)
Anacostia River Tunnel System (157 million gallons)
CSO outfalls (associated with proposed plan)
Blue Plains Advanced Wastewater Treatment Plant

development in the sewershed. GI projects will start in 2017 and will be completed by 2030.

For the Potomac River, DC Water will implement a hybrid green and gray solution. GI and targeted sewer separation will be used to control CSO 027, 028 and 029, while CSO 025 and 026 will be separated because the drainage areas for these outfalls are very small. Implementation will start in 2017 and will be completed by 2027. The largest CSOs are outfalls 020 through 024 and these will be controlled by a modified Potomac Tunnel, with a storage volume of 30 million gallons. The Potomac Tunnel will be drained by gravity to the Blue Plains Tunnel, thereby eliminating the need for a new very large pumping station to empty the tunnel near the National Mall. The Potomac Tunnel will be placed in service by 2030.

For both the Potomac River and Rock Creek, the recommended plan will result in CSO reductions and water quality improvements equivalent to those predicted for the CSO controls in the existing plan.

What are the Benefits of the Recommended Plan?

The hybrid GI plan offers many more benefits than the existing tunnel-only solution. These benefits include:

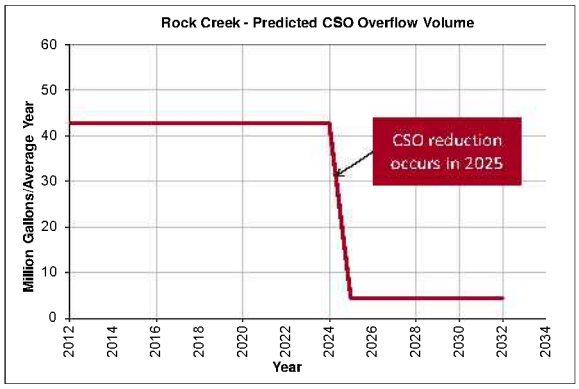
1. *Timing of CSO Reduction*

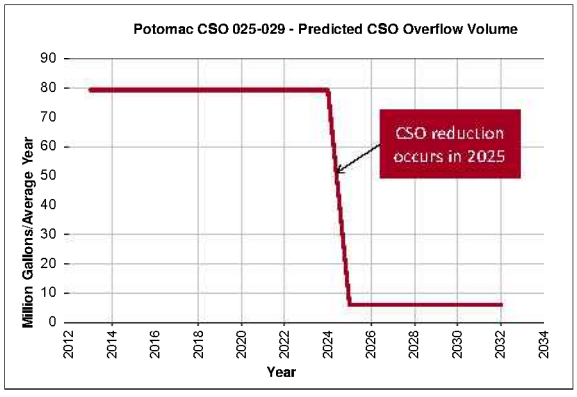
Under the existing plan, the District would need to wait until the tunnels are placed in service in 2025 before any additional CSO reduction is achieved. With the recommended plan, CSO reduction will begin to occur much earlier (in 2017).

Although the controls for Potomac CSOs 020-024 will be placed in operation in 2030

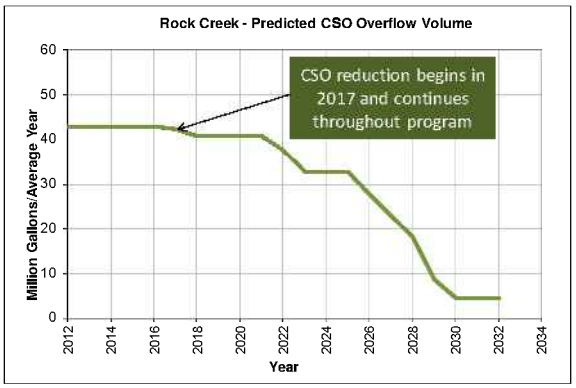
CSO Reduction versus Time

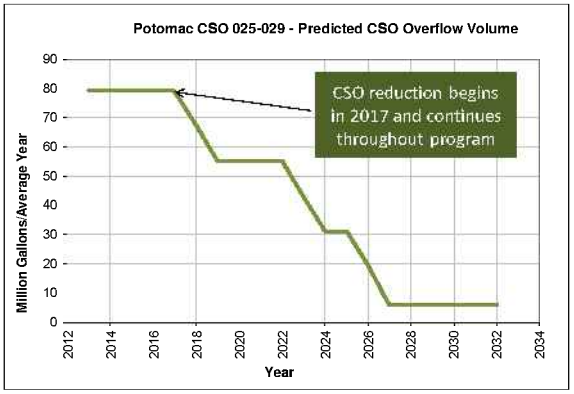
Existing Plan





Recommended Plan





instead of 2025, installation of these controls would likely have been delayed with the existing plan due to several factors including new federal requirements to perform an Environmental Impact Statement, and new planning and location challenges which did not exist when the original Consent Decree was signed. Establishing a new deadline will also mitigate the financial burden on rate payers for the $2.6 billion project.

2. *Added Environmental, Social and Economic Benefits*

GI can offer environmental, social and economic benefits that gray infrastructure does not, including, but not limited to, increased property values, neighborhood beautification, reduced heat island effects, habitat creation, green jobs, and enhanced community gathering spaces.

costs associated with the schedule of the existing plan coupled with other necessary sewer and wastewater improvements are projected to be unaffordable for more than 40% of households by 2018. The analysis also showed that extension of both the Consent Decree schedule and optimization of capital spending for other sewer and wastewater projects is necessary to maintain affordable rates.

To complete the CSO control program as early as possible, DC Water evaluated engineering constraints and determined that extending the Potomac River Tunnel schedule by five years and the GI schedule by five years would result in the earliest affordable, practical, and technically achievable schedules for CSO control. With the Consent Decree extended, DC Water determined that more than $2.5 billion dollars of other sewer and wastewater projects must be considered in an optimization of capital spending between 2015 and 2032 to meet the affordability criteria established by the analysis. As shown in the figure below, extending the

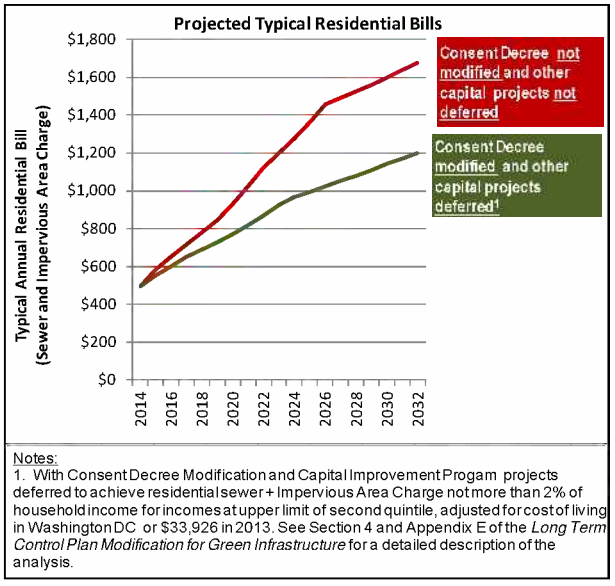
Triple Bottom Line Benefits of Green Infrastructure

3. *Reduced Financial Impact on Ratepayers by Spreading Out Construction*

DC Water updated its 2002 affordability analysis as part of evaluating GI plans for CSO control. The analysis showed that the

Consent Decree schedule and optimizing implementation of other capital projects is projected to reduce typical residential sewer bills from about $1,675 per year to about $1,200 per year.

Given that median sewer age will be approaching nearly 100 years by 2032, optimization of capital spending for other projects inevitably presents risks to customer service, environmental protection, and management of infrastructure. DC Water balanced these risks with our obligations to complete the CSO control program as soon as is practicable when the recommended schedule for CSO control described in this report was developed.



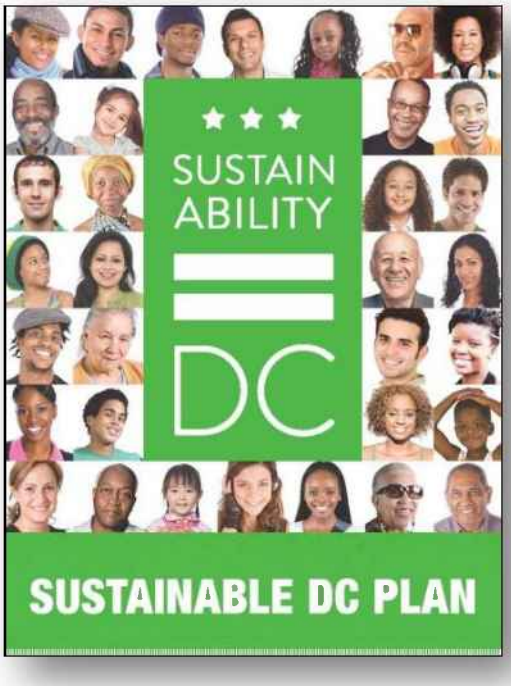
Notes:
1. With Consent Decree Modification and Capital Improvement Progam projects deferred to achieve residential sewer + Impervious Area Charge not more than 2% of household income for incomes at upper limit of second quintile, adjusted for cost of living in Washington DC or $33,926 in 2013. See Section 4 and Appendix E of the *Long Term Control Plan Modification for Green Infrastructure* for a detailed description of the analysis.

4. *Opportunity for Local, Green Jobs*

GI will increase opportunities for local, green jobs both for construction and for long term maintenance of the facilities. DC Water's economic analysis suggests that GI has the potential to create about 190 more local jobs over three decades than the current plan. See Appendix D of the *Long Term Control Plan Modification for Green Infrastructure* for details.

5. *Supports Sustainable DC Plan*

DC Water's GI program supports and advances the District's plan to make it the healthiest, greenest, most livable city in the nation over the next 20 years.



Sustainable DC Plan
(http://sustainable.dc.gov/)

Why is Time Needed to Implement the Hybrid GI Approach for the Potomac River and Rock Creek?

DC Water has determined that an extension of the schedule is required in order to implement the GI hybrid approach in the District's Potomac River and Rock Creek watersheds. Specifically, additional time is needed to implement GI for the following reasons:

- **Large-scale GI is new in the District.** Given the scale of such a project, time will

be needed to select GI technologies suitable for urbanized areas, address planning issues, develop agreements, and perform outreach to ensure successful GI implementation.

- **Adaptive Management.** DC Water will use an Adaptive Management Approach to implement GI. This means that projects will be constructed in a sequential fashion. In between construction phases, the projects will be monitored and assessed to evaluate their performance. Data collected and lessons learned during the monitoring will be used when planning and designing the next round of GI projects. This will ensure that the GI projects are practical and effective for CSO control and the betterment of the community.

Under both the existing and recommended plans, additional time will be needed to implement the Potomac Tunnel, due to the following:

- **New Federal Requirement to Prepare Environmental Impact Statement.** The development of the LTCP and the Consent Decree included a significant public process to select the CSO controls for each receiving water. Since the existing CSOs are located on National Park Service (NPS) property, and the Potomac Tunnel facilities may have a significant impact on their property, the NPS is requiring that an Environmental Impact Statement be prepared for the Potomac Tunnel. This was not envisioned when the schedule in the Consent Decree was entered in 2005. The NPS indicates that at least three years should be allowed for this process.

Green Roof at Eastside Pumping Station

- **Planning and Location Challenges.** The Potomac riverfront has changed significantly since the existing plan was finalized. The NPS has improved and completed facilities along the riverfront such as the Georgetown Waterfront Park, leaving few undeveloped or vacant sites other than valuable parkland in which to construct facilities. As a result, planning and obtaining approval for the Potomac facilities will take considerably longer than previously anticipated. DC Water's GI proposal will allow shortening the Potomac Tunnel, thereby minimizing impacts to riverfront resources such as the

Schedule Comparison – Existing and Recommended Plans

Georgetown Waterfront Park.

Together, the Environmental Impact Statement and planning and location challenges are expected to extend completion of the Potomac Tunnel beyond the 2025 deadline in the existing plan. DC Water's recommended schedule extension accounts for this anticipated extension.

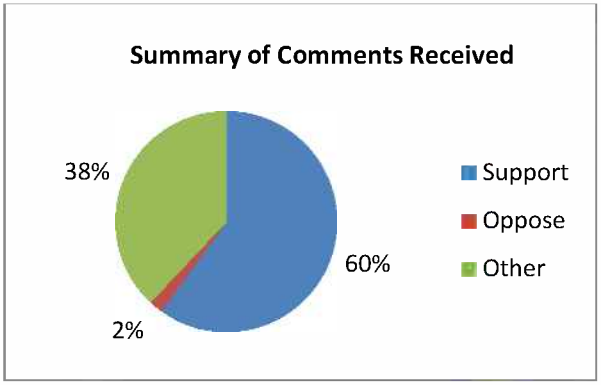
- **Utility Relocation.** Experience gained on the Anacostia River Tunnel System demonstrates that up-front time is needed to identify utilities and arrange for relocation prior to tunnel and shaft construction. This increases the time required to construct the Potomac Tunnel.

Public Comments and Responses

DC Water issued its Proposed Draft LTCP Modification to include GI in January 2014. The public comment period was open from January 12, 2014 through April 14, 2014. An extensive public outreach program was conducted to provide information about the Proposed Draft LTCP Modification and to solicit public comments. In response to the outreach, 366 commenters submitted 471 comments on the draft LTCP Modification for GI. The comments received have been bound in a separate report titled "*Public Comments, Long Term Control Plan Modification for Green Infrastructure,*" DC Water, May 2015 and a detailed response to the comments is provided in Appendix K.

Bioretention at DDOE Headquarters, 1200 First Street NE

The figure shows the disposition of the comments, with the majority of comments supporting the Proposed Draft LTCP Modification.



DC Water has made significant revisions to the draft plan in response to the comments. The key comments received and revisions to the plan are summarized below:

Nature of Commitment

DC Water's Proposed Draft LTCP Modification included committing $60 million for GI in Rock Creek and $30 million for GI for the Potomac CSOs 027, 028 and 029. This magnitude of expenditures was based on the estimated costs of the GI. A limit on the financial commitment was proposed given the uncertainties in terms of the cost to construct GI and in order to manage these risks to ratepayers. There was also precedent for a financial commitment in other enforceable documents such as New York City's order with the State of New York to construct GI.

Some commenters indicated that a financial commitment would not ensure that the

necessary amount of GI was constructed to provide the degree of CSO control required. These commenters suggested that the commitment to GI should be expressed in terms of acres of GI constructed, gallons stored, or a performance standard other than or in addition to a financial commitment.

In response to these comments, DC Water has removed the limit on its financial commitment to GI and expressed the commitment in terms of constructing sufficient GI and targeted sewer separation to manage the volume of runoff produced by 1.2" of rain falling on the number of impervious acres specified for the applicable sewershed. This is a commitment to manage a specified volume of runoff and will ensure that the necessary amount of GI is in place in order to provide the degree of CSO control required.

Feasibility/Effectiveness of GI

Some commenters indicated that GI may not be feasible to construct at a sufficient application rate to provide the degree of CSO control needed, or may not be as effective as anticipated.

Green Roof During Construction at DC Water's East Side Pumping Station

Given the lack of large scale implementation of GI in the District, DC Water has revised the LTCP Modification to provide for constructing the first GI project in the Potomac and Rock Creek sewersheds and then evaluating GI in terms of constructability, operability, efficacy, public acceptability and cost effectiveness. If, based on that evaluation, it is determined that it is impractical to complete all of the specified GI projects by the specified deadlines, then DC Water would be required to construct the gray controls as specified in the LTCP Modification. Should this occur, DC Water would be required to construct the gray controls within the same timeframe allowed for GI so there is no extension of the time allowed for implementation. If GI is determined to be practicable after the first project, then DC Water will continue to implement the remaining GI projects by the specified deadlines.

Schedule

Some commenters suggested that the seven year extension was too long and advocated for a shorter schedule. In addition, some commenters urged DC Water to accelerate individual components of the controls where feasible.

For GI, the schedule extension allows an adaptive management approach to be implemented to ensure that performance of the GI projects is optimized. Adaptive management means early GI projects will be monitored and assessed so that later projects are as practical and effective as possible. In response to comments, DC Water has evaluated the engineering, fiscal and practicality issues and has revised the modification to complete projects as early as practical. In addition, the separation at CSO 025 and 026 and Piney

Facility	Place in Operation Deadline		
	Proposed Draft LTCP Modification	Recommended Final LTCP Modification	Change
Potomac River			
1. Separate CSO 025, 026	2032	2023	9 years earlier
2. Potomac GI	2028	2027	1 year earlier
3. Potomac Tunnel	2030	2030	No change
Rock Creek			
4. Piney Branch Diversion Str. Improvements	2032	2020	12 years earlier
5. Rock Creek GI	2032	2030	2 years earlier

Branch Diversion Structure improvements have been substantially accelerated. The schedule revisions are summarized in the table above.

For the Potomac Tunnel, extra time in the schedule is needed compared to the original LTCP plan due to a new requirement to complete environmental studies, in view of the increased development in recent years along the Potomac River waterfront, and to mitigate the tremendous financial impacts on ratepayers. It is therefore not feasible to shorten the schedule for the Potomac Tunnel earlier than 2030.

Disruption due to Tunnel in Georgetown, NPS Property and Mall area

Some commenters expressed concern about potential disruption caused by tunneling, particularly in the Georgetown and National Park areas.

The Proposed Draft LTCP Modification included a 21 million gallon, approximately 4,500 foot long Potomac Tunnel to capture CSOs 020-024, a new pumping station to empty the tunnel and the addition of 75 million gallon per day of capacity at the Tunnel Dewatering Pumping Station and Enhanced Clarification Facility at Blue Plains. As part of the response to comments, DC Water has evaluated an approximately 23,000 foot long gravity Potomac Tunnel that would run from the Potomac River CSOs to connect to the Blue Plains Tunnel at Joint Base Anacostia-Bolling (formerly Bolling Air Force Base). This would eliminate the need for a tunnel dewatering pumping station for the Potomac Tunnel. This is advantageous because of the complexity of the station, the difficulty in siting such a facility in the vicinity of the National Mall area, long term operational and power requirements and costs and the need for a permanent building associated with a large deep pumping station. The alternative gravity tunnel provides substantially less disruption both

Bioretention Facility

DC Water Bioretention Facility at Irving St NW

during and after construction.

The gravity Potomac Tunnel also allows interconnecting the storage volumes of the Potomac and Anacostia River Tunnel Systems into one tunnel system, allowing any CSO on either water body access to the entire storage volume of both tunnels. DC Water's analyses have demonstrated that a 30 million gallon gravity Potomac Tunnel for CSO 020-024 connected to the Blue Plains Tunnel provides a degree of CSO control equal to the LTCP without the need to expand the Blue Plains Tunnel Pumping Station and wet weather treatment system. The gravity tunnel offers greater reliability and avoids a new pumping station, making it the recommended plan.

Stewardship for Ratepayer Dollars

Some commenters expressed concern over affordability for ratepayers.

DC Water is acutely aware of the heavy financial burden born by District ratepayers to implement the DC Clean Rivers Project and has taken steps to both mitigate and spread out water rate increases over time. Unfortunately, this is not voluntary spending by DC Water but is mandated to comply with the Clean Water Act through a Federal Consent Decree signed by the Department of Justice, EPA, the District of Columbia and DC Water. The Final LTCP Modification will mitigate rates by extending the schedule for the Potomac Tunnel, thereby slowing the rate of increase in rates compared to what otherwise would be required.

Maintenance

Some commenters expressed the importance of maintenance in assuring the GI is effective over the long term.

DC Water will perform maintenance or will arrange for others to perform maintenance of all GI implemented to control CSOs. DC Water will be ultimately responsible to ensure that maintenance is performed adequately to maintain the CSO reduction functions of the GI. DC Water also anticipates that this will be a requirement included in its National Pollutant Discharge Elimination System (NPDES) Permit issued by EPA.

Green Roof at Ft. Reno Reservoir

Support for Green Jobs

Some commenters supported the long term economic benefits of GI, specifically the ability to make jobs more accessible to unemployed local residents. This is especially true considering labor required to construct the facilities, as well as that required for long term maintenance.

GI will increase opportunities for local, green jobs both for construction and for long term maintenance of the facilities. DC Water will work to promote green jobs with a living wage for District residents. Activities may include establishing a certification program for GI jobs, partnering with organizations to provide training that ultimately leads to certification, conducting outreach in the District and partnering with local organizations.

Where Can I Obtain More Information?

More information is available on DC Water's website at www.dcwater.com/green or by contacting DC Water's Office of External Affairs at (202) 787-2200.

1 Introduction

1.1 Purpose

The District of Columbia Water and Sewer Authority (DC Water) is implementing a Long Term Control Plan (LTCP or DC Clean Rivers Project, DCCR) to control combined sewer overflows (CSOs) to the District's waterways. The DCCR is comprised of a variety of projects including pumping station rehabilitations, targeted sewer separation, green infrastructure at DC Water facilities and a system of underground storage/conveyance tunnels to control CSOs. The DCCR is being implemented in accordance with a Consent Decree (LTCP Decree) signed by DC Water, the District and the U.S Government that specifies the schedule for implementation. The Consent Decree is provided in Appendix A. Projects on the Anacostia River are first in the schedule and DC Water is implementing those projects in accordance with the Decree.

The purpose of this document is to provide information to the public on a proposed modification to the LTCP to incorporate Green Infrastructure (GI) on a large scale. The tunnel projects for the Potomac River and Rock Creek are later in the schedule and facility planning for those projects is scheduled to start in 2015 and 2016, respectively. Because of this, there is time to revise the LTCP to allow construction of a hybrid green/gray CSO controls instead of the all gray controls currently planned.

Unlike single-purpose gray infrastructure which uses tanks, tunnels and pipes to store and convey CSO, GI uses vegetation and soil to manage stormwater where it falls. GI has the ability to reduce stormwater and CSOs, and provide multiple environmental, social and economic benefits. Examples of these benefits include improved air quality, reduction in heat island effects, improved property values and local job creation. In addition, GI consists of many small projects which can be brought on line as soon as individual projects are completed. In contrast, gray CSO projects can typically only be brought on line when all the elements are completed. Because of this, GI projects can provide earlier CSO reduction than all-gray projects.

Based on an assessment of the sewersheds, DC Water's recommended plan is to implement hybrid CSO controls for the Potomac and Rock Creek as follows:

- In Rock Creek, construct GI instead of the Piney Branch tunnel to control the Piney Branch CSO
- On the Potomac River, construct a hybrid green and gray control system for the Potomac River CSOs

This document provides the bases and rationale for the proposed change to the LTCP to allow implementation of hybrid green/gray controls.

1.2 Background

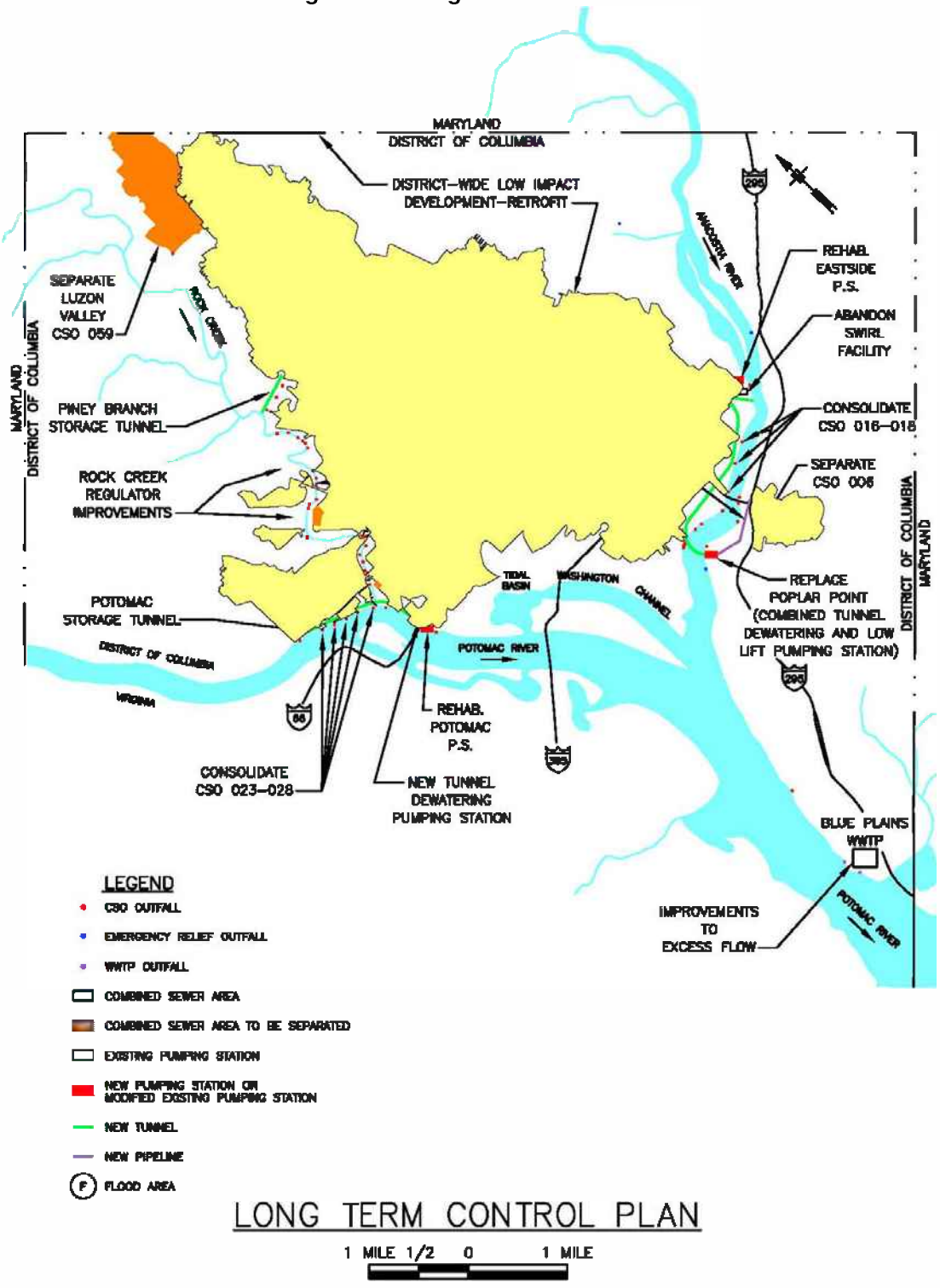
1.2.1 Long Term Control Plan

Like many older cities in the United States, the sewer system in the District is comprised of both combined sewers and separate sanitary sewers. A combined sewer carries both sewage and runoff from storms. Modern practice is to build separate sewers for sewage and stormwater, and no new combined sewers have been built in the District since the early 1900's. Approximately one-third of the District (12,478 acres) is served by combined sewers. The majority of the area served by combined sewers is in the older developed sections of the District.

In the combined sewer system, sewage from homes and businesses during dry weather conditions is conveyed to the District of Columbia's Advanced Wastewater Treatment Plant at Blue Plains (Blue Plains), which is located in the southwestern part of the District on the east bank of the Potomac River. There, the wastewater is treated to remove pollutants before being discharged to the Potomac River. When the capacity of a combined sewer is exceeded during storm events, the excess flow, which is a mixture of sewage and stormwater runoff, is discharged to the Anacostia and Potomac Rivers, in addition to Rock Creek and tributary waters, through outfalls. This excess discharge during storm events is called CSO. A total of 47 active CSO outfalls are listed in DC Water's NPDES Permit issued by the United States Environmental Protection Agency (EPA).

Communities with combined sewer systems are required to prepare long term plans for control of CSOs in accordance with the 1994 CSO Policy at Section 402 (q) of the Clean Water Act. In accordance with the CSO Policy and its NPDES permit requirements, DC Water submitted a Draft LTCP to EPA in 2001. After an extensive public participation program which generated over 2,300 comments on the Draft LTCP, DC Water submitted a Final LTCP to EPA in 2002. The Final LTCP is shown on Figure 1-1. The DC Department of the Environment (formerly Department of Health) and EPA approved the Final LTCP and determined that CSOs remaining after implementation of the plan would not cause or contribute to the exceedance of water quality standards, subject to post construction monitoring. Regulatory agencies also determined that the CSOs remaining after implementation of the plan would comply with total maximum daily loads (TMDLs) established for the receiving waters. An extended executive summary of the LTCP called Control Plan Highlights is provided in Appendix B.

Figure 1-1. Long Term Control Plan



1.2.2 Total Nitrogen Removal/ Wet Weather Plan

On April 5, 2007, EPA issued a modification to DC Water's NPDES permit. The permit modification included a total nitrogen effluent limit for Blue Plains of 4.689 million pounds per year. The total nitrogen limit was developed by EPA to achieve the goals of the Chesapeake Bay Program for nutrient reductions. In addition to meeting the new effluent limit for total nitrogen, DC Water had existing NPDES Permit requirements for treating wet weather flows at Blue Plains. The latter requirement is part of DC Water's LTCP for the combined sewer system.

When the LTCP was finalized in 2002, there was no effluent limit for total nitrogen in DC Water's NPDES permit for Blue Plains and the LTCP. The imposition of the new total nitrogen limit could require a modification to the LTCP and its implementation schedule. DC Water conducted evaluations to assess the impact of adding the new total nitrogen effluent limit on top of the LTCP and existing NPDES permit requirements for treating wet weather flows. On October 12, 2007, DC Water submitted its Final Total Nitrogen Removal/Wet Weather Plan (TN/WW Plan) to EPA. The TN/WW Plan is provided as a companion document to the Consent Decree Modification.

Under the LTCP and the NPDES permit existing at the time, Blue Plains was rated for an annual average flow of 370 mgd. During wet weather events, flows up to 740 mgd receive complete treatment for up to 4 hours. After the first 4 hours, the complete treatment capacity is reduced to 511 mgd to protect the biological process. Additional flows of up to 336 mgd that exceed the complete treatment capacity of the plant receive excess flow treatment, which consists of screening, grit removal, primary treatment and disinfection before being discharged to the Potomac River. This provides a total treatment capacity of 1076 mgd for the first four hours and 847 mgd thereafter.

The TN/WW Plan modified the plant treatment capacities and the handling of flows during wet weather. The major components of the TN/WW Plan are as follows:

- Complete treatment capacity – Blue Plains will provide complete treatment up to 555 mgd for the first four hours and 511 mgd thereafter. In accordance with the existing NPDES permit, combined sewer system flow (CSSF) conditions (i.e., wet weather events) exist and start when plant influent flow is greater than 511 mgd. CSSF conditions stop four hours after plant influent flow drops below 511 mgd or 4 hours has elapsed since the start of CSSF conditions, whichever occurs last.

- Enhanced nitrogen removal (ENR) – ENR facilities will be constructed with capacity to provide complete treatment for the flow rates identified above and to meet the new total nitrogen effluent limit.

- Enhanced Clarification Facility (ECF) – A 225 mgd ECF facility will be constructed at Blue Plains.

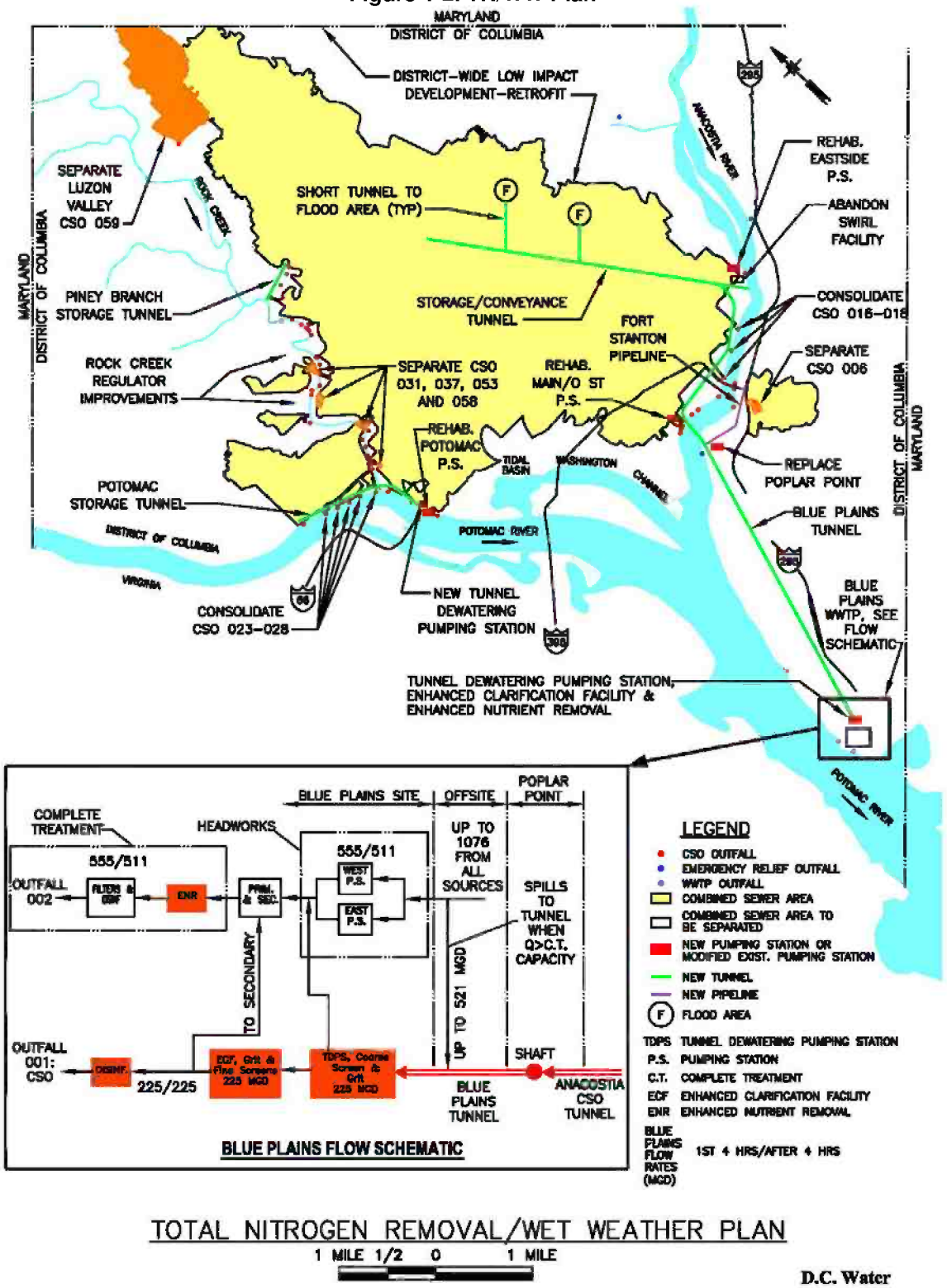
- Tunnel to Blue Plains and System Storage Volume – A new tunnel is being constructed from Poplar Point to Blue Plains. The total tunnels system storage volume will be increased from 126 mg to 157 mg. This new tunnel segment will not only serve as a flow equalization

facility but will also allow a reduction in the required capacity of the ECF and the peak flow rates that receive complete treatment at the Plant.

- Outfall Sewer Overflow to Blue Plains Tunnel – Connections between the existing Outfall sewers on the influent side of Blue Plains and the tunnel to Blue Plains will be constructed. These facilities will allow flow from the collection system that exceeds the complete treatment capacity of the plant to overflow into the tunnel.

- Tunnel Dewatering Pumping Station – Under the Final LTCP, a tunnel dewatering pumping station was proposed to be constructed at the tunnel terminus at Poplar Point. As part of the TN/WW plan, the same tunnel dewatering pumping station is relocated to the new terminus of the tunnel at Blue Plains. The pumping station will be sized to have a minimum firm capacity of 225 mgd, equal to the capacity of the ECF. In addition, the facility will have the ability to dewater the tunnel system up to the new ECF and be able to discharge ECF effluent to complete treatment and discharge at Outfall 002 or at Outfall 001. Figure 1-2 shows the TN/WW plan.

Figure 1-2. TN/WW Plan



1.3 Consent Decrees

DC Water has entered into two consent decrees (CD) related to its CSO program. Each of these decrees is described below:

Three-Party Consent Decree - Civil Action No. 1:00CV00183TFH and No. 02-2511 (TFH)
DC Water and the District of Columbia entered into this CD with the United States Government and certain citizen plaintiffs to resolve allegations regarding the combined sewer system (CSS). The CD was lodged with and entered by the court on June 25, 2003 and October 10, 2003, respectively. The CD provides a schedule for implementation of various operation and maintenance-type items associated with DC Water's Nine Minimum Controls Program. In addition, the CD provides a schedule for replacement of the inflatable dams in the CSS and for rehabilitation of DC Water's pumping stations.

Long Term Control Plan Consent Decree - Civil Action No. 1:CV00183TFH
DC Water and the District of Columbia entered into this CD with the United States Government. The CD was entered by the court on March 23, 2005, and provides a schedule for implementation of the LTCP.

DC Water is proposing to modify the LTCP as described in subsequent sections.

1.4 Partnership Agreement

On December 10, 2012, the EPA, District of Columbia and DC Water signed a Partnership Agreement (PA) to advance Green Infrastructure for urban wet weather pollution control. The PA is included in Appendix C. The PA established a framework and working relationship between the parties to support sustainable stormwater management that can yield multiple benefits for community livability. The PA also demonstrates each party's commitment to GI. The following is a summary of the commitments in the PA:

All Parties (EPA, District, DC Water)

- Implement a Green Design Challenge to engage private sector in demonstrating and advancing GI
- Enlist participation by public and private organizations in a collaborative effort to develop next generation GI designs
- Facilitate participation by local academic institutions in various aspects of the GI Demonstration Project
- Actively involve the environmental community in the GI initiative to facilitate implementation based on an agreed upon course of action
- Review and assess the water quality benefits and impacts of alternative green and gray/green controls compared to the benefits and impacts of the controls now required in the Potomac and Rock Creek watersheds.

DC Water and District

- Consult with each other on a continuing basis to ensure that the GI Demonstration Project, water quality review and assessment, and alternatives analysis conform to EPA's expectations and Clean Water Act requirements.

DC Water

- Once regulatory framework is in place, conduct GI demonstration project
- Prepare EIS required for the Potomac Storage Tunnel

EPA

- Communicate with EPA's Office of Research and Development (ORD) on the progress of the GI Demonstration Project and opportunities for ORD's involvement.
- Assist DC Water in sharing the results of its GI Demonstration Project work so that other communities nation-wide can benefit from DC Water's experiences

The PA also lays out a procedure for modifying the Consent Decree which consists of the following steps:

- DC Water submits draft proposed CD Modification package to EPA
- DC Water public notices proposed CD Modification package within 60 days of receiving EPA comments
- Public Notice the CD Modification package for 60 days
- DC Water responds to comments and submits revised proposed CD Modification Package to EPA in 21 days
- EPA/DOJ determines whether or not to support the proposed CD Modification and makes the corresponding recommendation to the court
- Federal Judge decides whether to accept recommendation from EPA/DOJ
- Consent Decree is modified

Note that in lieu of constructing a demonstration project for GI, DC Water is now proposing to construct hybrid green/gray CSO controls.

1.5 CSO Controls in LTCP Consent Decree

The LTCP Consent Decree specifies the schedule for implementation of the DCCR. The major requirements of the decree are described in the following subsections.

1.5.1 Anacostia River Projects

The Anacostia River Projects components included in the LTCP Consent Decree are summarized in Table 1-1.

Table 1-1. Anacostia River Projects in LTCP Decree

Component	Description
Anacostia River	
Storage Tunnel from Poplar Point to Northeast Boundary Outfall	49 million gallon storage tunnel between Poplar Point and Northeast Boundary. Tunnel will intercept CSOs 009 through 019 on the west side of the Anacostia. Project includes new tunnel dewatering pumping station and low lift pumping station at Poplar Point.
Storage/Conveyance Tunnel Parallel to Northeast Boundary Sewer	77 million gallon storage/conveyance tunnel parallel to the Northeast Boundary Sewer. Also includes side tunnels from main tunnel along West Virginia and Mt. Olivet Avenues NE and Rhode Island and 4th St NE to relieve flooding. Abandon Northeast Boundary Swirl Facility upon completion of main tunnel.
Outfall Consolidation	Consolidate the following CSOs in the Anacostia Marina area: CSO 016, 017 and 018
Separate CSO 006	Separate this CSO in the Fort Stanton Drainage Area
Ft Stanton Interceptor	Pipeline from Fort Stanton to Poplar Point to convey CSO 005, 006 and 007 on the east side of the Anacostia to the storage tunnel.

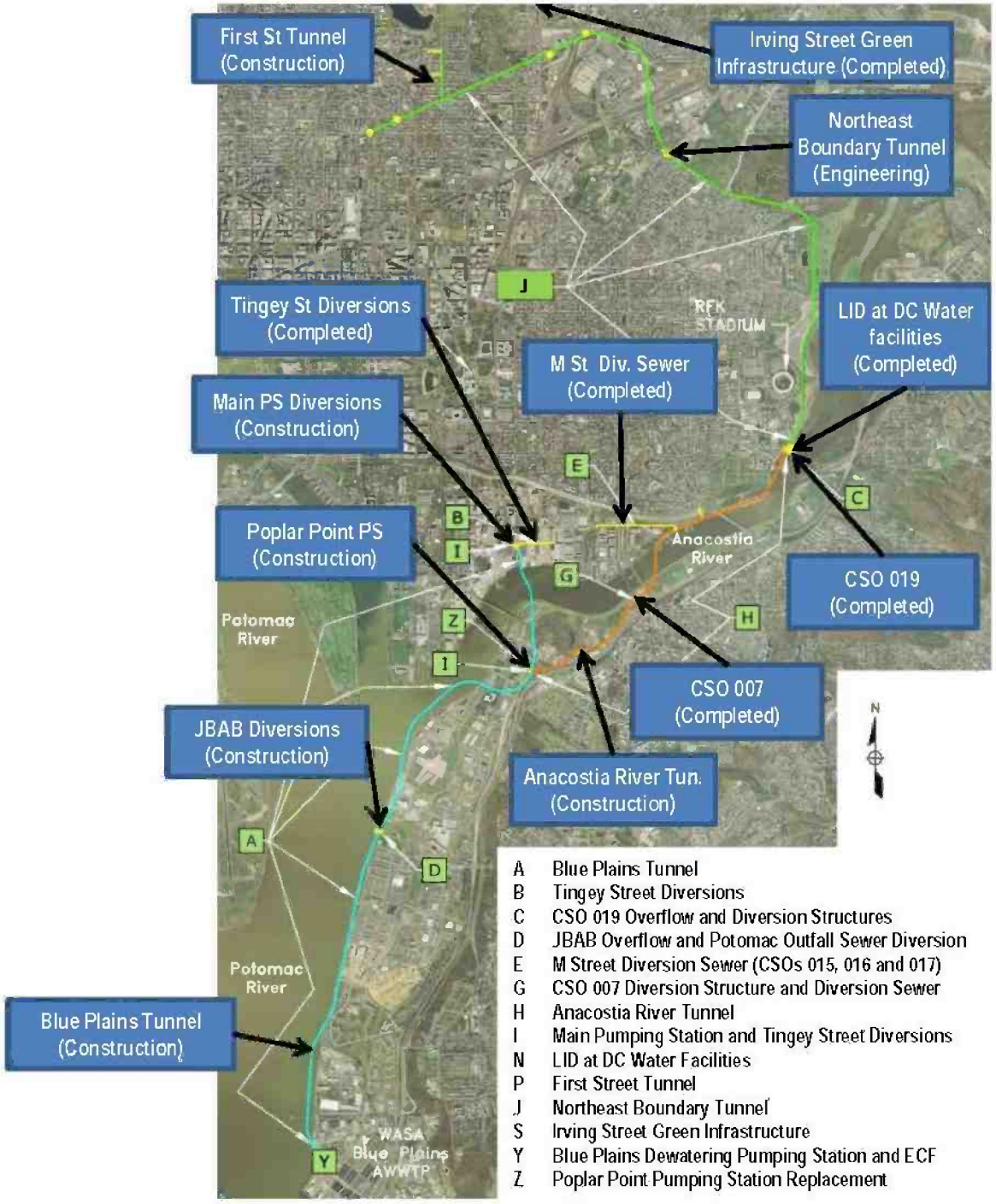
As a result of the TN/WW Plan, DC Water has added 31 mg of storage to the Anacostia Tunnel system for a total of 157 mg of storage. This was accomplished by extending the tunnel from Poplar Point to Blue Plains and constructing the tunnel dewatering pumping station at Blue Plains in lieu of Poplar Point. These and other changes to the LTCP are not reflected in the LTCP Decree. DC Water is proposing to modify the LTCP to conform it to the TN/WW Plan.

Based on the current level of planning, the Anacostia River Projects have been divided into various contract divisions to facilitate implementation. There is one contract division proposed for each of the three major tunnel segments and their associated shafts. The other contract divisions are comprised of near-surface diversion structures, associated diversions, junction sewers and the tunnel overflow structures. The planned contract divisions are listed in Table 1-2. Figure 1-3 shows the contract divisions and the current status of implementation.

Table 1-2. Planned Contract Divisions for Anacostia River Projects

Contract Division	Description
A	Blue Plains Tunnel
B	Tingey Street Diversion Sewer for CSOs 013 and 014
C	CSO 019 Overflow and Diversion Structures
D	Joint Base Anacostia-Bolling Overflow and Diversion Structures
E	M Street Diversion Sewer (CSOs 015, 016, and 017)
G	CSO 007 Diversion Sewer
H	Anacostia River Tunnel
I	Main Pumping Station Diversions
N	Low Impact Development at DC Water Facilities
J	Northeast Boundary Tunnel
P	First Street Tunnel
S	Irving Street Green Infrastructure
Y	Blue Plains Tunnel Dewatering Pumping Station and Enhanced Clarification Facility
Z	Poplar Point Pumping Station Replacement

Figure 1-3. Anacostia River Projects Status (as of May 2015)



1.5.2 Potomac River Projects

The control measures selected for the Potomac River are predicted to limit overflows to four events per average year. The principal control measures include rehabilitation of the Potomac Pumping Station and construction of a storage tunnel from west of the Key Bridge, along the Potomac River waterfront parallel to Georgetown, and terminating at Potomac Pumping Station. The tunnel will intercept the Georgetown CSOs and the large CSOs downstream of Rock Creek. A new pumping station would be constructed to dewater the tunnel. In addition, the LTCP will consolidate and close all CSOs between the Key Bridge and Rock Creek to remove the impact of these CSOs from the Georgetown waterfront area.

The major elements of the Final LTCP for the Potomac River Projects are summarized in Table 1-3 and are shown on Figure 1-4.

Table 1-3. Potomac River Projects

Component	Description	Status (as of May 2015)
Potomac River		
Replace Inflatable Dams (1)	Replace inflatable dams at Potomac River CSOs where these are installed	Completed
Rehabilitate Potomac Pumping Station (1)	Rehabilitate station to firm 460 mgd pumping capacity	Completed
Outfall Consolidation (2)	Consolidate CSOs 023 through 028 in the Georgetown Waterfront Area.	Future work
Potomac Storage Tunnel (2)	58 million gallon storage tunnel from Georgetown to Potomac Pumping Station. Includes tunnel dewatering pumping station	Future work

Notes:
(1). Required by Three Party Consent Decree
(2). Required by LTCP Consent Decree

Figure 1-4. Potomac River Projects

1.5.3 Rock Creek Projects

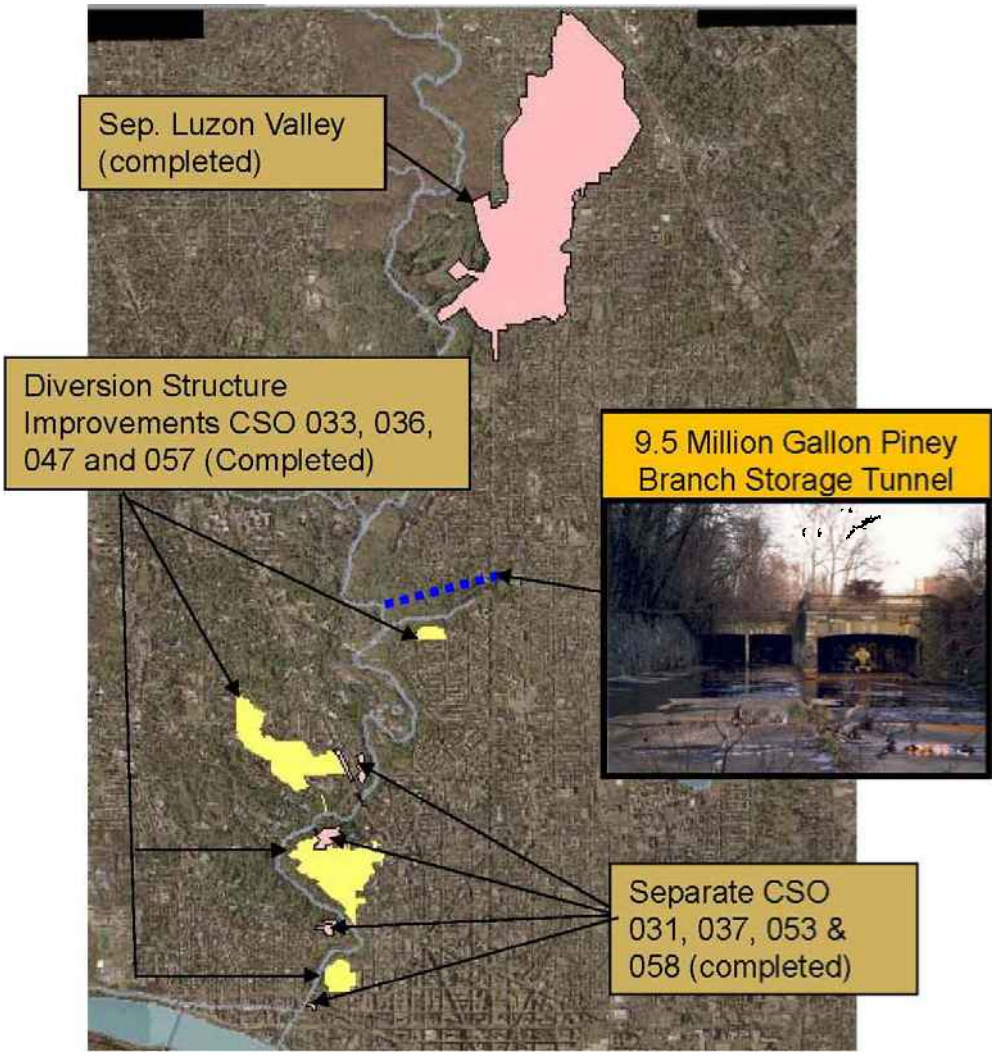
The control measures in the LTCP for Rock Creek are predicted to limit Piney Branch overflows to one per average year. The remaining overflows in Rock Creek will be controlled to 4 events per average year. The principal control measures include separation of four CSOs, construction of a storage tunnel at Piney Branch, and monitoring and regulator improvements to four CSOs south of Piney Branch.

The major elements of the Final LTCP for Rock Creek are summarized in Table 1-4 and are shown on Figure 1-5.

Table 1-4. Rock Creek Projects

Component	Description	Status (as of May 2015)
Rock Creek		
Separate Luzon Valley	Separate CSO 059	Completed
Separation	Separate CSOs 031, 037, 053, and 058.	Completed
Monitoring at CSO 033, 036, 047 and 057	Conduct monitoring to confirm prediction of overflows. If overflows confirmed, then perform the following: • Regulator Improvements: Improve regulators for CSO 033, 036, 047 and 057. • Connection to Potomac Storage Tunnel: Relieve Rock Creek Main Interceptor to proposed Potomac Storage Tunnel when it is constructed	Completed
Storage Tunnel for Piney Branch (CSO 049)	9.5 million gallon storage tunnel	Future work

Figure 1-5. Rock Creek Projects



1.5.4 System-Wide Improvements

The LTCP also includes the following system-wide improvements:

- Low Impact Development Retrofit (LID-R) at DC Water Facilities – the Decree requires DC Water to construct $3 M of LID at DC Water facilities and to evaluate the effectiveness of these measures. The projects are complete.

- Excess Flow Treatment Improvements at Blue Plains – the Decree requires the addition of four new primary clarifiers and improvement to the excess flow treatment control and operations. Because of the TN/WW plan, these improvements have been deleted and are scheduled to be replaced by a new 225 mgd enhanced clarification facility (ECF).

1.5.5 Consent Decree Schedule

There are numerous deadlines and interim milestones in the LTCP Decree. Major deadlines are summarized in Table 1-5.

Table 1-5. Key Deadlines in LTCP Consent Decree

Item	Deadline Type	Deadline
Anacostia River Projects		
CSO 006 Separation	Place in Operation	Completed -2010
Tunnel from Blue Plains to RFK Stadium	Place in Operation	March 23, 2018
Complete System	Place in Operation	March 23, 2025
Potomac River Projects		
Potomac Tunnel	Start Facility Plan	Completed - 2015
	Award Design Contract	March 23, 2018
	Award Construction Contract	March 23, 2021
	Place in Operation	March 23, 2025
Rock Creek Projects		
Separate CSO 059 Luzon Valley		Completed - 2002
Separate CSO 031, 037, 053, 058		Completed - 2011
Rock Creek Regulator Improvements		Completed - 2013
Piney Branch Tunnel	Start Facility Plan	March 23, 2016
	Award Design Contract	March 23, 2019
	Award Construction Contract	March 23, 2022
	Place in Operation	March 23, 2025
System-Wide		
LID-R at DC Water Facilities	Place in Operation	Completed - 2014

1.6 Predicted CSO Reduction

The DC Department of the Environment (formerly Department of Health) and EPA approved the Final LTCP and determined that CSOs remaining after implementation of the plan would not cause or contribute to the exceedance of water quality standards, subject to post construction monitoring. Regulatory agencies also determined that the CSOs remaining after implementation of the plan would comply with total maximum daily loads (TMDLs) established for the receiving waters. Table 1-6 shows the CSOs predicted as a result of implementation of the DCCR.

Table 1-6. Key Deadlines in LTCP Consent Decree

Item	Anacostia River	Potomac River	Rock Creek	Total
CSO Overflow Volume (mg/avg. yr.)				
1996 – DC Water formed	2,142	1,063	49	3,254
2015 – After inflatable Dams and Pumping Station rehabilitations	1,258	654	48	1,960
2025 – LTCP in Place	54	79	5	138
% Reduction	98%	93%	90%	96%
Number of Overflows (#/avg. yr.)				
1996 – DC Water formed	82	74	30	
2015 – After inflatable Dams and Pumping Station rehabilitations	75	74	30	
2025 – LTCP in Place	2	4	1 / 4 (1)	

Notes:

(1) One overflow per average year at Piney Branch, four overflows per average year at other Rock Creek CSOs

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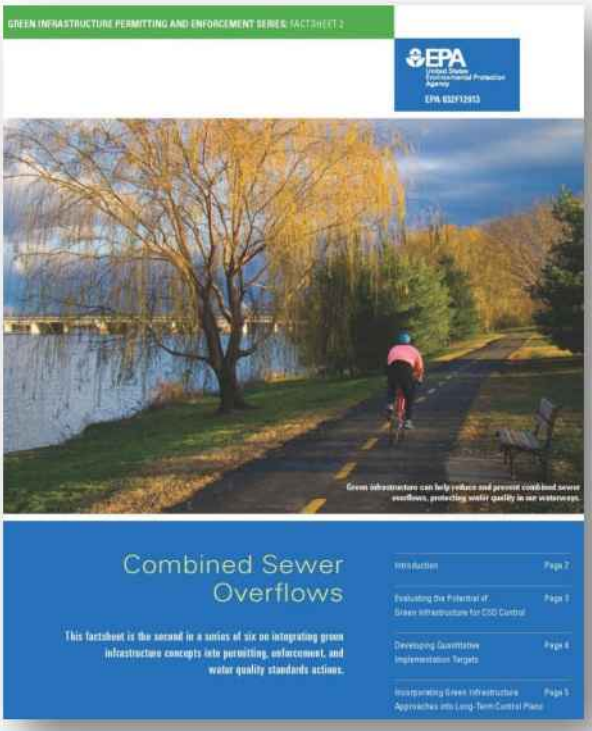
2 Bases for Modification

2.1 New Technology and Recognition by Regulatory Agencies

The LTCP was developed from 1998-2002. At that time, GI was not a well developed and recognized technology for providing CSO control. In addition, there was no formal recognition of the technology by regulatory agencies as a viable method for providing CSO control. Because of this and other factors, GI in the LTCP was limited to a $3 M demonstration project at DC Water facilities.

Since development of the LTCP, GI has been recognized as a potentially viable technology for controlling CSOs. Further, EPA strongly encourages the use of GI approaches to manage wet weather flows. Since 2007, EPA's Office of Water has released the following policy memos and documents supporting the integration of green infrastructure into NPDES permits and CSO programs:

- Memorandum, Achieving Water Quality Through Integrated Municipal Stormwater and Wastewater Plans
  In October 2011, EPA's Office of Water (OW) and Office of Enforcement and Compliance Assurance (OECA) issued a joint memo encouraging EPA Regions to assist their state and local partners in pursuing an integrated planning approach to Clean Water Act waste and stormwater obligations. The memo identifies green infrastructure as one example of a comprehensive solution that can improve water quality while supporting other quality of life attributes that enhance the vitality of communities.



EPA Factsheet 2: CSOs

- Memorandum, Protecting Water Quality with Green Infrastructure in Water Permitting and Enforcement Programs
  In April 2011, EPA OW and OECA jointly issued a memo supporting the use of green infrastructure. The memo reaffirms the commitment of both offices to work with interested communities on incorporating green infrastructure into stormwater permits and into remedies for non-compliance with the Clean Water Act.

- Memorandum, Use of Green Infrastructure in NPDES Permits and Enforcement
  In August, 2007, EPA issued a memo encouraging the incorporation of green infrastructure into National Pollutant Discharge Elimination System (NPDES) stormwater permits and CSO

long term control plans. Additionally, the memo states that green infrastructure can and will be used in future EPA enforcement activities.

- Memorandum, Using Green Infrastructure to Protect Water Quality in Stormwater, CSO, Nonpoint Source and other Water Programs
  In March, 2007, Benjamin Grumbles, EPA's Assistant Administrator for Water, issued this memo to promote green infrastructure as a viable stormwater management solution.

- EPA Permitting and Enforcement Series
  In 2012, EPA issued a Permitting and Enforcement series guide to integrating green infrastructure into NPDES wet weather programs. The series consists of six factsheets and four supplements as follows:

  - Factsheet 1: General Accountability Considerations for Green Infrastructure
  - Factsheet 2: Combined Sewer Overflows
  - Factsheet 3: Sanitary Sewer Overflows
  - Factsheet 4: Stormwater
  - Factsheet 5: Total Maximum Daily Loads
  - Factsheet 6: Water Quality Standards
  - Supplement 1: Consent Decrees that Include Green Infrastructure Provisions
  - Supplement 2: Consent Decree Language Addressing Green for Grey Substitution
  - Supplement 3: Green Infrastructure Models and Calculators
  - Supplement 4: Green Infrastructure in Total Maximum Daily Loads

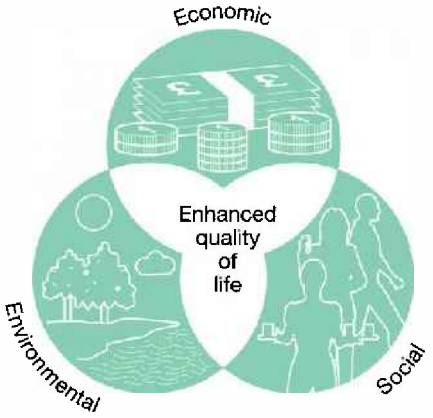
2.2 Added Benefits

Unlike single-purpose gray stormwater infrastructure, which uses tanks, tunnels and pipes to store and convey stormwater, GI uses vegetation and soil to manage stormwater where it falls. GI has the potential to not only reduce stormwater and combined sewer overflows (CSOs), but to provide multiple environmental, social and economic benefits. Known as Triple Bottom Line, the added benefits fall into three categories:

Environmental

- Water Quality and Quantity - By retaining rainfall from small storms, green infrastructure reduces stormwater discharge volumes. Lower discharge volumes translate into reduced combined sewer overflows. Green infrastructure can also mitigate flood risk by slowing and reducing stormwater discharges.

- Air Quality – Increased vegetation can remove pollutants, such as particulate matter and carbon monoxide, thereby improving air quality.



- Urban Heat Island Reduction - The urban heat island (UHI) effect occurs when urban areas replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Trees, green roofs, and other green infrastructure features can cool urban areas by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

US Tax Court Green Roof

- Energy Conservation: GI can reduce local temperatures and shade building surfaces, lessening the cooling demand for buildings, thereby reducing energy needs and decreasing emissions from power plants.

- Carbon Sequestration - Since GI includes plants which use carbon dioxide as part of photosynthesis, GI has the potential to reduce carbon load to the atmosphere and assist with mitigation of greenhouse gases.

- Habitat Improvement - GI can provide habitat for birds, mammals, amphibians, reptiles, and insects. Even small patches of vegetation such as green roofs provide habitat for a variety of insects and birds.

Social

- Health Effects - Increased tree canopy has the potential to reduce ozone and particulate pollution levels enough to benefit mortality, hospital admissions, and work loss days due to illness.

- Enhanced Aesthetics - The aesthetic benefits provided by GI have the potential to increase the quality of life in the District by increasing local jobs, decreasing crime and enhancing the enjoyment of the citizenry

- Reduced Disruption during Construction – Since GI involves primarily construction on a small scale, it can reduce large construction impacts (traffic, noise, dust, closures and relocations) associated with heavy civil construction projects.

Economic

- Poverty reduction/job creation - Specialized labor is required for construction of conventional gray infrastructure (e.g., tunneling). Such skilled laborers might typically be already employed in the construction field. GI creates the opportunity to hire local unskilled – and otherwise unemployed – laborers for landscaping and restoration activities. GI thus can provide an economic boost to the local community and can decrease the costs of social

services that would otherwise be required. The economic benefits of GI in the District are described in a report in Appendix D.

- Enhanced Property Values – Improved aesthetics, decreased crime and increased live-ability can improve property values in the areas where GI is installed.

- Enhanced recreation and improved quality of life - The aesthetic benefits provided by GI have the potential to increase the quality of life in the District by increasing local jobs, property values and recreational space. A recent economic study found that when compared to grey infrastructure, a GI program in the District will provide nearly twice as many local jobs.

2.3 DC Water's GI Investigations

DC Water has invested significant resources and funds ($3.5 M) over the past three years to research and analyze GI for CSO control. This work was documented in technical memoranda which are included in the appendices as follows:

- Appendix E: Economic Impact of Alternative CSO Control Strategies
- Appendix F: Technical Memorandum No. 2 - Approach to Hydrologic and Hydraulic Modeling
- Appendix G: Technical Memorandum No. 4 - The District of Columbia's Experience with Green Infrastructure
- Appendix H: Technical Memorandum No. 5 - Green Infrastructure Experience – Foreign and Domestic Case Studies
- Appendix I: Technical Memorandum No. 6 - Green Infrastructure Technologies
- Appendix J: Technical Memorandum No. 7 - Green Infrastructure Screening for the Potomac River and Rock Creek

Technical Memorandum No. 7 (Screening Analysis) assessed the feasibility of implementing GI by itself or in combination with gray infrastructure. The results showed that there are viable green and green/gray hybrid solutions to CSO control. Based in part on this analysis, DC Water has proposed the hybrid green/gray CSO controls summarized in Section 3.

3 Control Plan for Rock Creek and Potomac River

DC Water is recommending a modification of its LTCP to change the CSO control plan for the largest CSO in Rock Creek (Piney Branch, CSO 049) and the Potomac River CSOs. The control plan includes green and green/gray controls. Each control technology will be used where it is the most appropriate. The hybrid green/gray controls are predicted to provide a degree of CSO control equivalent to the gray controls in the LTCP. The hybrid approach will have a higher socio economic benefit to the District, especially in the communities served by GI. Figure 3-1 at the end of this section compares the recommended controls to those in the existing LTCP.

3.1 Green Controls for Rock Creek's Piney Branch Sewershed

3.1.1 Scope

GI will be constructed in the Piney Branch drainage area in Rock Creek sized to manage the volume of runoff produced by 1.2" of rain falling on 365 impervious acres (30% of the impervious acres) in the sewershed. GI projects may include bioretention practices (bioretention cells, bioswales, vegetated filter strips, and tree box filters), rooftop collection practices (green roofs, blue roofs, downspout disconnection, rain barrels, and cisterns) and permeable pavement. These facilities will be constructed in both public and privately-owned spaces. In addition to GI, targeted sewer separation may be utilized to offload storm water from the combined sewer system.

30% GI Implementation in Rock Creek's Piney Branch Sewershed
Total Sewershed area = 2,329 acres
Impervious area = 1,215 acres
30% of impervious acres = 365 acres
Manage volume of runoff produced by 1.2" of rain falling on 365 impervious acres

In addition to GI, the weir height of the existing diversion structure (Structure 70) serving CSO 049 will be raised to increase the capture of combined sewage. The resulting captured sewage will be diverted to the existing East Rock Creek Diversion Sewer for conveyance to Blue Plains for treatment. This control structure modification is not predicted to increase overflow frequency or volume at other downstream CSOs in the Rock Creek sewershed.

3.1.2 Schedule

GI has not been used at a large scale in dense urban areas to provide a high degree of CSO control. Therefore, there is a need to develop basic information regarding permitting, location of facilities, public outreach and involvement, development of design details and maintenance. DC Water will use an adaptive management approach to implement GI. This means that projects will be constructed in a sequential fashion. Lessons learned on early projects will be used to adjust and improve later projects to make GI successful.

DC Water does not own significant property in the District. Construction of GI therefore requires permits and concurrence from the property owner, which is the District or Federal Government in the majority of cases. Siting of GI in public space will require developing and adopting new policies regarding how to organize public space. Examples include establishing standards regarding how

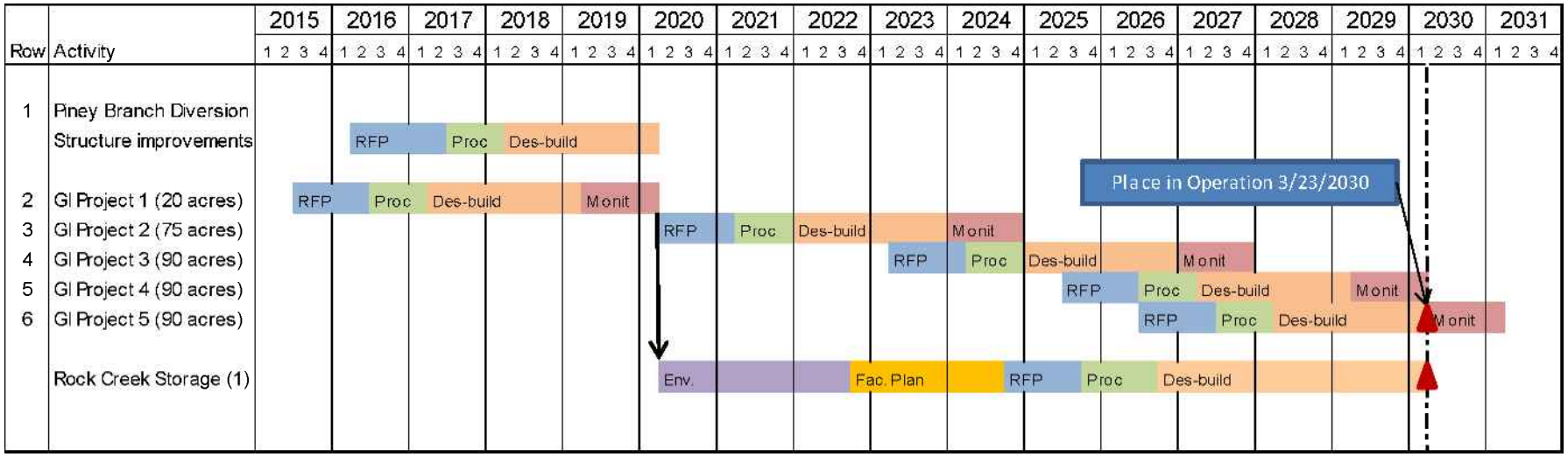
bioretention, parking, cross walks and pedestrian access will coexist in the public right of way. In addition, maintenance standards and responsibilities will need to be established and addressed. Further, codes and regulations will need to be reviewed and possibly revised to encourage and allow GI construction in public space. These institutional and planning issues will need to be addressed in order to have successful implementation of GI.

Because of the items identified above, a schedule extension is required in order to implement GI for CSO control. The current consent decree requires completion of the controls for Rock Creek by March 23, 2025. Based on an adaptive management approach and a review of feasible planning, design and construction schedules, DC Water has determined that an extension of the schedule to March 23, 2030 (5 years) is required in order to implement GI. The Piney Branch diversion structure improvements can be implemented early in the schedule.

Given that there is some uncertainty associated with the ability to implement GI in the District at a large scale, DC Water proposes to construct the first GI project in Rock Creek and then evaluate GI in terms of constructability, operability, efficacy, public acceptability and cost effectiveness. If, based on that evaluation, GI is determined to be impracticable, then DC Water will construct the 9.5 million gallons of storage (gray infrastructure) for the Piney Branch CSO. If GI is determined to be practicable after the first project, then DC Water will continue to implement the remaining GI projects.

Figure 3-2 shows the schedule and the basis for the schedule is summarized below:

- Environmental Approvals: This involves prepare National Environmental Policy Act (NEPA) and District Environmental Policy Act documentation necessary to construct the project.
- Facility Plan: The Facility Plan involves preparing preliminary engineering information necessary for detailed design such as siting, geotechnical data, existing utility, property ownership, design criteria and other information.
- Prepare Request for Proposal (RFP) and Neighborhood Outreach: DC Water anticipates using a design-build process that will require coordination with the District and with neighborhood stakeholders and private property owners. Based on past DC projects, the time needed for outreach and RFP preparation is 12 months for GI projects.
- Procurement: The bidding and award process for GI projects will take 9 months which is typical for DC Water construction contracts. The first contract is anticipated to take only 6 months, accounting for a smaller contract scope.
- Design and Construction: GI and sewer separation projects will be performed using design-build project delivery. Based on the area of coverage and prior DC Water design and construction work under the Anacostia River Projects, each contract will take 2 years.
- Post-Construction Monitoring: The schedule includes 12 months of post construction monitoring. The results will be used to determine the effectiveness in a variety of different rainfall and weather conditions, and to inform the implementation approach for subsequent projects.



Notes:

1. Rock Creek Storage will only be constructed if GI is determined to be impracticable after GI Project 1 in Rock Creek

Figure 3-2. Rock Creek Schedule

3.1.3 Predicted Performance

Hydraulic modeling predictions indicate that GI implementation and modifications to Structure 70 will eliminate the need to construct 9.5 MG of tunnel storage included in the LTCP. The GI program is predicted to provide a degree of CSO control equivalent to the gray controls in the LTCP, as summarized in Table 3-1.

Predicted water quality is summarized in Table 3-2 and the GI controls are predicted to provide a degree of water quality performance in the receiving water equivalent to the gray controls in the LTCP.

Figure 3-3 shows that GI allows earlier reductions in CSO overflow volume than the gray controls because individual GI components provide a benefit as soon as they are placed in operation. This is in contrast to the gray controls which typically require all of the structural components to be completed before the facility provides a CSO reduction benefit.

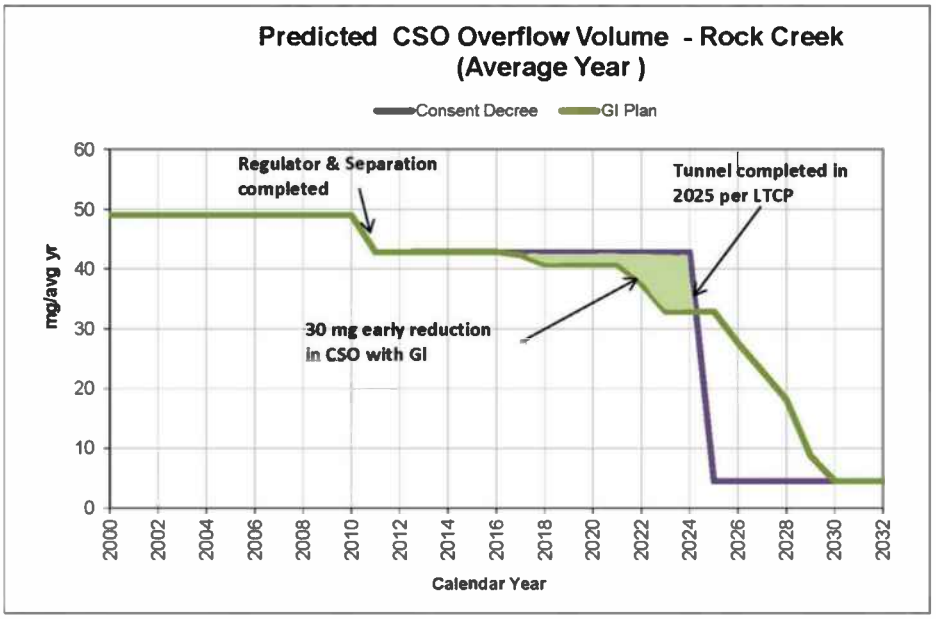


Figure 3-3. Predicted CSO Overflow Volume in Rock Creek

Table 3-1
Piney Branch Predicted CSO Overflows in Average Year

Parameter	Before LTCP[1]	LTCP	Green Controls[2]
No. of Overflows (#/avg yr)	25	1	1
Overflow Volume (mg/avg yr)	39.73	1.41	<1
% reduction from Before LTCP	–	96%	96% or greater

Table 3-2
Predicted Water Quality in
Rock Creek after Piney Branch (Segment 17) in Average Year

Parameter	Before LTCP[1]	LTCP	Green Controls[2]
# Months Fecal Geomean>200 (all loads)	12	12	12
# Months Fecal Geomean>200 (CSO only)	0	0	0
# Days Fecal>200 (all loads)	335	335	335
# Days Fecal>200 (CSO Only)	24	1	1
# Days Fecal>200 (all loads) May - Sept	135	135	135
# Days Fecal>200 (CSO Only) May - Sept	15	1	1
# Months E. Coli Geomean>126 (all loads)	12	12	12
# Months E. Coli Geomean>126 (CSO only)	0	0	0
# Days E. Coli>126 (all loads)	365	365	365
# Days E. Coli>126 (CSO Only)	24	1	1
# Days E. Coli>126 (all loads) May - Sept	153	153	153
# Days E. Coli>126 (CSO Only) May - Sept	15	1	0
# Days D.O.< 5 mg/L (all loads)	0	0	0
# Days D.O.< 5 mg/L (CSO Only)	0	0	0

Notes for Tables 3-1 and 3-2:

1. Results shown for Before LTCP are without Phase1 Controls in place (i.e., without inflatable dams, pumping station rehabilitations and Northeast Boundary Swirl Facility in operation).
2. At the low levels of CSO overflows projected herein, model accuracy is highly dependent on many variables such as the accuracy of rainfall data, information on the drainage area and other factors. Further, additional overflows will occur for rain events which exceed or are not represented in the average year. The model predictions contained herein do not change the level of CSO control determined to be adequate to meet water quality standards which was included by DC Water in its LTCP, and subsequently approved by EPA and the D.C. Department of the Environment.

3.2 Hybrid GI Plan for Potomac River

3.2.1 Scope

DC Water will construct the following controls for the Potomac River CSOs:

- **Potomac Tunnel (CSOs 020 – 024)**
  The Potomac Storage Tunnel will capture CSOs 020 through 024. These outfalls serve the major interceptors draining Rock Creek and the large downtown areas in the Potomac sewershed. Given the large overflow volume produced by these outfalls and the highly urbanized nature of the sewershed, DC Water will construct gray infrastructure to control these CSOs. The tunnel in the LTCP was a 58 million gallon (mg) facility with a tunnel dewatering pumping station at the low end. After rain events, the pumping station would bleed captured flow via the existing system to Blue Plains for treatment. The large size of the tunnel was driven, in part, by the inability to completely dewatering the tunnel during back-to-back rain events.

  As part of this modification, DC Water is proposing to construct a gravity tunnel from CSO 024 to interconnect with the Blue Plains Tunnel on the Anacostia System. The total volume of the Potomac Tunnel will be 30 mg and the tunnel will be emptied by gravity. This configuration will create one interconnected tunnel system. The advantages of this system include:

  - The Potomac and Anacostia Tunnel Systems will be interconnected, with a total system storage volume of 187 mg (30 mg for the Potomac + 157 mg for the Anacostia River Tunnel System). Since rainfall has both geographic and temporal variability, the interconnection of the tunnel system improves the ability of the system to provide CSO control. As an example, intense rain events in one part of the District can utilize the tunnel system volume as needed to control overflows. This, combined with the sewer separation and GI, allows the 30 mg Potomac Tunnel to provide a degree of control equivalent to the gray controls in the LTCP.

  - The gravity tunnel does not require construction of a new pumping station in the National Mall area. This preserves space for other higher value use. In addition, it reduces the need for operation and maintenance associated with a complex mechanical system. Elimination of the pumping station also improves reliability and redundancy since the gravity tunnel does not require electrical power or other mechanical equipment to function.

  - The gravity tunnel improves the reliability and operability of the existing sewer system. The system will be configured such that if the Potomac Pumping Station loses power, then normal sanitary flows in the system will drop into the tunnel by gravity for conveyance to Blue Plains, thereby preventing a dry weather overflow. Further, if the Potomac Pumping Station or the Potomac Force Mains experience

equipment failures or need to be worked on for repair or maintenance, the gravity tunnel can be used as a backup to convey flows to Blue Plains for treatment.

- The gravity Potomac Tunnel is more environmentally responsible because it eliminates the need for an energy intensive pumping station.

- **Separation of Combined Sewers (CSOs 025 – 026)**
  The drainage areas for CSO 025 (17 acres) and CSO 026 (3 acres) are very small and, therefore, it is practical to separate the tributary combined sewers. Separation will result in the elimination of combined sewer overflows from these sewersheds.

CSO 025 Separation
Sewershed = 17 acres

CSO 026 Separation
Sewershed = 3 acres

CSO 027 30% GI Implementation
Sewershed = 164 acres
Impervious = 104 acres
30% GI = 31 acres

CSO 028 30% GI Implementation
Sewershed = 21 acres
Impervious = 13 acres
30% GI = 4 acres

CSO 029 60% GI Implementation
Sewershed = 330 acres
Impervious = 164 acres
60% GI = 98 acres

- **Green Infrastructure (CSOs 027 – 029)**
  GI will be constructed in the CSO 027, 028 and 029 drainage areas sized to provide a retention capacity equivalent to 1.2" of rain falling on 133 impervious acres in the sewersheds. This is equivalent to GI treatment of 30% of impervious areas in the CSO 027 and 028 sewersheds, and 60% of impervious areas in the CSO 029 sewershed. GI projects may include bioretention practices (bioretention cells, bioswales, vegetated filter strips, and tree box filters), rooftop collection practices (green roofs, blue roofs, downspout disconnection, rain barrels, and cisterns), permeable pavement, and large-volume underground storage. In addition to GI, targeted sewer separation may be utilized to offload storm water from the combined sewer system. Diversion structures within the CSO 027, 028, and 029 sewersheds will be modified to increase diversion capacities. The diversion structure improvements coupled with the GI are predicted to provide a degree of CSO control equivalent to the LTCP.

3.2.2 Schedule

As with Rock Creek, an adaptive management approach is recommended for the Potomac River to address institutional and planning challenges for GI. The same issues exist on the Potomac River and DC Water will follow the same approach and schedule for the GI for CSOs 027, 028 and 029. The current consent decree requires completion of the controls for the Potomac River controls by March 23, 2025. DC Water has determined that an extension of the schedule to 2027 (3 years) is required in order to implement GI while addressing adaptive management and institutional and planning challenges.

Given that there is some uncertainty associated with the ability to implement GI in the District at a large scale, DC Water proposes to construct the first GI project in the Potomac and then evaluate GI in terms of constructability, operability, efficacy, public acceptability and cost effectiveness. If, based on that evaluation, GI is determined to be impracticable for CSO 027, 028 and 029, then DC Water will construct the Potomac Tunnel with a 40 million gallon capacity instead of a 30 million gallon capacity and will connect CSOs 027, 028 and 029 to the Potomac Tunnel (9.5 million gallons of storage (gray infrastructure) for the Piney Branch CSO). If GI is determined to be practicable after the first project, then DC Water will continue to implement the remaining GI projects.

For the Potomac Tunnel, the current consent decree requires placing the facilities in operation by March 23, 2025. Because of changes that have occurred since the consent decree was negotiated, the Potomac Tunnel schedule should be extended by five years to 2030. This schedule extension is required for the following reasons:

- Requirement to prepare Environmental Impact Statement – The development of the LTCP and LTCP consent decree included a significant public process to select the controls for receiving water. Because the existing CSOs are located on National Park Service property, the Potomac Tunnel facilities may have a significant impact on Park Property. Because of this, the National Park Service has indicated that an Environmental Impact Statement will need to be prepared for the Potomac Tunnel. This was not envisioned or planned for when the schedule in the original consent decree was established. The NPS indicates that at least three years should be allowed for this process.

- Planning and Siting Challenges – The Potomac River front is essentially completely developed. There are few, if any, undeveloped or open sites absent valuable parkland in which to construct facilities. As a result, planning and obtaining approval for the Potomac facilities will take considerably longer than anticipated. Developing the consensus necessary to site facilities, obtaining land rights and obtaining approvals necessary for construction will add significant time to the project.

- Utility relocation – Experience gained on the Anacostia River Projects demonstrates that up-front time is needed to identify utilities and arrange for them to be relocated prior to tunnel and shaft construction. DC Water has therefore planned for early utility relocation contracts.

- Ability to Expand Tunnel to Include CSO 027, 028 and 029 – Time is required to construct and evaluate the first GI project in the sewersheds for CSO 027, 028 and 029. This is required to determine whether a 30 million gallon or 40 million gallon tunnel is required.

The sewer separation projects for CSO 025 and 026 are independent of the GI and the Potomac Tunnel. These projects can therefore proceed earlier in the schedule and can be completed by 2023.

Figure 3-4 shows the schedule and the basic steps in the schedule are similar to that required for the Rock Creek Projects.

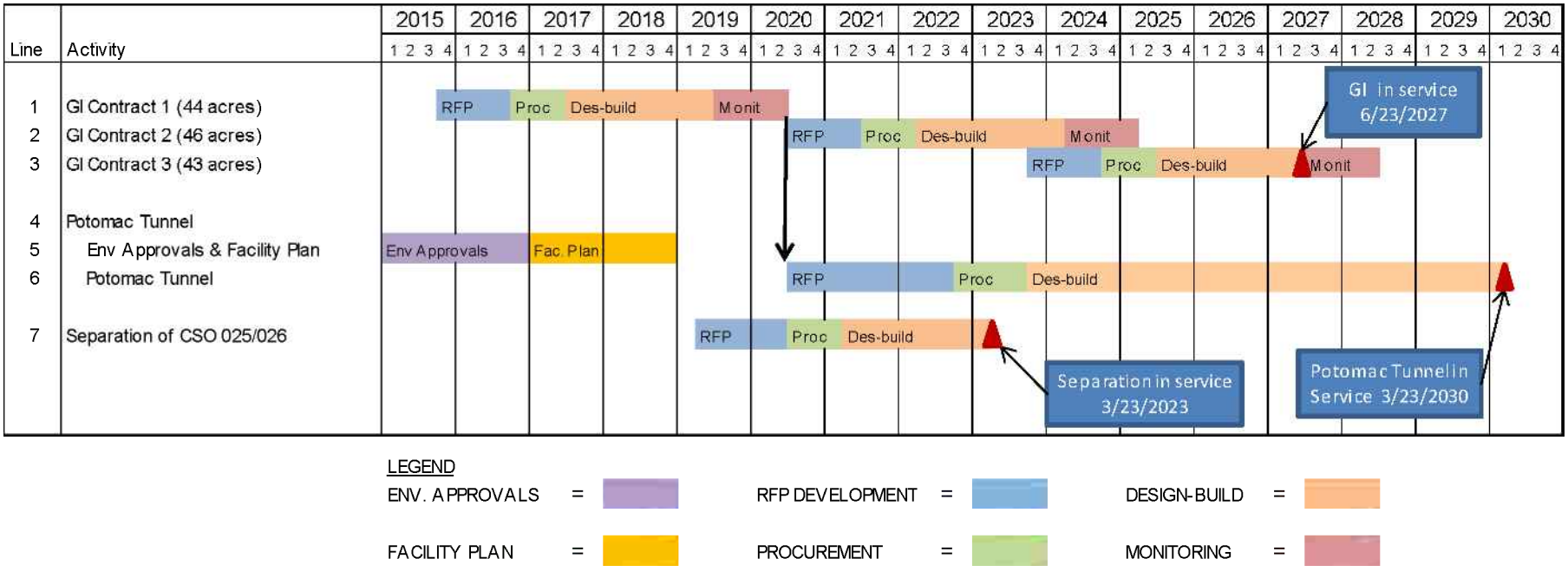


Figure 3-4. Potomac Schedule

3.2.3 Predicted Performance

Once fully implemented, the hybrid green/gray approach will provide the same overall degree of control for the Potomac River as the LTCP, as summarized in Table 3-5 below. Predicted water quality is summarized in Table 3-3, and also meets the improvements predicted for the LTCP. Table 3-4 demonstrates that the pollutant loads to the Potomac River and the water quality in the Potomac River are predicted to be equal to or better than that predicted for the LTCP.

Table 3-3
Potomac River Predicted CSO Overflows
(Average Year)

Parameter	Before LTCP[1]	LTCP	Hybrid GI Plan[2]
No. of Overflows (#/avg yr)	74	4	Equivalent to LTCP
Overflow Volume (mg/avg yr)	953	79	
% reduction from Before LTCP	--	92%	

Notes:
1. Results shown for Before LTCP are without Phase1 Controls in place (i.e. without inflatable dams, pumping station rehabilitations and Northeast Boundary Swirl Facility in operation).

Table 3-4
Potomac River Predicted Water Quality
Memorial Bridge (Segment 6) in Average Year

Parameter	Before LTCP[1]	Original LTCP	Hybrid GI Plan[2]
# Months Fecal Geomean>200 (all loads)	3	1	1
# Months Fecal Geomean>200 (CSO only)	0	0	0
# Days Fecal>200 (all loads)	142	109	109
# Days Fecal>200 (CSO Only)	57	6	3
# Days Fecal>200 (all loads) May - Sept	64	44	44
# Days Fecal>200 (CSO Only) May - Sept	33	4	1
# Months E. Coli Geomean>126 (all loads)	2	0	0
# Months E. Coli Geomean>126 (CSO only)	0	0	0
# Days E. Coli>126 (all loads)	118	77	74
# Days E. Coli>126 (CSO Only)	60	6	3
# Days E. Coli>126 (all loads) May - Sept	57	36	30
# Days E. Coli>126 (CSO Only) May - Sept	35	5	1
# days D.O.< 5 mg/L (all loads)	0	0	0
# days D.O.< 5 mg/L (CSO Only)	0	0	0

Notes:

1. Results shown for Before LTCP are without Phase1 Controls in place (i.e., without inflatable dams, pumping station rehabilitations and Northeast Boundary Swirl Facility in operation).
2. At the low levels of CSO overflows projected herein, model accuracy is highly dependent on many variables such as the accuracy of rainfall data, information on the drainage area and other factors. Further, additional overflows will occur for rain events which exceed or are not represented in the average year. The model predictions contained herein do not change the level of CSO control determined to be adequate to meet water quality standards which was included by DC Water in its LTCP, and subsequently approved by EPA and the D.C. Department of the Environment.

Table 3-5
Blue Plains Facilities, Flows and Loads, and Receiving Water Quality
(Average Year)

Parameter	LTCP	TN/WW Plan[1]	Hybrid GI Plan [1]
Facility Capacities			
Blue Plains complete treatment capacity (mgd)			
1st 4 hrs	740	555	555
After 4 hrs	511	511	511
Excess flow treatment (mgd)	336		
ECF capacity (mgd)	None	225	225
Anacostia tunnel storage volume (mg)	126	157	157
Anacostia tunnel max dewatering rate (mgd)	170	225	225
Min. tunnel dewatering time (hrs)	59	17	17
Outfall 001 Flows and Loads			
Volume (mg/avg yr)	1548	2657	3012
Avg Flow Rate (mgd)	4.2	7.3	8.3
CBOD5 (lb/avg yr)	730,724	703,562	797,861
TSS (lb/avg yr)	1,679,633	586,890	664,884
Ammonia (lb/yr)	112,320	123,461	140,504
TN (lb/avg yr)	219,475	179,396	203,229
TP (lb/avg yr)	30,985	3,989	4,516
Fecal Coliform (MPN x 10^{15}/avg yr)	411	2.0	2.3
E Coli (MPN x 10^{15}/avg yr)	300	1.3	1.4
Outfall 002 Flows and Loads			
Volume (mg/avg yr)	139,596	138,505	138,150
Avg Flow Rate (mgd)	382	379	378
CBOD5 (lb/avg yr)	5,821,153	5,775,659	5,753,948
TSS (lb/avg yr)	8,149,614	8,085,922	8,055,527
Ammonia (lb/yr)	4,424,076	1,617,184	1,611,105
TN (lb/avg yr)	17,579,883	4,509,604	4,485,771
TP (lb/avg yr)	209,562	207,924	207,142
Fecal Coliform (MPN x 10^{15}/avg yr)	106	105	105
E Coli (MPN x 10^{15}/avg yr)	67	66	66
Backcalculated Nitrogen Effluent (mg/L)	15.1	3.9	3.7
Outfall 001 + 002 Flows and Loads			
Volume (mg/avg yr)	141,144	141,162	141,162
Avg Flow Rate (mgd)	387	387	387
CBOD5 (lb/avg yr)	6,551,877	6,479,221	6,551,808
TSS (lb/avg yr)	9,829,247	8,672,812	8,720,410

Parameter	LTCP	TN/WW Plan[1]	Hybrid GI Plan [1]
Ammonia (lb/yr)	4,536,396	1,740,645	1,751,609
TN (lb/avg yr)	17,799,358	4,689,000	4,689,000
TP (lb/avg yr)	240,546	211,912	211,658
Fecal Coliform (MPN x 10^{15}/avg yr)	517	107	107
E Coli (MPN x 10^{15}/avg yr)	367	67	67
Anacostia CSO Overflows (Model Predictions)			
#/Avg Year	2	0	0
Overflow Volume/avg year (mg)	54	0	0
Potomac Water Quality at Segment 129- Blue Plains			
CSO & WWTP Loads Only			
# months FC > 200/100 ml geomean	0	0	0
# days FC > 200/100 ml	9	1	1
# months E Coli >126/100 ml geomean	0	0	0
# days E Coli > 126/100 ml	12	1	1
# days DO <5.0 mg/L	0	0	0
Min Day DO (mg/L)	>5	6.2	6.2
All Loads Present			
# months FC > 200/100 ml geomean	0	0	0
# days FC > 200/100 ml	27	12	12
# months E Coli >126/100 ml geomean	0	0	0
# days E Coli > 126/100 ml	25	7	7
# days DO <5.0 mg/L	27	20	17
Minimum Day DO (mg/L)	4.0	4.6	4.7

Notes:

1. At the low levels of CSO overflows projected herein, model accuracy is highly dependent on many variables such as the accuracy of rainfall data, information on the drainage area and other factors. Further, additional overflows will occur for rain events which exceed or are not represented in the average year. The model predictions contained herein do not change the level of CSO control determined to be adequate to meet water quality standards which was included by DC Water in its LTCP, and subsequently approved by EPA and the D.C. Department of the Environment.
2. FC= fecal coliform
3. DO = dissolved oxygen
4. MPN = Most probable number

Figure 3-5 shows that GI allows earlier reductions in CSO overflow volume for the Georgetown CSOs than the gray controls because individual GI components provide a benefit as soon as they are placed in operation. This is in contrast to the gray controls which typically require all of the structural components to be completed before the facility provides a CSO reduction benefit.

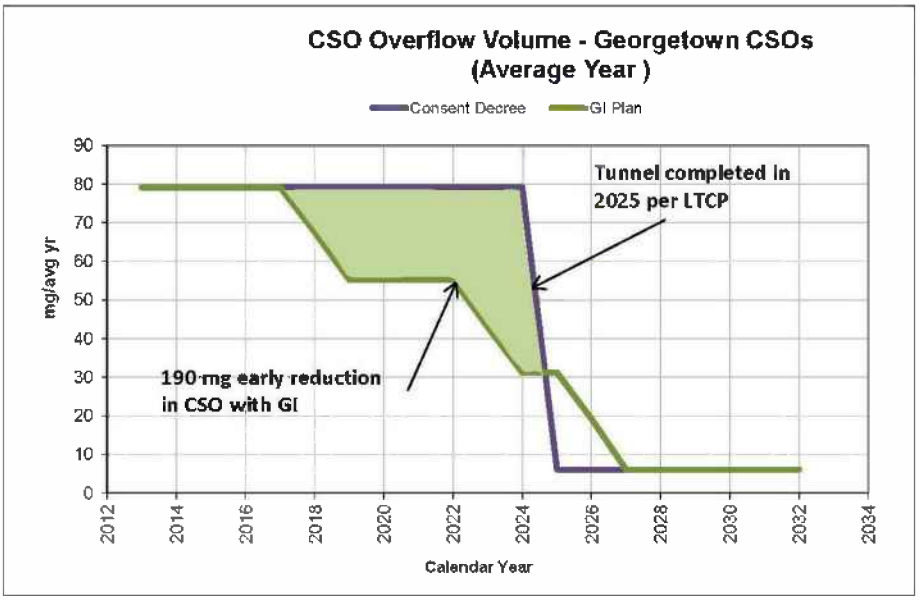


Figure 3-5. Predicted CSO Overflow Volume from Georgetown CSOs

Figure 3-6 shows that for Potomac CSOs 020-024, the recommended plan will result in a delay in CSO control for those outfalls from 2025 until 2030. This additional time is necessary due to new federal requirements to perform an Environmental Impact Statement, new planning and location challenges which did not exist when the original consent decree was signed and to mitigate the financial impact on rate payers.

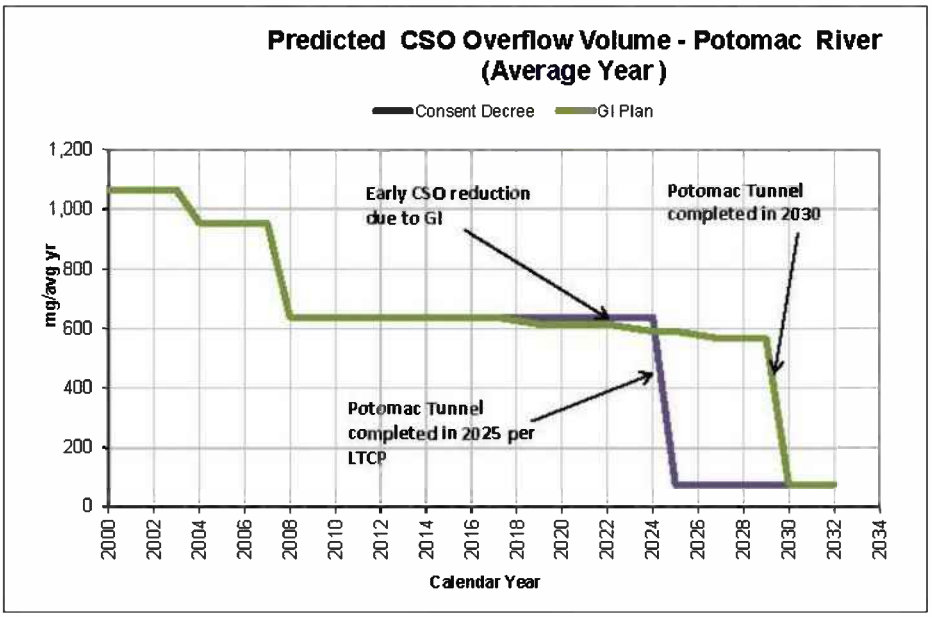


Figure 3-6. Predicted CSO Overflow Volume from all Potomac CSOs

3.3 Change in GI for MS4 Improvements

The District of Columbia recently promulgated stormwater management regulations to address MS4 requirements. The District elected to require that these MS4 regulations apply in the CSO area as well as the MS4 area. In addition to other requirements, the regulations require that land disturbing activities of more than 5000 square feet capture the first 1.2" of runoff volume from the sites. Land disturbing activities in the District public right of way must meet the maximum extent practicable standard. The MS4 regulations require the construction of GI to control storm water volumes.

The new MS4 regulations will therefore require GI to be constructed as a result of redevelopment and other land disturbing activities in the same sewersheds where DC Water will be constructing GI (CSO 027, 028 and 029 on the Potomac and Piney Branch CO 049 on Rock Creek). If this GI is constructed as a result of the MS4 program, it will reduce the GI that DC Water must construct in order to obtain the same degree of CSO control. DC Water will compile the amount of GI actually constructed in the specific targeted sewersheds (CSO 027, 028 and 029 on the Potomac and Piney Branch CSO 049 on Rock Creek) and will reduce the GI required to be constructed based on the retention capacity of the GI constructed pursuant to MS4 requirements.

3.4 Coordination with District

GI can be constructed in public space and private space. DC Water is committed to encouraging GI construction in private space. Possible tactics will be evaluated as part of the GI program but may include review of existing regulations, incentives and partnering with non-profit groups

In public space in the Piney Branch and CSO 027-029 sewersheds, the District of Columbia is the primary public landowner. Coordination and cooperation between the District and DC Water will be important for the success of the GI program for CSO control. The District and DC Water are committed to working together to encourage and make more cost effective the implementation of GI in the District. This coordination is already underway. As an example, the District Department of Transportation is producing engineering design standards and guidelines for construction of GI in the public right of way. DDOE has produced a Stormwater Management Guidebook as part of the MS4 regulations which include design approaches and guides for GI. DC Water has published Utility Protection Guidelines when constructing GI near water and sewer infrastructure. DC Water and the District have provided input and consultation on each other's guidelines and standards to optimize efficiency and ensure consistency.

The District's new MS4 regulations have made considerable progress toward implementing GI and will support DC Water's GI plan. The regulations were issued in July 2013 and require the construction of GI for stormwater control for land disturbing activities that disturb more than 5,000 square feet. This is required in the combined sewer area as well as in the separate MS4 area. These regulations will encourage GI and will make the CSO controls more effective on a City-wide basis.

The District is also implementing the Mayor's Sustainable DC Plan, which lays out a path to make the District the healthiest, greenest, most livable city in the nation over the next 20 years. Improving

the environment and making the District more sustainable are key features of the plan, which is available at http://sustainable.dc.gov/finalplan.

The District and DC Water will continue to work together as GI is implemented to:

- Minimize regulatory and institutional barriers to construction of GI
- Maximize cost effectiveness by looking for opportunities to add GI as part of ongoing DC Government capital projects to minimize costs
- Ensure consistency of design standards as applicable
- Encourage and facilitate GI construction in public and private space.
- Encourage consistency and transfer of ideas and standards between the MS4 program and the CSO program

3.5 Maintenance

DC Water will perform maintenance or will arrange for others to perform it. DC Water will be ultimately responsible to assure that maintenance is performed adequately to maintain the CSO reduction functions of the GI. DC Water also anticipates that this will be a requirement in its National Pollutant Discharge Elimination System (NPDES) Permit issued by EPA.

3.6 Post Construction Monitoring

The NPDES Permit specifies the scope and schedule for post construction monitoring. In accordance with the permit, DC Water will perform post construction monitoring at the completion of the program.

3.7 Compliance with 1994 CSO Policy

The Recommended Final LTCP Modification is in compliance with the CSO Policy. Table 3-6 identifies the key requirements in the CSO Policy and summarizes how the hybrid green/gray approach complies with the Policy.

Table 3-6. Demonstration of Compliance with 1994 CSO Policy

CSO Policy Reference	CSO Policy Requirement	Demonstration of Compliance
II.B.	Implement Nine Minimum Controls	DC Water is implementing a Nine Minimum Controls Plan. Once constructed and in service, the new CSO controls will be operated and maintained in accordance with the nine minimum controls
C.	Long Term Control Plan Development	The CD modifications will modify the LTCP as described in this document
C.1.	Characterization, Monitoring and Modeling	Characterization and monitoring were performed as part of the development of the LTCP. The calibrated models were used to make the performance predictions as part of the GI Screening Analysis.

CSO Policy Reference	CSO Policy Requirement	Demonstration of Compliance
C.2.	Public Participation	Public outreach was conducted as part of the development of the GI Plan and is described in the preceding section.
C.3.	Evaluation of Alternatives	A range of alternatives were considered in the GI Screening Analysis.
C.4.	Cost//Performance Considerations	Cost, performance, efficacy and compliance with water quality standards were evaluated as part of the preparation of the GI Screening Analysis.
C.5.	Operational Plan	The operation and maintenance plan and associated nine minimum controls requirements will be reviewed and adjusted if necessary upon implementation of the controls in the GI Plan.
C.6.	Maximizing Flow at Existing POTW	The LTCP maximizes flow to Blue Plains for treatment. Further, the GI Screening Analysis evaluated maximizing tunnel storage through treatment during wet weather, as described in section 3.2.1 above.
C.7.	Implementation Schedule	An implementation schedule is included.
C.8.	Post Construction Monitoring Program	The NPDES Permit includes detailed provisions requiring post construction monitoring at defined intervals in the implementation of the program.
III.	Coordination with State Water Quality Standards	Subject to post-construction monitoring, the original LTCP was determined to meet water quality standards. The GI Plan is predicted to provide CSO control performance equal to or better than the original LTCP.

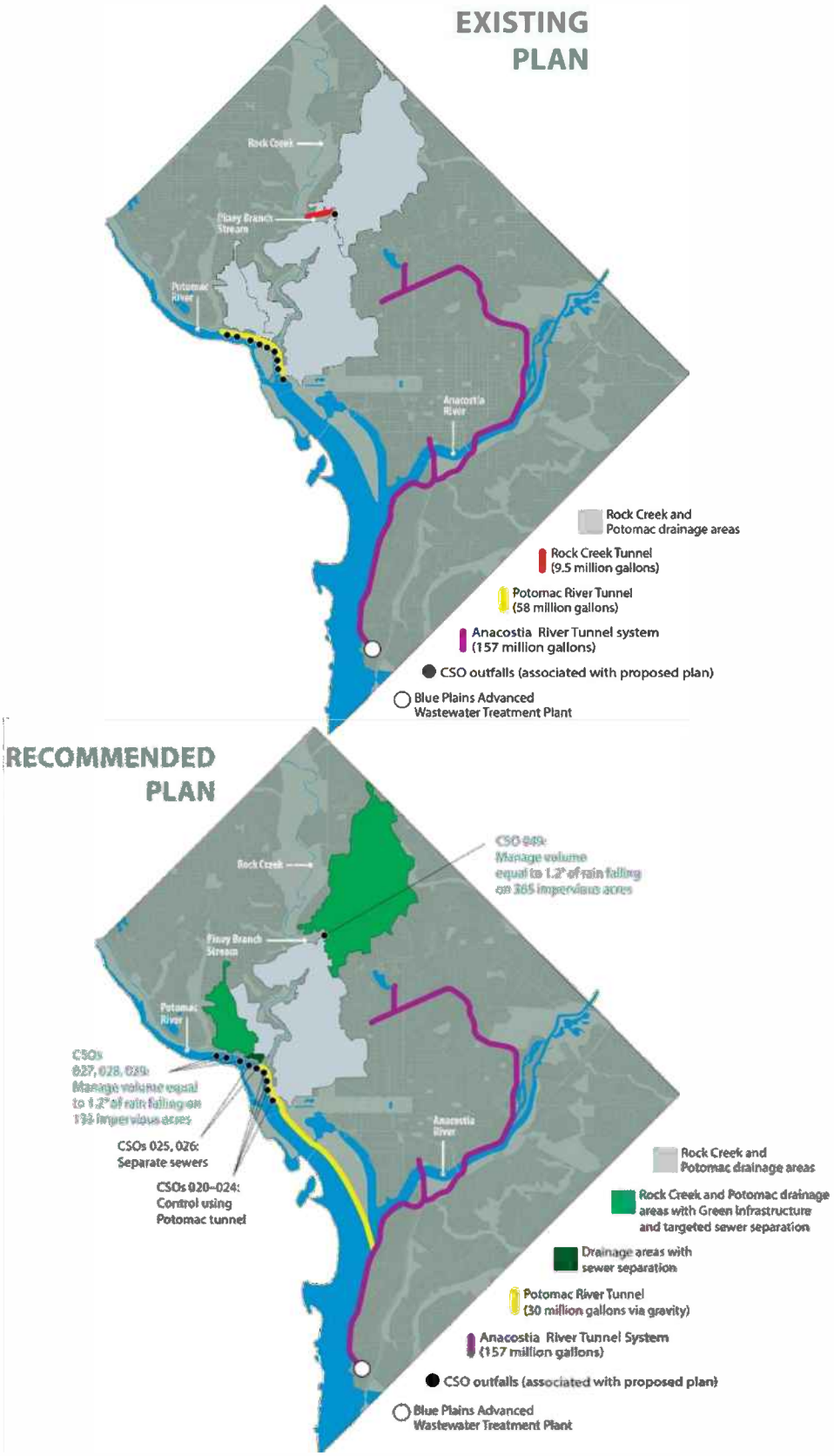

EXISTING PLAN
Rock Creek
Piney Branch Stream
Potomac River
Anacostia River
Rock Creek and Potomac drainage areas
Rock Creek Tunnel (9.5 million gallons)
Potomac River Tunnel (58 million gallons)
Anacostia River Tunnel system (157 million gallons)
CSO outfalls (associated with proposed plan)
Blue Plains Advanced Wastewater Treatment Plant
RECOMMENDED PLAN
Rock Creek
CSO 049: Manage volume equal to 1.2" of rain falling on 365 impervious acres
Piney Branch Stream
Potomac River
CSOs 027, 028, 039: Manage volume equal to 1.2" of rain falling on 132 impervious acres
CSOs 025, 026: Separate sewers
CSOs 020–024: Control using Potomac tunnel
Anacostia River
Rock Creek and Potomac drainage areas
Rock Creek and Potomac drainage areas with Green Infrastructure and targeted sewer separation
Drainage areas with sewer separation
Potomac River Tunnel (30 million gallons via gravity)
Anacostia River Tunnel System (157 million gallons)
CSO outfalls (associated with proposed plan)
Blue Plains Advanced Wastewater Treatment Plant

Figure3-1

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4 Financial Affordability Update

4.1 Background

From 1998 to 2001, DC Water developed its Draft LTCP. Following an extensive public comment period where more than 2,300 comments were received, DC Water finalized its LTCP in July 2002. On March 23, the LTCP Consent Decree was entered with the court requiring implementation of the LTCP.

As part of the development of LTCP, DC Water performed a financial affordability analysis based on information available at the time. The purpose of this document is to update the financial affordability analysis. This update is being performed for the following two main reasons:

Significant Changes Have Impacted the Burden on Ratepayers
Since the LTCP Consent Decree was entered in 2005, there have been significant changes that have impacted the burden on District ratepayers. These include, but are not limited to:

- Nitrogen Removal at Blue Plains' effluent to meet the Chesapeake Bay TMDL - this requirement was added to DC Water's NPDES permit in 2007. As a result of this requirement, DC Water implemented the Total Nitrogen Removal/Wet Weather Plan (TN/WW Plan) at a cost of nearly $950 million

- Biosolids Program – In order to achieve a sustainable program for biosolids from Blue Plains Wastewater Treatment Plant, DC Water is implementing a biosolids program. The program includes construction of Cambi digesters which will allow production of Class A biosolids.

- Increased costs for DC Clean Rivers Project – The DC Clean Rivers Project is a $2.6 billion program. This is more than the original estimate in 2002 when the LTCP was finalized.

- Schedule acceleration of Anacostia River Tunnel – In July and September 2102, severe flooding impacted the Bloomingdale and LeDroit park neighborhoods in the Northeast Boundary Sewershed tributary to the Anacostia River. As a result of this, the Anacostia River Projects tunnel facilities have been accelerated in schedule to provide earlier flood mitigation than originally included in the Decree. The First Street tunnel will be placed in operation in 2016 instead of 2025 and the complete Northeast Boundary Tunnel system is scheduled to be placed in operation in 2022 instead of 2025. This has significantly impacted spending on the program

- Infrastructure renewal – The sewer system in the District is extremely old, with some sewers constructed as early as the 1870's. The median age of sewers in the District is over 70 years old. Given this, a significant rehabilitation and renewal program is underway to preserve and improve the sewer system.

Financial Affordability Guidance has Changed

The financial analysis performed as part of the development of the LTCP was based on EPA's CSO guidance document (*Combined Sewer Overflows - Guidance for Financial Capability Assessment and Schedule Development*, Feb 1997, EPA 832-B-97-004). This approach essentially uses 2% of median household income as the threshold for affordability for sewer rates. This approach to measure ratepayer affordability has come under scrutiny with organizations such as the American Water Works Association (AWWA) and the Water Environmental Federation (WEF) recommending alternative approaches.

In response to these issues including the increased financial burdens imposed on water agencies and communities, EPA has also recognized the need to incorporate greater flexibility in meeting Clean Water Act (CWA) requirements. In a January 13, 2013 Memorandum, the Agency clarified its policy going forward on affordability issues as well on using the integrated planning framework process to provide the regulated community with the necessary flexibility to meet CWA requirements while lessening the financial burden, especially to low income populations.

DC Water's complete affordability update is included in Appendix E and this section presents a summary of the results.

4.2 Affordability Measures for the District.

The 1997 Final EPA guidance presented methods for estimating the annual cost per household (for CSO capital expenditures) and for comparing that estimate against Median Household Income (MHI) to derive a "Residential Indicator" (RI). Although the 1997 guidance document did not prescribe a regulatory threshold ratio, it implied that sewer rates resulting in a typical residential bill exceeding 2 percent of MHI could be considered unaffordable.

EPA has acknowledged the increasing cost burden to communities of complying with the CWA, as well as the methodological limitations of using the RI as an indicator of affordability. As a result of these concerns, EPA issued a memorandum on January 13, 2013 that addressed financial affordability issues and clarified the Agency's policy going forward. The Agency's overall message, as articulated in the memorandum, was that EPA has developed, in cooperation with the regulated community, the "Integrated Planning Approach Framework" that "encourages municipalities to balance CWA requirements in a manner that addresses the most pressing health and environmental protections issues first." The memorandum also attempts to clarify that it is not EPA's policy that the RI, based on expenditures as a percentage of MHI, constitutes the sole measure of affordability. The Agency further emphasized that it is a "common misperception that the EPA requires communities to spend to a level of 2% of MHI to meet CWA obligations." Instead, EPA states that the percent MHI calculation should be considered along with a "suite of other financial indicators to assess the overall burden on a community."

DC Water evaluated the following factors to assess affordability:

- Sources of revenue for DC Water
- Current sewer rates and affordability based on MHI
- Household income distribution in the District\
- Poverty rates in the District

- Distribution of income and poverty by Ward
- Degree of public assistance or food stamp use
- Cost of living in DC compared to the national average

The analysis showed that the income distribution in the District is significantly skewed with a large percentage of households in poverty and in affluence, with lower amounts of households with middle incomes. The analysis also showed that the cost of living in the District is significantly higher than in the U.S., primarily due to elevated housing, transportation and food costs.

Given both the skewed distribution of household income and the high cost of living for District of Columbia residents compared to the national average, using 2 percent of unadjusted MHI as the threshold for unaffordability does not effectively capture the real burden of increasing sewer bill costs on low income populations. Considering affordability across a broader household income distribution provides the most accurate indication of how utility bills pose financial burdens to the population of customers.

Therefore, to assess affordability, DC Water used the following alternative criteria for the affordability measurements

- Unadjusted MHI
- Cost of Living Adjusted (COLA) MHI
- Unadjusted Upper Limit of the Second Quintile for Household Income
- COLA Adjusted Upper Limit of the Second Quintile for Household Income

4.3 Scenarios Evaluated

DC Water used its financial model to assess the impact of capital expenditures on rates. The financial model allows the user to enter annual capital outlays to determine the impact on revenue generation for DC Water and on ratepayer household incomes. The financial model was run for the following scenarios:

- Scenario 1 Original Consent Decree – this is the CIP that existed when the 2002 LTCP Decree was negotiated. This was evaluated using the measures of affordability described above

- Scenario 2 Status Quo CIP – this includes the current CIP with the Anacostia River Projects finishing in 2022, and the Potomac and Rock Creek Tunnels finishing in 2025

- Scenario 3 Constrained CIP – for this scenario, the Anacostia River Projects are completed in 2022, the Potomac Tunnel is completed in 2030, and the Potomac and Rock Creek GI projects are completed in 2032. To meet affordability limits, wastewater and sewer CIP projects were deferred.

4.4 Results

Table 4-1 presents the results of the rate model calculation for the various scenarios. Shaded values indicate wastewater costs more than 2% of income for the various scenarios listed.

Table 4-1
Results Summary - Predicted Sewer Bills as Percent of Income

	Scenario 1- Original Decree			Scenario 2 – Status Quo CIP			Scenario 3 – CIP Constrained by Upper Limits 2nd Quintile		Scenario 3 – CIP Constrained by Adjusted Upper Limit 2nd Quintile	
Year	% MHI	% Upper Limit 2nd Quintile	% Adjusted Upper Limit 2nd Quintile	% MHI	% Upper Limit 2nd Quintile	% Adjusted Upper Limit 2nd Quintile	% Upper Limit 2nd Quintile	% Adjusted Upper Limit 2nd Quintile	% Upper Limit 2nd Quintile	% Adjusted Upper Limit 2nd Quintile
FY2014	1.0	1.4	1.9	0.8	1.05	1.51	1.05	1.51	1.51	1.05
FY2015	0.9	1.2	1.7	0.91	1.21	1.73	1.15	1.64	1.64	1.15
FY2016	0.9	1.3	1.8	0.98	1.32	1.89	1.23	1.77	1.74	1.22
FY2017	1.0	1.4	1.9	1.04	1.42	2.03	1.32	1.90	1.85	1.29
FY2018	1.0	1.5	2.1	1.09	1.50	2.16	1.42	2.04	1.92	1.34
FY2019	1.1	1.5	2.2	1.15	1.60	2.29	1.53	2.19	1.99	1.39
FY2020	1.1	1.6	2.3	1.23	1.72	2.47	1.65	2.36	2.06	1.44
FY2021	1.2	1.8	2.5	1.31	1.85	2.65	1.77	2.54	2.14	1.49
FY2022	1.3	1.9	2.7	1.39	1.99	2.86	1.91	2.73	2.22	1.55
FY2023	1.3	2.0	2.8	1.44	2.08	2.98	1.98	2.83	2.31	1.61
FY2024	1.4	2.1	3.0	1.49	2.17	3.11	2.04	2.92	2.37	1.66
FY2025	1.2	1.9	2.7	1.54	2.27	3.25	2.10	3.01	2.39	1.67
FY2026	1.3	2.0	2.8	1.60	2.37	3.40	2.13	3.05	2.41	1.68
FY2027	1.3	2.0	2.8	1.59	2.38	3.41	2.16	3.10	2.42	1.69
FY2028	1.3	2.0	2.9	1.57	2.39	3.42	2.20	3.15	2.44	1.70
FY2029	1.3	2.1	2.9	1.56	2.40	3.43	2.23	3.20	2.46	1.72
FY2030	1.3	2.1	3.0	1.55	2.40	3.45	2.23	3.19	2.48	1.73
FY2031	1.4	2.3	3.2	1.54	2.41	3.46	2.22	3.18	2.49	1.74
FY2032	1.3	2.2	3.1	1.53	2.42	3.47	2.21	3.17	2.50	1.74

4.5 Conclusions

The following are the conclusions of the affordability update:

- Using a sewer bill threshold of 2 percent of MHI is a poor indicator for assessing affordability. In jurisdictions such as Washington, DC, not only are household incomes highly skewed but there has been an increasing divergence between high income households and low income households. From 2006 to 2012, for example, MHI grew more than 28 percent while household incomes at the upper limit of the second quintile grew only 20 percent. Consequently by 2011 the MHI was 25 percent higher than the upper limit of the second quintile.

- Evaluating the financial impacts of DC Water's CIP on the ratepayer base found that impacts to lower income households become much more apparent when the upper limit of the second quintile is used than when using the 2 percent of MHI threshold. With the COLA factor taken into account, forecasted sewer bills become unaffordable to 40 percent of the households as soon as 2018.

- The impacts on ratepayers for the Status Quo CIP (Scenario 2, CSO Projects completed by 2025) are significantly worse than projected when the LTCP Consent Decree was entered and negotiated.

- The analysis showed that extension of both the Consent Decree schedule and deferment of other sewer and wastewater projects is necessary to maintain affordable rates. To achieve CSO control as early as possible, we evaluated engineering constraints and determined that extending the Potomac River Tunnel schedule by five years and the GI schedule by seven years would result in the earliest practical and technically achievable schedules for CSO control. Given this schedule constraint, DC Water determined that more than $2.5 billion dollars of other sewer and wastewater projects must be deferred between 2014 and 2032 to meet the affordability criteria established by the analysis. Given that average sewer age will be approaching nearly 100 years by 2032, this deferment of other projects inevitably presents risks to customer service, environmental protection, and management of infrastructure. DC Water balanced these risks with our obligations to complete the CSO control program as soon as is practicable when we developed the proposed schedule for CSO control described in this report.

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5 Public Comments and Responses

5.1 Introduction

As part of DC Water's proposal for a Long Term Control Plan Modification for Green Infrastructure (LTCP Modification), a public comment period was instituted from January 12, 2014 through April 14, 2014. A public outreach program was conducted to provide information about the proposed modification and to solicit public comments. This section summarizes the outreach conducted, the comments received and the revisions made to the draft plan in response to comments.

5.2 Public Outreach

Public outreach was facilitated via notifications and advertisements disseminated using distribution channels including press releases, print and social media, DC Water's website, emails and mailings. The following summarizes public outreach conducted:

- Washington Post Legal Notice
  A legal notice was placed in the Washington Post on January 12, 2014. The notice described the purpose of the LTCP modification, indicated where additional information could be obtained and the method and deadline for submitting comments. A second legal notice was placed in the Washington Post on March 9, 2014 extending the public comment period to April 14, 2014.

- Public Information Depositories
  Hard copies of the "*Long Term Control Plan Modification for Green Infrastructure*" Document and its Executive Summary, were made available for review from January 22 through April 14, 2014 at the reference desks of the following libraries in District of Columbia neighborhoods:
  - Capitol View Library - 5001 Central Avenue, SE
  - Mount Pleasant Library - 3160 16th Street, NW
  - Rosedale Library - 1701 Gales Street, NE
  - William O. Lockridge/Bellevue Library - 115 Atlantic Street, SW
  - Martin Luther King, Jr. Library Room 307 - 901 G Street, NW
  - Southeast Library - 403 7th Street, SE
  - Shepherd Park Library - 7420 Georgia Avenue, NW
  - Tenley-Friendship Library - 4450 Wisconsin Avenue, NW
  - Lamond-Riggs Library - 5401 South Dakota Avenue, NE

- Web Site
  The proposed modification, public meeting dates and an on-line survey were placed on the DC Water website on a dedicated web page. A link through the DC Water homepage and its rotating banner were also implemented to facilitate easier access. During the comment period, the webpage overall statistics recorded 3,623 sessions and 2527 new users. Visitors to the

site were also provided links to the following:

- YouTube video of General Manager Hawkins' presentation at the January 22, 2014 GI Summit
- Informational presentation slides presented at DC Water sponsored public meetings
- January 22, 2014 GI Summit slides
- February 18 and 20, 2014 GI Public Meetings
- March 5, 2014 Poplar Point and GI Public Meeting
- February 19, 2014 Kojo Nnamdi Show radio interview of General Manager Hawkins describing the proposed LTCP Modification

- Meetings
  DC Water conducted the meetings summarized below to share information regarding the proposed plan and to solicit public comments:
  - On January 22, 2014, DC Water hosted a Public Summit Meeting held at the Metropolitan Washington Council of Governments. Attendees could review a series of 12 stations manned by DC Clean Rivers technical staff discussing various project components graphically represented on presentation boards. The meeting began with an overview of the proposed amendments and supporting justification presented by General Manager George Hawkins, followed by a question and answer period.

  - On Tuesday, February 18, 2014, DC Water hosted a public meeting in support of its Green Infrastructure proposal at Georgetown Visitation Preparatory School, located at 1524 35th Street, NW. The meeting was held in the 2nd floor New Founders Hall. Attendees could review a series of 12 stations manned by DC Clean Rivers technical staff discussing various project components graphically represented on presentation boards. The meeting began with an overview of the proposed amendments and supporting justification presented by General Manager George Hawkins, followed by a question and answer period.

  - On Thursday, February 20, 2014, DC Water hosted a public meeting in support of its Green Infrastructure proposal at Petworth Public Library, located at 4200 Kansas Avenue, NW. Attendees could review a series of 12 stations manned by DC Clean Rivers technical staff discussing various project components graphically represented on presentation boards. The meeting began with an overview of the proposed amendments and supporting justification, followed by a question and answer period.

  - On Thursday, February 27, 2014, DC Water hosted a public meeting in support of its Northeast Boundary Tunnel Project/Green Infrastructure proposal at McKinley Technology High School, located at 151 T Street, NE.

  - On Tuesday, March 4, 2014, DC Water attended the monthly meeting of ANC 2E to discuss its Green Infrastructure proposal for the Georgetown community. The meeting was held at Georgetown Visitation Preparatory School, located at 1524 35th Street, NW, in the 3rd floor Founder's Hall.

- On Tuesday, March 4, 2014, DC Water attended the monthly meeting of ANC 4A to present its Green Infrastructure proposal. The location of the meeting was held at Fort Stevens Recreation Center, located at 1327 Van Buren Street, NW.

- On Wednesday, March 5, 2014, DC Water hosted a public meeting in support of its Poplar Point Pumping Station Replacement Project/Green Infrastructure proposal at United Planning Organization-Ralph Waldo "Petey" Greene Community Service Center, located at 2907 Martin Luther King, Jr. Avenue, SE.

- On Wednesday, March 12, 2014, DC Water attended the monthly meeting of ANC 4C to present its Green Infrastructure proposal. The meeting was held at Petworth Public Library, located at 4200 Kansas Avenue NW.

- On Wednesday, March 12, 2014, DC Water conducted a briefing on its Green Infrastructure plan to the Construction Management Association of America at the Frank D. Reeves Center, located at 2000-14th Street, NW.

- On Thursday, March 13, 2014, DC Water attended the monthly meeting of ANC 3B to discuss the water quality and cost implications of its Green Infrastructure proposal. The meeting was held at Stoddert Elementary School, located at 4001 Calvert Street, NW.

- On Thursday, March 13, 2014, DC Water attended the monthly meeting of ANC 3E to present its Green Infrastructure proposal. The meeting was held at Woodrow Wilson High School, located at 3950 Chesapeake Street, NW.

- On Thursday, April 3, 2014, DC Water's Clean Rivers Project team attended the 5th Annual Ward 2 Town Hall co-hosted by DC Water General Manager George Hawkins and District Councilmember Jack Evans to provide information and address inquiries pertaining to the proposed Green Infrastructure plan. The meeting was held at Francis-Stevens Education Campus, 2425 N Street NW.

- On Wednesday, April 9, 2014, DC Water's Clean Rivers Project team attended the 5th Annual Ward 8 Town Hall Meeting co-hosted by DC Water General Manager George Hawkins and District Councilmember Marion Barry to provide information and address inquiries pertaining to the proposed Green Infrastructure plan. The meeting was held at United Planning Organization's Ralph Waldo "Petey" Greene Community Service Center, 2907 Martin Luther King Jr. Avenue SE.

- On Thursday, April 10, 2014, DC Water's Clean Rivers Project team attended the 5th Annual Ward 4 Town Hall Meeting co-hosted by DC Water General Manager George Hawkins and District Councilmember Muriel Bowser to provide information and address inquiries pertaining to the proposed Green Infrastructure plan. The meeting was held at Shepherd Elementary School, 7800 14th Street NW.

- Social Media
  DC Water posted the Draft LTCP Modification release, meeting notices and the public comment period extension on both DC Water Twitter and Facebook. In addition, two Facebook ads and two promoted tweets were completed to promote the modification to a wider audience. Also, General Manager Hawkins' videotaped presentation at the Green Infrastructure Summit was posted on YouTube (https://www.youtube.com/-watch?v=JkUJH0Tdh3o) and received 167 visits.

- Public Information Materials
  DC Water created multiple dedicated materials for use in the LTCP Modification public comment period including:

  - 600 informational brochures were printed and distributed at public meetings and events
  - Direct mail or ebill inserts were sent to 120,000 DC Water customers between January and April 2014
  - Comment cards were distributed to approximately 600 attendees at the Public Meetings
  - Reference to the LTCP Modification proposal and its comment period was also provided in the "*DC Water Biannual Report April 2014 Combined Sewer Overflow (CSO) Control Activities Clean Rivers Project News*" newsletter which had ongoing mailings to 120,000+ customers between the end of March and end of April, 2014.

- On-Line Survey
  Seventy-one individuals responded to one or more questions and 51 provided narrative comments.

- Earned Media
  Outreach was conducted to several key DC reporters and bloggers to brief them on the proposed Modification. DC Water General Manager George Hawkins was interviewed live on February 19, 2014 by WAMU's Kojo Nnamdi (http://thekojonnamdishow.org/shows-/2014-02-18/dc-water-proposes-green-infrastructure).

  In addition, the following media printed stories about the LTCP modification proposal:

  - *'Green' Modifications Proposed to D.C. Clean-water Plan; Environmentalists are Skeptical*, Mike DeBonis, Washington Post, January 23, 2014 (http://www.washingtonpost.com/local/dc-politics/green-modifications-proposed-to-dc-clean-water-plan-environmentalists-are-skeptical/2014/01/23/e4c43068-8459-11e3-bbe5-6a2a3141e3a9_story.html).

  - *DC Water Proposal Would Swap Tunnels for Green Infrastructure*, Washington City Paper/Housing Complex Blog, posted by Aaron Wiener on January 22, 2014 at 5:35 pm. (http://www.washingtoncitypaper.com/blogs/housingcomplex/2014/01/22/dc-water-proposal-would-swap-tunnels-for-green-infrastructure/).

- *DC Water Modifies Long Term Control Plan to Include Green Infrastructure* Civil+Structural Engineer webpost (http://www.cenews.com/post/2696/dc-water-modifies-long-term-control-plan-to-include-green-infrastructure).

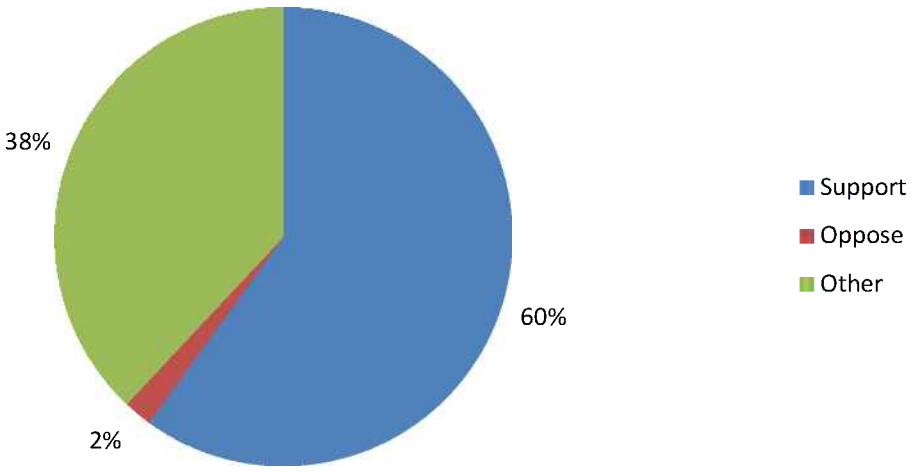
- Key Stakeholder Outreach
  Extensive outreach via phone and email was conducted to stakeholders announcing the LTCP Modification and seeking input including environmental, business and jobs training groups. Briefings were provided to ANCs, Mayor Gray, Congresswoman Norton, DC Councilmember Mary Cheh and key stakeholders. In addition, dedicated email invitations to the January 22, 2014 Green Infrastructure Summit, DC Water February 18 and 20, 2014 Public Meetings and DC Water Town Hall meetings were sent.

5.3 Public Comments

In response to the outreach, 366 commenters submitted 471 comments on the draft LTCP Modification for GI. The comments received have been bound in a separate report titled "*Public Comments, Long Term Control Plan Modification for Green Infrastructure*", DC Water, May 2015.

Figure 5-1 shows the disposition of the comments, with the majority of comments supporting the proposed modification. Comments considered to be "other" in nature covered a variety of topics including comments on other aspects of DC Water's operations, requests for information or suggestions for implementing the program.

Figure 5-1. Summary of Comments



Since a large number of comments were received and because there are significant degrees of overlap and common themes in the comments, the comments were grouped by type and subject matter and addressed together in a commentary type response. The goal of this approach is to produce a commentary that is both readable and comprehensive. The comments were grouped as being related to the following topics:

- Nature of Commitment
- Degree of Control
- Rates/ Financial
- Implementability
- Schedule
- Maintenance
- Implementation Strategies
- Miscellaneous
- General Opposition
- General Support

Appendix K provides a response to each type of comment received.

5.4 Modifications to Draft GI Plan in Response to Comments

As part of finalizing the LTCP Modification for GI, DC Water has made significant revisions to the draft plan. This section describes the major revisions made.

- **Nature of Commitment**
  DC Water's Proposed Draft LTCP Modification included committing $60 million for GI in Rock Creek and $30 million for GI for the Potomac CSOs 027, 028 and 029. This magnitude of expenditures was based on the estimated costs of the GI. A limit on the financial commitment was proposed given the uncertainties in terms of the cost to construct GI and in order to manage these risks to ratepayers. There was also precedent for a financial commitment in other enforceable documents such as New York City's order with the State of New York to construct GI.

  Some commenters indicated that a financial commitment would not ensure that the necessary amount of GI was constructed to provide the degree of CSO control required. These commenters suggested that the commitment to GI should be expressed in terms of acres of GI constructed, gallons stored, or a performance standard other than or in addition to a financial commitment.

  In response to these comments, DC Water has removed the limit on its financial commitment to GI and expressed the commitment in terms of constructing sufficient GI and targeted sewer separation to manage the volume of water produced by 1.2" of rain falling on the number of impervious acres specified for the applicable sewershed. This is a commitment to manage a specified volume of runoff and will ensure that the necessary amount of GI is in place in order to provide the degree of CSO control required.

- **Feasibility/Effectiveness of GI**
  Some commenters indicated that GI may not be feasible to construct at a sufficient application rate to provide the degree of CSO control needed, or may not be as effective as anticipated.

  Given the lack of large scale implementation of GI in the District, DC Water has revised the LTCP Modification to provide for constructing the first GI project in the Potomac and Rock Creek sewersheds and then evaluating GI in terms of constructability, operability, efficacy, public acceptability and cost effectiveness. If, based on that evaluation, it is determined that it is impractical to complete all of the specified GI projects by the specified deadlines, then DC Water would be required to construct the gray controls as specified in the LTCP Modification. Should this occur, DC Water would be required to construct the gray controls within the same timeframe allowed for GI so there is no extension of the time allowed for implementation. If GI is determined to be practicable after the first project, then DC Water will continue to implement the remaining GI projects by the specified deadlines.

- **Schedule**

  Some commenters suggested that the seven year extension was too long and advocated for a shorter schedule. In addition, some commenters urged DC Water to accelerate individual components of the controls where feasible.

  For GI, the schedule extension allows an adaptive management approach to be implemented to ensure that performance of the GI projects is optimized. Adaptive management means early GI projects will be monitored and assessed so that later projects are as practical and effective as possible. In response to comments, DC Water has evaluated the engineering, fiscal and practicality issues and has revised the modification to complete projects as early as practical. In addition, the separation at CSO 025 and 026 and Piney Branch Structure improvements have been substantially accelerated. The schedule revisions are summarized in Table 5-1.

  For the Potomac Tunnel, extra time in the schedule is needed compared to the original LTCP plan due to a new requirement to complete environmental studies, in view of the increased development in recent years along the Potomac River waterfront, and to mitigate the tremendous financial impacts on rate payers. It is therefore not feasible to shorten the schedule for the Potomac Tunnel earlier than 2030.

Table 5-1
Schedule Comparison

Facility	Place in Operation Deadline		Change
	Proposed Draft LTCP Modification	Recommended Final LTCP Modification	
Potomac River			
1. Separate CSO 025, 026	2032	2023	9 years earlier
2. Potomac GI	2028	2027	1 year earlier
3. Potomac Tunnel	2030	2030	No change
Rock Creek			
4. Piney Branch Diversion Structure Improvements	2032	2020	12 years earlier
5. Rock Creek GI	2032	2030	2 years earlier

- **Disruption due to Tunnel in Georgetown, NPS Property and Mall area**
  Some commenters expressed concern about potential disruption caused by tunneling, particularly in the Georgetown and National Park areas.

  The Proposed Draft LTCP Modification included a 21 million gallon, approximately 4,500 foot long Potomac Tunnel to capture CSOs 020-024, a new pumping station to empty the tunnel and the addition of 75 million gallon per day of capacity at the Tunnel Dewatering Pumping Station (TDPS) and Enhanced Clarification Facility (ECF) at Blue Plains. As part of the response to comments, DC Water has evaluated an approximately 23,000 foot long gravity Potomac Tunnel that would run from the Potomac River CSOs to connect to the Blue Plains Tunnel at Joint Base Anacostia-Bolling (formerly Bolling Air Force Base). This would eliminate the need for a tunnel dewatering pumping station for the Potomac Tunnel. This is advantageous because of the complexity of the station, the difficulty in siting such a facility in the vicinity of the National Mall area, long term operational and power requirements and costs and the need for a permanent building associated with a large deep pumping station. Because of the elimination of the pumping station, the gravity tunnel provides substantially less disruption both during and after construction.

  The gravity Potomac Tunnel also allows interconnecting the storage volumes of the Potomac and Anacostia River Tunnel Systems into one tunnel system, allowing any CSO on either water body access to the entire storage volume of both tunnels. DC Water's analyses have demonstrated that a 30 million gallon gravity Potomac Tunnel for CSO 020-024 connected to the Blue Plains Tunnel provides a degree of CSO control equal to the LTCP without the need to expand the Blue Plains Tunnel Pumping Station and wet weather treatment system. Because the gravity tunnel offers greater reliability and avoids a new pumping station, the gravity tunnel is the recommended plan.

- **Stewardship for Ratepayer Dollars**
  Some commenters expressed concern over affordability for ratepayers.

  DC Water is acutely aware of the heavy financial burden bourn by District ratepayers to implement the DC Clean Rivers Project and has taken steps to both mitigate and spread out water rate increases over time. Unfortunately, this is not discretionary spending by DC Water but is mandated to comply with the Clean Water Act through a Federal Consent Decree signed by the Department of Justice, EPA, the District of Columbia and DC Water. The Final LTCP Modification will mitigate rates to the extent possible by extending the schedule for the Potomac Tunnel, thereby slowing the rate of increase in rates compared to what otherwise would be required.

- **Maintenance**
  Some commenters expressed the importance of maintenance in assuring the GI is effective over the long term.

  DC Water will perform maintenance or will arrange for others to perform maintenance of all GI implemented to control CSOs. DC Water will be ultimately responsible to ensure that

maintenance is performed adequately to maintain the CSO reduction functions of the GI. DC Water also anticipates that this will be a requirement included in its National Pollutant Discharge Elimination System (NPDES) Permit issued by EPA.

- **Support for Green Jobs**
  Some commenters supported the long term economic benefits of GI, specifically the ability to make jobs more accessible to unemployed local residents. This is especially true considering labor required to construct the facilities, as well as that required for long term maintenance.

  GI will increase opportunities for local, green jobs both for construction and for long term maintenance of the facilities. DC Water will work to promote green jobs with a living wage for local residents. Activities may include establishing a certification program for GI jobs, partnering with organizations to provide training that ultimately leads to certification, conducting outreach in the District and partnering with local organizations.

6 Proposed LTCP Modifications for Green Infrastructure

6.1 Changes to CSO Controls/Schedule

In order to proceed with the hybrid green/gray controls for the Potomac River and GI for Rock Creek's Piney Branch sewershed, modification of the LTCP is required. Proposed changes to the LTCP are summarized below:

Potomac River CSO Controls

- Require implementation of GI and targeted sewer separation to control CSOs 027, 028, and 029 with the facilities managing volume of water runoff produced by a 1.2" of rain falling on 133 impervious acres. Phased implementation of GI would be required, with all facilities being placed in operation by 2027.
- Indicate that DC Water has awarded a contract for preparation of an Environmental Impact Statement for the Potomac Tunnel.
- Change the deadline for start of the Facility Plan for the Potomac Tunnel from 2015 to 2017
- Require the construction of a 30 million gallon tunnel to control CSOs 020, 021, 022 and 024 with facilities being placed in operation by 2030. Drain the tunnel by gravity to the Blue Plains Tunnel.
- Require the construction and evaluation of the first GI project in the Potomac sewershed to determine its practicability. If, based on that evaluation, GI is determined to be impracticable, require the construction of a 40 million gallon Potomac Tunnel in lieu of the 30 million gallon tunnel and require CSOs 027, 028 and 029 to be controlled by the tunnel. If GI is determined to be practicable after the first project, require the continued implementation of GI.
- Require sewer separation of CSOs 025 and 026 by 2023 to eliminate these outfalls from the combined sewer system.
- Delete the requirement to consolidate CSOs 024 through 028 and replace this requirement with the other CSO controls described above.

Rock Creek CSO Controls

- Delete the requirement to construct the Piney Branch Tunnel.
- Require implementation of GI and targeted sewer separation to control Piney Branch CSO 049 with facilities managing the volume of water runoff produced by a 1.2" of rain falling on 365 impervious acres. Phased implementation of the GI would be required, with all facilities being placed in operation by 2030.
- Require the construction and evaluation of the first GI project in Rock Creek to determine its practicability. If, based on that evaluation, GI is determined to be impracticable, require the construction of 9.5 million gallons of storage for Rock Creek's Piney Branch CSO 049. If GI is determined to be practicable after the first project, require the continued implementation of GI.

Low Impact Development-Retrofit

- Delete the requirement for DC Water to review current LID and LIDR information to determine if the sizes of the Potomac and Piney Branch tunnels can be reduced with the installation of LID and LIDR.

Other

- Require DC Water and the District to cooperate and coordinate efforts to facilitate implementation of GI in the District.

Case Study #1: DC Water CSO LTCP
Attachment 1-3
DC Water's 2012 Inter-Municipal Agreements

BLUE PLAINS INTERMUNICIPAL AGREEMENT of 2012

[Effective: 4/3/13]

Among the
District of Columbia
District of Columbia Water and Sewer Authority
Fairfax County, Virginia
Montgomery County, Maryland
Prince George's County, Maryland
Washington Suburban Sanitary Commission

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BLUE PLAINS INTERMUNICIPAL AGREEMENT OF 2012

PREAMBLE

THIS BLUE PLAINS INTERMUNICIPAL AGREEMENT OF 2012, is made among the **DISTRICT OF COLUMBIA** (District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY**, **Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC), collectively, "the Parties." This Agreement shall be known as "this IMA" or "the 2012 IMA."

Witness:

WHEREAS, the Parties desire to protect the fish, wildlife, scenic and recreational qualities of the Chesapeake Bay, the Potomac River estuary, the Anacostia River, and other tributary waters, pursuant to the federal Clean Water Act, while providing wastewater collection and treatment services and related biosolids management for the Blue Plains Service Area (BPSA); and

WHEREAS, the District, Fairfax, Montgomery, Prince George's, and WSSC entered into the Blue Plains Intermunicipal Agreement of 1985 (the 1985 IMA) in order to resolve a variety of critical wastewater treatment, biosolids management, and cost allocation issues with the Blue Plains Wastewater Treatment Plant (Blue Plains); and

WHEREAS, much of the wastewater collection and all of the wastewater treatment and related biosolids management required by the 1985 IMA was provided by the District at Blue Plains until 1996, when the District created DC Water as an independent authority with regional responsibilities to provide these and other services through the operation and management of Blue Plains and Other Associated Facilities; and

WHEREAS, the District holds title to the real property, appurtenances, and fixtures of Blue Plains; and

WHEREAS, DC Water is the National Pollutant Discharge Elimination System (NPDES) permit holder for and operates Blue Plains; and

WHEREAS, WSSC is an agency created by the State of Maryland to provide water supply and wastewater collection and treatment and biosolids management services to Montgomery and Prince George's, whose governments each appoint three (3) of WSSC's six (6) Commissioners; WSSC, on behalf of the residents of Montgomery and Prince George's, contributes their allocated share of costs of wastewater services provided by DC Water; and

WHEREAS, the District, Fairfax, Montgomery, and Prince George's are governments, which have cooperated to provide wastewater collection and treatment and biosolids management to protect the public health of their residents and to provide the infrastructure necessary to realize their respective current and long-range planning

and development goals; additionally Fairfax purchases wastewater services directly from DC Water and retails such services to Fairfax customers; and

WHEREAS, the District and DC Water have individual service agreements with other entities, known as Non-Party Users, that have defined Allocated Flow Capacity within the IMA but are not Signatories to the IMA, and Fairfax and WSSC also have individual service agreements with other entities, known as Indirect Users, that share a portion of Fairfax or WSSC's Allocated Flow Capacity within the BPSA; and

WHEREAS, DC Water represents the interests of the Non-Party Users and is responsible for enforcing any Limited Party Agreements with Non-Party Users, whether those agreements are in the name of DC Water or the District, and Fairfax and WSSC are responsible for enforcing any Limited Party Agreements which they have with Indirect Users; and

WHEREAS, the existing institutional arrangements for wastewater treatment, biosolids management, and for Capital Cost and Operating and Maintenance (O&M) Cost allocations among the Parties set forth in the 1985 IMA had their origin in a series of agreements dating back to the 1950s; and

WHEREAS, the Parties have demonstrated their willingness to share in the burdens associated with the demands of regional wastewater collection and treatment and biosolids management for the BPSA; and

WHEREAS, the Parties desire to establish an equitable arrangement for allocating Capital Costs in relationship to their Allocated Flow Capacity and for allocating O&M Costs in relationship to their Actual Flows, with the potential need to allocate certain costs based on factors not linked to capacity allocation or flow (e.g. loadings); and

WHEREAS, the Parties desire to improve and formalize mechanisms for continued cooperation, coordination and communication among the Parties, including capacity planning and technical input regarding Blue Plains and Other Associated Facilities and the BPSA; and

WHEREAS, the Parties desire to provide for a continuing water quality monitoring and evaluation program to address Potomac River estuary, Anacostia River and Chesapeake Bay water quality issues, as well as to recognize the continued need for long-term regional water quality planning, wastewater planning, and biosolids management planning for the BPSA and the region as a whole; and

WHEREAS, the Parties desire to set forth their rights, obligations and responsibilities with respect to the use and management of facilities necessary for wastewater collection and treatment and for biosolids management for the BPSA; and

WHEREAS, the Parties acknowledge that changing conditions may require modifications to Allocated Flow Capacity, Peak Flow Limitations and cost allocations as well as constraints on loadings and potential load allocations; and

WHEREAS, the Parties acknowledge the need for flexibility and expedited responsiveness concerning many issues of wastewater collection and treatment systems and facilities, and biosolids management issues within the BPSA and, to that end, desire to authorize the use of Derivative Agreements to implement the intent of the Parties.

NOW, THEREFORE, the undersigned Parties agree that

1. This Blue Plains Intermunicipal Agreement of 2012 (this IMA) is entered into for the purposes of:
   a. Allocating the wastewater treatment capacity of Blue Plains and Other Associated Facilities and related peak flows for the collection system;

   b. Equitably allocating the Capital Costs of wastewater treatment and biosolids management;

   c. Equitably allocating O&M Costs;

   d. Defining the responsibilities of pretreatment and operational requirements and biosolids management;

   e. Defining the process of making future wastewater capacity planning decisions, including addressing load allocations;

   f. Providing a mechanism for continuing coordination, cooperation and communication; and

   g. Providing environmental stewardship.

2. Upon signing of this IMA by all Parties, this IMA shall replace the 1985 IMA, and as of such date the 1985 IMA shall be of no further force and effect, and the Blue Plains Regional Committee shall become the Regional Committee created by this IMA.

3. The terms used in this IMA are defined in **Section 12. Glossary**.

4. The headings used in this IMA are for reference purposes only.

-END OF PAGE-

SECTION 1. KEY PRINCIPLES

The provisions of this IMA, and the Derivative Agreements created to implement it, are based upon certain Key Principles. This IMA and the Derivative Agreements shall be governed by and consistent with these Key Principles. These Key Principles shall guide any interpretation or dispute resolution process.

1. **Ensure Best Management -** The Parties commit to continued cooperation, coordination and communication to ensure the best possible management of all Multi-Jurisdiction Use Facilities (MJUFs), including Blue Plains and Other Associated Facilities for the benefit of the District, Fairfax, Montgomery and Prince George's and their residents. In this regard, the Parties acknowledge that, irrespective of their individual agreements with Non-Party Users and Indirect Users of Blue Plains, the Parties shall meet their contractual obligations under this IMA.

2. **Capacity Allocations and Peak Flow Limitations** - The wastewater treatment flow capacity and Peak Flow Limitations, and associated loadings for Blue Plains, are defined and allocated among the Parties and Non-Party Users as set forth in this IMA.

3. **Management of Flows and Loads** - The Parties agree to manage their flows in accordance with their Allocated Flow Capacity and associated Peak Flow Limitations, and overall loads in accordance with Blue Plains Design Load Capacities.

4. **Assessment of Capital Costs** - All Capital Costs associated with Blue Plains and Other Associated Facilities which are MJUFs, shall be assessed in relationship to the District's, Fairfax's and WSSC's and Non-Party Users' Allocated Flow Capacity, Peak Flow Limitations, or other approved Usage Allocation as may be agreed among the Parties. The methodologies and tools used to make those determinations are defined in this IMA. DC Water shall assess Capital Costs against Non-Party Users in accordance with applicable contracts. These Capital Costs shall include the costs associated with rehabilitation of or other improvements to existing facilities, as well as construction of new facilities.

5. **Assessment of Operating and Maintenance (O&M) Costs and Other Costs** - All O&M Costs associated with MJUFs and processes shall be assessed in relationship to the Parties' and Non-Party Users' Billing Flows, or other approved Usage Allocation as may be agreed among the Parties; and DC Water shall be responsible for O&M Costs of Non-Party Users. The Parties also bear financial responsibility for certain fines, penalties and claims.

6. **Costs of Biosolids Management** - The Parties accept individual and collective regional responsibility for the long-term viability of management for biosolids generated by Blue Plains, and agree to appropriately share the biosolids management Capital Costs in proportion to their Allocated Flow Capacity, and O&M Costs in proportion to their Billing Flows.

7. **DC Water's Responsibility for Operation of Blue Plains** - While DC Water shall afford the other Parties due opportunity to review and comment on important technical and financial issues that may affect the other Parties' rights and obligations under this IMA, or that may have regional implications, DC Water shall continue to exercise its discretion and judgment with regard to the operation, maintenance and management of Blue Plains and Other Associated Facilities.

8. **Agreement to Cooperate with DC Water -** The Parties have historic, current and future responsibilities for the effective and efficient development of the region, and the provision and maintenance of the region's infrastructure, including wastewater collection and treatment, and biosolids management within the BPSA. These interconnected responsibilities require the close cooperation and collaboration by the other Parties with DC Water.

9. **Assessment of Projected Flow Capacity Needs and Future Expansion** - The Parties recognize that the wastewater flow capacity and loading requirements for all Parties and Non-Party Users within the BPSA must be assessed periodically and plans made to provide adequate wastewater collection and treatment facilities. They further recognize that the District shall always possess wastewater treatment capacity at Blue Plains sufficient to meet its Projected Flow Capacity Needs; and, therefore, that all future Projected Flow Capacity Needs may or may not be able to be met at Blue Plains. The Parties agree to establish procedures to define these Projected Flow Capacity Needs, identify options to provide for these needs, agree on time frames for notification and actions, and agree on the allocation of capacity and costs. The District has no obligation to expand the currently authorized capacity or loadings of Blue Plains, although an expansion option is not precluded. The Parties may decide to expand Blue Plains or Other Associated Facilities, or accommodate such future flows at facilities other than Blue Plains, based on a Jointly Managed Study. The Parties (and Non-Party Users, as appropriate) agree to share the costs of an expansion at Blue Plains or Other Associated Facilities, or at any other facilities, based on agreed upon capacity and loading allocations, and associated Peak Flow Limitations.

10. **Protection of Water Quality** – Stewardship and protection of the water quality of the Potomac River estuary, the Anacostia River, and contributing to the health of the Chesapeake Bay are fundamental values of the Parties. Achieving these goals is an inherent function of Blue Plains, manifested through its NPDES permit.

11. **Effect and Amendment of this IMA and Derivative Agreements** - This IMA remains in effect until June 30, 2111, unless amended, replaced or terminated earlier by mutual consent of all the Parties. The Parties may amend this IMA in accordance with its terms. The Parties may create, amend or terminate any associated Derivative Agreements addressing implementation of this IMA, as provided in this IMA. Certain agreements, set forth in the Appendix, which were suspended, extinguished or superseded by the 1985 IMA, are extinguished and superseded by this IMA.

12. **Dispute Resolution** - The Parties agree to a dispute resolution process to resolve differences regarding interpretation of or disputes regarding this IMA or the Derivative Agreements.

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SECTION 2. GOVERNANCE

A. LEVELS OF AUTHORITY

The physical and financial interdependence of Blue Plains and Other Associated Facilities requires regular forums where technical, policy and financial issues affecting more than one Party can be presented and discussed, and where differences and disputes can be resolved. The Parties agree that they shall make every effort to achieve consensus decisions. In fulfilling these responsibilities, the Parties may proceed or act at three different levels of authority: (1) the policy level, (2) the administrative level or (3) the technical level.

B. AUTHORITY TO ACT AND GENERAL PARTY RESPONSIBILITIES

1. **Basis** - Authority for action or decision by each member of the three (3) bodies identified herein as levels of governance is pursuant to applicable enabling legislation, charter provisions or formal policies of each Party.

2. **General Party Responsibilities**
   a. Unless otherwise stated herein, each Party shall determine which of its officials or staff will act on its behalf.

   b. Unless otherwise stated herein, each Party shall be responsible for any notice to its officials, staff or constituents, pursuant to applicable legislation, charter provisions, or formal or informal policies of the Party.

   c. Consistent with the respective bylaws of the Leadership Committee and the Regional Committee, those Committees may allow observers invited by members of those committees to attend their meetings.

C. POLICY LEVEL: THE IMA SIGNATORIES

1. **Signatory** - The Signatories of this IMA are the highest level of officials of each Party, as designated below:
   a. District of Columbia – Mayor
   b. DC Water – Chairman, Board of Directors
   c. Fairfax County, Virginia – Chairman, Board of Supervisors
   d. Montgomery County, Maryland – President, County Council and County Executive
   e. Prince George's County, Maryland – Chair, County Council and County Executive
   f. Washington Suburban Sanitary Commission – Chair and Vice Chair

2. Each Signatory warrants that its signature is authorized.

3. Written agreement of the Parties, at the Signatory level, is required to revise, amend or terminate this IMA pursuant to **Section 10**.

4. Signatory review shall constitute the last or highest internal level of dispute resolution under **Section 10**.

D. ADMINISTRATIVE LEVEL: THE IMA LEADERSHIP COMMITTEE

1. **Composition** - The IMA Leadership Committee (the Leadership Committee) shall be composed of the governmental Chief Administrative Officers and the Operating Agencies' General Managers, i.e. six (6) members, consisting of one (1) member from each Party as designated below:
   a. District of Columbia – City Administrator
   b. DC Water – General Manager
   c. Fairfax County, Virginia – County Executive
   d. Montgomery County, Maryland – Chief Administrative Officer
   e. Prince George's County, Maryland – Chief Administrative Officer
   f. Washington Suburban Sanitary Commission – General Manager

2. **General Responsibility** - The Leadership Committee shall oversee the implementation of this IMA. The Committee shall convene at least annually to receive briefings and to resolve issues or endorse positions presented by the Regional Committee or a Party, including dispute resolution.

3. **Specific Functions** - The Leadership Committee is charged with overseeing this IMA which function includes, where appropriate or required, authorization, review and approval of:
   a. Derivative Agreements, except for Limited Party Agreements, and amendments to or termination of Derivative Agreements, except for Limited Party Agreements, entered into pursuant to **Section 11**, in order to address routine, procedural or operational elements of this IMA;

   b. Final interpretations of this IMA and Derivative Agreements for matters referred to it by the Regional Committee or when dispute resolution has been invoked;

   c. Action on issues covered by this IMA and Derivative Agreements that have a potential policy or fiscal impact on the Parties, or on the capability of Blue Plains to effectively provide wastewater treatment; and

   d. Other duties as set forth in this IMA.

4. **Procedures**
   a. The Leadership Committee shall act by the unanimous agreement of all of its members and formal action documented in minutes or other documents.

   b. The Leadership Committee may agree that certain decisions or actions implementing this IMA may be made by the unanimous agreement of the respective governmental Chief Administrative Officers or the unanimous agreement of the respective Operating Agency Representatives alone. The Parties acknowledge that Fairfax is both a governmental entity and an Operating Agency, and may participate in either subgroup as appropriate.

c. The Leadership Committee shall select a chair and develop procedures consistent with this IMA.

5. **Regional Committee Input** - The Leadership Committee may seek the recommendation of and request reports from the Regional Committee.

E. TECHNICAL LEVEL: THE IMA REGIONAL COMMITTEE

1. **Composition** - The IMA Regional Committee (the Regional Committee) shall be composed of 12 members, consisting of two (2) members from each Party.

2. **Appointment** - Members of the Regional Committee shall be appointed by the members of the Leadership Committee for their respective Party, and shall consist of professional staff representatives from each of the Parties.

3. **General Responsibilities**
   a. The Regional Committee is created for the purpose of assisting in the interpretation, administration and implementation of this IMA and to resolve issues pertaining to Blue Plains that are within the scope of this IMA and the Derivative Agreements.

   b. The Regional Committee shall identify issues relevant to the implementation and oversight of this IMA, and shall coordinate, review and consider appropriate actions for the effective provision of wastewater collection and treatment and biosolids management to support the current and future Projected Flow Capacity Needs of the BPSA.

   c. The Regional Committee shall make recommendations to the Leadership Committee and, where appropriate, to other entities with respect to the rights and obligations of the Parties.

   d. The Regional Committee shall make decisions and take actions as delegated to it by the Leadership Committee.

4. **Specific Functions** - The Regional Committee is responsible for the following:
   a. Implementing this IMA and Derivative Agreements, including:
      1) Recommendations on policy issues;

      2) Initial resolution of disputes associated with implementation;

      3) Providing recommendations to the Leadership Committee on amendments to this IMA;

      4) Providing recommendations to the Leadership Committee on creation, modification or termination of Derivative Agreements to address routine, procedural or operational elements of this IMA;

5) Providing guidance and recommendations for any other issues that may arise within the scope of this IMA.

b. Evaluating the terms of agreements with Non-Party Users and Indirect Users;

c. Evaluating population impacts, flow projections and service area boundaries;

d. Providing analysis of flow measurement and data collection efforts, as well as flow management programs and their flow capacity impacts;

e. Evaluating the Parties' flows and conformance with Allocated Flow Capacity and Peak Flow Limitations;

f. Defining and assessing the Parties' Projected Flow Capacity Needs, loading requirements and options;

g. Evaluating proposals regarding any capacity reallocation;

h. Evaluating proposed permit conditions, including potential capacity and financial impacts;

i. Establishing cost allocations for Capital Costs and O&M Costs of MJUFs;

j. Evaluating Blue Plains impacts and contributions towards meeting local and regional water quality goals;

k. Providing input and regional support for Blue Plains biosolids management program;

l. Evaluating the Parties' compliance with their requirements under Blue Plains Pretreatment Program;

m. Providing recommendations for DC Water's proposed "Capital Improvements Program Budget" and annual "Operating Budget" as they relate to MJUFs; and

n. Other duties as set forth in this IMA.

5. **Serve as a Forum** - The Regional Committee shall provide a forum for in-depth discussion and coordination regarding the wastewater and biosolids technical, policy and financial issues affecting Parties. Any Party may submit issues to the Regional Committee for review and comment prior to regional action or prior to Implementation by DC Water or any other Party.

6. **Procedures** - The Regional Committee shall act by the unanimous agreement of all of its members and formal action documented in minutes or other documents.

a. The Regional Committee may agree that certain categories of decisions or actions may be made by the unanimous agreement of the representatives of the

governmental entities alone or the unanimous agreement of the Operating Agency Representatives alone. The Parties acknowledge that Fairfax is both a governmental entity and an Operating Agency, and may participate in either subgroup, as appropriate.

b. The Regional Committee shall select its own chair and develop its own procedures consistent with this IMA.

c. The Regional Committee shall meet at least quarterly.

d. The Regional Committee may create standing or ad-hoc subcommittees or work groups to address issues/topics as required. These subcommittees/work groups shall be responsible for addressing issues assigned to them, and for developing recommendations for the Regional Committee.

e. The Operating Agency Representatives are a subset of members of the Regional Committee and shall be a standing work group of the Regional Committee.

7. **Annual Work Program and Budget for Secretariat Services** - The Regional Committee shall recommend, and the Leadership Committee shall approve, an annual work program and budget, and an agreement with an entity to provide secretariat services for the Leadership Committee, the Parties and the Regional Committee to carry out their responsibilities under this IMA, as set forth in a Service Agreement.

8. **Annual Work Program and Budget for a Regional Water Quality Management Program** - The Regional Committee shall recommend, and the Leadership Committee shall approve, an annual work program and budget, and an agreement with an entity to address a regional water quality management program, as set forth in a Service Agreement.

9. **Regional Committee Communication with Parties** - On behalf of the Leadership Committee, the Regional Committee shall prepare an annual report to the Parties regarding the implementation of this IMA, and shall provide such other reports on its activities as the Leadership Committee or Signatories may require.

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SECTION 3. BLUE PLAINS PERMIT RESPONSIBILITIES AND TREATMENT PROCESS REQUIREMENTS

A. DC WATER'S OVERALL PERMIT RESPONSIBILITIES

As operator of Blue Plains and Other Associated Facilities, DC Water is responsible for monitoring pending federal, state and local statutory and regulatory developments; and for anticipating potential impacts on the Blue Plains National Pollution Discharge Elimination System (NPDES) permit, or other permit requirements, as a result of such developments. DC Water is also responsible for monitoring and analyzing other issues that can reasonably be expected to impact Blue Plains permit conditions, programs and process requirements. DC Water's assessment of these impacts shall include, but not be limited to, an assessment of the potential impacts on Blue Plains and Other Associated Facilities and Pretreatment Program requirements.

B. DC WATER'S NOTIFICATION RESPONSIBILITIES

If DC Water determines that any matter or issue in this **Section 3** may result in modification of permit conditions, programs or process requirements at Blue Plains and Other Associated Facilities, it shall determine the anticipated timing and potential financial impacts of such modifications on the Parties and Non-Party Users, and shall inform the Regional Committee. Potential financial impacts include Capital Costs, as well as O&M Costs. Once DC Water identifies the need for additional Capital Costs or O&M Costs, the other Parties shall have an opportunity to comment on the timing and other aspects of the projects prior to the projects proceeding.

C. INDIVIDUAL PARTY RESPONSIBILITIES

Each Party is responsible for its share of any financial commitment, including Capital Costs and O&M Costs, to address any modification of permit conditions, programs or process requirements at Blue Plains, as set forth in **Section 5**.

D. COLLECTIVE PARTY RESPONSIBILITIES

In addition to addressing the financial impacts of regulations, permit conditions, programs, and process impacts determined under this **Section 3**, the Parties agree to evaluate this IMA to determine if any elements, including, but not limited to, cost elements need to be amended.

E. REGIONAL WATER QUALITY MANAGEMENT PROGRAM SUPPORT

1. **Stewardship** - The Parties recognize their collective and regional responsibilities for the long-term protection of the Potomac River estuary and the Anacostia River water quality, and supporting restoration of the Chesapeake Bay; and responding to other environmental requirements impacting Blue Plains and Other Associated Facilities. The Parties agree to fulfill these objectives of regional water quality management planning, monitoring and modeling programs in the most cost-effective manner for Blue Plains.

2. **Program Activities** - The Parties shall actively support regional water quality and environmental programs to monitor and analyze state, federal and local water quality

management policies and regulations, as well as wastewater treatment and biosolids management technologies and permitting issues, and engage in policy and technical advocacy.

F. DERIVATIVE AGREEMENT – Derivative Agreements shall address additional matters set forth in this **Section 3**. They may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 4. BLUE PLAINS FLOW CAPACITY, LOADS, AND PEAK FLOWS - ALLOCATIONS AND LIMITATIONS

A. BLUE PLAINS ALLOCATED FLOW CAPACITY

1. Basis for Capacity Allocations

a. The Allocated Flow Capacity for the District, Fairfax, WSSC, and Non-Party Users is defined in **Table 4-A** below.

b. The Allocated Flow Capacity is based on Blue Plains current Design Flow Capacity and reflects the ability of Blue Plains to provide treatment of the incoming wastewater under Annual Average Hydrologic Conditions.

c. It is recognized that the Captured Stormwater Flows (CSF) that receive treatment to meet the Combined Sewer Overflow Long-term Control Plan (CSO LTCP) requirements are not part of the District's Allocated Flow Capacity.

TABLE 4-A

BLUE PLAINS ALLOCATED FLOW CAPACITY	
ENTITIES	**ALLOCATIONS (MGD)[1]**
District of Columbia	152.50
Non-Party Users:	
Loudoun County Sanitation Authority, Virginia	13.80
Dulles Airport, Virginia	1.50
Town of Vienna, Virginia	1.50
Naval Ship Research & Development Center, Maryland	0.07
National Park Service, Maryland	0.03
Sub-total	16.90
District of Columbia – Total	**169.40**
WSSC[2] (for Prince George's County & Montgomery County), **Maryland – Total**	**169.60**
Fairfax County, Virginia[3] **- Total**	**31.00**
Grand Total – Blue Plains Design Flow Capacity	**370.00**

[1] Flows represent Annual Average Hydrologic Conditions.
[2] The Allocated Flow Capacity for WSSC is on behalf of Prince George's and Montgomery; with any sub-allocations determined by separate agreements between those entities. The WSSC allocation also includes wastewater from other political jurisdictions with which WSSC has separate agreements.
[3] The Allocated Flow Capacity for Fairfax also includes wastewater from other political jurisdictions with which Fairfax has separate agreements.

2. **Compliance with Capacity Allocations**
   a. The District, Fairfax and WSSC shall comply with their Allocated Flow Capacity.

   b. Compliance with the Allocated Flow Capacity by the District, Fairfax and WSSC shall be assessed based on their Adjusted Flow, and as calculated in **Operating Agreement #3.**

   c. Continued use of this Allocated Flow Capacity by the District, Fairfax, WSSC or Non-Party Users, however, shall be dependent on the respective entity making the financial contribution for its appropriate share of the Capital Cost and O&M Costs of all MJUFs in accordance with **Section 5**.

3. **Assessment of Future Needs** - Assessment of Projected Flow Capacity Needs for the District, Fairfax, WSSC and Non-Party Users, as compared to their Allocated Flow Capacity, shall be in accordance with **Section 7**.

4. **Compliance by Non-Party Users and Indirect Users**
   a. The District and DC Water shall use their best efforts to require Non-Party Users to comply with their Allocated Flow Capacity.

   b. Fairfax and WSSC shall use their best efforts to require Indirect Users to comply with their capacity allocations as defined under Limited Party Agreements with the Indirect Users.

   c. Irrespective of such efforts, all Parties shall be bound by their Allocated Flow Capacity.

5. **Conditions on Limited Party Agreements for a Transfer of Allocated Flow Capacity**
   a. Before a Limited Party Agreement, as permitted by **Section 11**, for a transfer of Allocated Flow Capacity can be executed:
      1) It must include terms which do not change the financial obligations required under this IMA to DC Water for the Allocated Flow Capacity being transferred; and

      2) It shall be reviewed by the Regional Committee to ensure, among other matters, that the proposed transfer does not change the rights and responsibilities of a Party as set forth in this IMA.

   b. Financial arrangements pursuant to a Limited Party Agreement for a transfer of Allocated Flow Capacity shall be determined by the involved parties.

-END OF PAGE-

B. BLUE PLAINS EFFLUENT LOADS AND BLUE PLAINS EFFLUENT LOAD ALLOCATIONS

1. **Basis for Blue Plains Effluent Loads and Blue Plains Effluent Load Allocations** - The Blue Plains Effluent Loads and the associated Blue Plains Effluent Load Allocations shall be consistent with Blue Plains permit and as defined in **Operating Agreement #1**.

2. **Requirements for Transfers of Flow and/or Effluent Load Allocations Outside Blue Plains or BPSA**
   a. If the District, Fairfax or WSSC determine that it will divert any or all of its current or projected wastewater flows originating in the BPSA from Blue Plains, the associated Effluent Load Allocation may be transferred away from Blue Plains.

   b. The transfer of any Effluent Load Allocations away from Blue Plains, whether by the District, Fairfax, WSSC or by others, shall result in a proportionate reduction in the usable Allocated Flow Capacity of the Party(ies) having their Effluent Load Allocations reduced; unless additional Blue Plains Load Allocations or Blue Plains Load Offsets are obtained. This shall not result in a change to the Allocated Flow Capacities defined in **Table 4-A.**

C. BLUE PLAINS INFLUENT LOADS AND INFLUENT DESIGN LOAD CAPACITY

1. **Basis for Blue Plains Influent Loads**
   a. The pollutant loads from all influent wastewater flows to Blue Plains, their concentrations, associated flow characteristics, and related design assumptions are related to Blue Plains Influent Load(s) and are expressed as the Design Load Capacity, as defined in **Operating Agreement #1**.

   b. The Design Load Capacity is based on Blue Plains current Design Flow Capacity and reflects the ability of Blue Plains to provide treatment of the incoming wastewater under maximum year flow conditions.

2. **Compliance with Blue Plains Influent Loads** - The Parties shall work to ensure that pollutant loads from all influent flows do not exceed Design Load Capacity(ies), as defined in **Operating Agreement #1;** unless pollutant loads in excess of the Design Load Capacity(ies) have been determined by DC Water to not pose a potential risk of contributing to Blue Plains Permit violations.

D. MONITORING OF AND RECOMMENDATIONS REGARDING INFLUENT FLOWS AND LOADS

1. DC Water shall routinely sample and monitor influent loads and wastewater process performance, with input from the other Parties, to determine if and when either the collective or individual influent concentrations from each Party appear to exceed normal variations in influent wastewater strength as determined by DC Water.

2. Such assessments shall address, but not be limited to addressing wastewater and Captured Stormwater Flow contributions, as well as Inflow/Infiltration ("I/I") impacts on influent loads.

3. DC Water shall determine whether these variations have the potential to impact Blue Plains plant performance, permit compliance, Allocated Flow Capacity, Effluent Load Allocations, or the Design Load Capacity, and make recommendations to the Regional Committee.

4. DC Water shall review influent flow rates and influent loads compared to Design Flow Capacity and Design Load Capacity values, and recommend whether plant-wide influent loads may need to be sub-allocated to the District, Fairfax, WSSC and Non-Party Users, or if any adjustments to the Allocated Flow Capacities might be required in order to meet NPDES permit requirements.

5. The Regional Committee shall routinely review all of these matters to determine whether the rights and responsibilities of the Parties are affected, and to make necessary recommendations to the Leadership Committee regarding, but not limited to, the following: cost elements, Effluent Load Allocations, and/or Allocated Flow Capacity. These recommendations shall address potential assignments to the District, Fairfax and WSSC, individually or collectively, as well as to Non-Party Users.

E. BLUE PLAINS SERVICE AREA (BPSA) PEAK FLOW LIMITATIONS - GENERAL CONDITIONS

1. **Peak Flow Limitations** - The Peak Flow Limitations for metered points of connection between the collection systems of two (2) or more Parties within the BPSA are defined as follows:
   a. Potomac Interceptor (PI) and other interceptors for WSSC, Fairfax and Non-Party Users' flows to collection systems operated by DC Water - **Table 4-B**.

   b. Interceptors for WSSC flows to collection systems operated by DC Water – **Table 4-C.**

   c. Interceptors for District flows to collection systems operated by WSSC - **Table 4-D.**

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Table 4-B - PEAK FLOW LIMITATIONS[1] FOR WSSC, FAIRFAX COUNTY & NON-PARTY USERS FOR THE POTOMAC INTERCEPTOR & OTHER INTERCEPTORS OPERATED BY DC WATER, FAIRFAX AND WSSC

Jurisdiction / Agency Points of Connection	Flow Capacity (Annual Average in MGD)	Peak Flow Limitation (MGD)	Peak/ Average Ratio
WSSC			
Cabin John (to MUPI)[2]	**10.3**	**23.3**	**2.3**
Cabin John (to PI)	6.1	37.0	6.1
Muddy Branch	8.4	28.3	3.4
Watts Branch	5.8	16.5	2.8
Rock Run	1.3	5.6	4.3
Subtotal to PI	**21.6**	**87.4**	
WSSC Total to PI & UPI[3]	**31.9**	**110.7**	**3.5**
Fairfax County			
Sully Road #1	4.0	14.0	3.5
Sully Road #2	1.1	3.0	2.7
Rock Hill Road	0.9	2.4	2.7
Sugarland Run	4.0	14.0	3.5
Great Falls[4]	8.7	30.0	3.4
Scotts Run	2.9	10.2	3.5
Subtotal to PI	**21.6**	**73.6**	
Pimmit Run	9.4	35.0	3.7
Fairfax Total to PI & Pimmit Run	**31.0**	**108.6**	**3.5**
Loudoun County Sanitation Authority to PI	**13.8**	**31.9**	
Other Non-Party Users to PI	**3.1**	**7.2**	
Grand Total to PI	**60.1**	**200.1**	

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[1] The Peak Flow Limitations and peak flow ratios for the Potomac Interceptor are acknowledged to be greater than design and modeling values.
[2] MUPI - Maryland Upper Potomac Interceptor
[3] UPI - Upper Potomac Interceptor
[4] This excludes the flow from the Town of Vienna, Virginia.

TABLE 4-C – PEAK FLOW LIMITATIONS FOR WSSC FOR OTHER INTERCEPTORS OPERATED BY DC WATER

Jurisdiction / Agency Points of Connection	Flow Capacity (Annual Average in MGD)	Peak Flow Limitation (MGD)
WSSC		
Little Falls Trunk Sewer	7.6	20.8
Rock Creek Main Interceptor[1] and Relief	33.5	56.6
Anacostia Forcemain & Project 89	83.2	185.0
Watts Branch Interceptor (Prince George's County)	1.3	5.9
Upper Oxon Run Trunk Sewer	6.1	15.6
Barnaby Branch	2.8	8.4
Owens Road	1.7	5.5
Indian Head Highway	1.5	5.3
TOTAL	**137.7**	**N/A**

TABLE 4-D – PEAK FLOW LIMITATIONS FOR THE DISTRICT FOR OTHER INTERCEPTORS OPERATED BY WSSC

Jurisdiction / Agency Points of Connection	Flow Capacity (Annual Average in MGD)	Peak Flow Limitation (MGD)
DISTRICT		
Point M-Kennedy St.	0.7	4.4
Point S-Fort Dupont St.	0.4	3.0
Point W-30th St.	0.7	4.8

2. **Basis for Peak Flow Limitations** - The Peak Flow Limitations, defined in **Table 4-B, Table 4-C, and Table 4-D**, have been developed consistent with the Allocated Flow Capacity for the District, Fairfax, WSSC and Non-Party Users, and reflect the maximum flows that have been determined (through modeling and historical observation of system performance) that the BPSA collection systems can convey without exceeding the capacity of the sewer system during wet weather conditions (e.g., rainfall or snowmelt events).

3. **Constraints on Peak Flow Limitations**
   a. The Peak Flow Limitations, defined in **Table 4-B, Table 4-C, and Table 4-D**, are predicated on the assumption that the District, Fairfax, and WSSC shall not make piping/service area modifications that would increase or significantly alter the character of the peak flows delivered to these points of connection.

[1] This includes that portion of Silver Spring Maryland which enters the Rock Creek Main Interceptor Sewer within the District.

b. If the District, Fairfax or WSSC proposes to make such modifications, they shall submit requests to DC Water, and DC Water will evaluate the request to determine whether such modifications can be accommodated.

c. The District, Fairfax and WSSC shall manage their systems or flow management so that the peak flows or sustained peak flows are consistent with historical patterns and assumptions underlying the Peak Flow Limitations, as determined by DC Water.

4. **Adjustments to Peak Flow Limitations**

a. The peak flows from the District, Fairfax or WSSC can exceed their Peak Flow Limitations for any point of connection, as defined in **Table 4-B**, **Table 4-C,** and **Table 4-D,** if their Adjusted Flow does not exceed their Allocated Flow Capacity and if there are no adverse hydraulic impacts to the affected interceptors. Any peak flow shaving facilities or operations must be approved by DC Water with respect to proposed peak flow rates, duration, and overall interceptor system capacity.

b. DC Water shall routinely monitor all peak flows within the BPSA collection system, determine appropriate action for any problems which arise, and make recommendations to the Regional Committee, consistent with **Section 6**. Specific details for how this monitoring and assessment shall be conducted are described in **Operating Agreement #3.**

c. Should future model analysis or observation of system performance indicate a need to revise these Peak Flow Limitations, the affected Parties shall support appropriate modifications to these limits, or to the system to ensure compliance with permit and other legal and Operational Requirements.

5. **Compliance by District, Fairfax and WSSC with Peak Flow Limitations**

a. Except as otherwise provided herein, the District, Fairfax and WSSC shall comply with their Peak Flow Limitations at the various points of connection.

b. Continued use of these Peak Flow Limitations by the District, Fairfax and WSSC, however, shall be dependent on that entity making the financial contribution for its appropriate share of the Capital Cost and O&M Costs of all MJUFs in accordance with **Section 5**.

c. The Parties shall ensure that the District, Fairfax and WSSC's collection systems limit the amount of I/I entering these systems. Collection systems shall be maintained so that I/I volumes do not contribute to exceedances of the Peak Flow Limitations.

6. **Compliance by Non-Party Users & Indirect Users with Peak Flow Limitations**

a. Continued use of these Peak Flow Limitations by the Non-Party Users, however, shall be dependent on that entity making the financial contribution for its appropriate share of the Capital Cost and O&M Costs of all MJUFs in accordance with **Section 5**.

b. The Parties shall use their best efforts to require Non-Party Users and Indirect Users to comply with the defined Peak Flow Limitations.

c. Except as otherwise provided herein, irrespective of such efforts, the Parties shall comply with the Peak Flow Limitations.

d. As appropriate and necessary, collection systems for the Non-Party Users and Indirect Users should limit the amount of I/I entering these systems.
   1) DC Water shall be responsible for ensuring that similar requirements are upheld by the Non-Party Users;

   2) Fairfax and WSSC shall be responsible for ensuring that similar requirements are upheld by the Indirect Users; and

   3) Irrespective of such efforts, and except as provided herein, the Parties shall be bound by these requirements.

7. **Wastewater Collection System Connections**
   a. **Additional Interconnections** - Subject to the conditions imposed by this IMA and any other conditions which might be imposed by the Parties at the time, additional interconnections between the wastewater collection systems of the District, Fairfax, WSSC and Non-Party Users shall be allowed.

   b. **No Requirement to Accept Flow Causing an Exceedance** - The District, Fairfax and WSSC shall not be required to accept flow into its wastewater collection system if that flow exceeds its own or the Non-Party User's Peak Flow Limitations.

   c. **Sewer Connection Approval** - Every connection of a sewer by the District, Fairfax or WSSC, or a Non-Party User, to the sewage collection system of another shall be made only based on prior written approval of the Operating Agency representative for that entity to whom the connection is being made, with notice provided to the Regional Committee.

F. ADDITIONAL BPSA PEAK FLOW LIMITATIONS – POTOMAC INTERCEPTOR (PI) CONDITIONS

1. **Additional Basis for PI Peak Flow Limitations** - These Peak Flow Limitations are based on analysis that indicates that the PI has not overflowed when the sum of the peak flows delivered has been limited to the 220-240 million gallons per day range. This performance is due to the large service area, timing of flows and rainfall variability.

2. **Potential Modifications to Potomac Interceptor Peak Flow Limitations**
   a. DC Water shall monitor flows and the performance of the PI system to determine if overflows do occur; and then shall work with Fairfax and WSSC to identify the reasons and to determine if revisions/reductions to the Peak Flow Limitations presented in **Table 4-B** are required.

   b. If DC Water determines based upon its monitoring and technical analysis that such revisions/reductions are necessary, it can require those reductions until this IMA is amended and Fairfax and WSSC shall comply with such determination.

G. DERIVATIVE AGREEMENT – Operating Agreement #1, Blue Plains Flow Capacity, Loads and Peak Flows – Allocations and Limitations, addresses additional matters set forth in this Section. It may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 5. FINANCIAL RESPONSIBILITIES OF PARTIES

A. ASSIGNMENT OF RESPONSIBLITIES

1. **Acknowledgements**
   a. The Parties acknowledge their financial responsibility for their respective shares of the Capital Costs and the O&M Costs of all MJUFs, including but not limited to Blue Plains and Other Associated Facilities. The Parties also bear financial responsibility for certain fines, penalties and claims.

   b. The Parties acknowledge that the "*Blue Plains Intermunicipal Agreement of 1985 Equity Payment Study*" (dated February, 1987), and the subsequent "equity payments" required by the 1985 IMA, reconciled all Capital Cost contributions for the Parties prior to 1987 and established a new baseline as of 1988 for calculating and allocating any future Capital Costs associated with Blue Plains.

2. **Leadership Committee** - The Leadership Committee shall ensure that the financial commitments of the Parties and Non-Party Users are met.

3. **Regional Committee**
   a. The Regional Committee shall agree upon MJUFs determinations and cost allocations, with detailed project lists and cost rationales, as well as billing and payment procedures.

   b. The Regional Committee shall address any new cost elements and cost allocation issues.

   c. The Regional Committee shall also ensure that a record is kept of calculations, procedures and agreements which implement this **Section 5**, including financial allocations for Capital Costs, O&M Costs, billing and payment procedures, User Fees, as well as fines, penalties and claims.

B. DETERMINATION OF MULTI-JURISDICTION USE FACILITIES (MJUFs)

1. **Basis for Making MJUF Determinations** - DC Water shall make determinations of the extent to which any facility is utilized by one or more entities and is, therefore, a MJUF; and, based thereon, shall make a recommendation regarding how the cost of building, operating, maintaining, or rehabilitating the facilities might be equitably shared among those entities, as more fully described in **Section 3.B.3**. below.

2. **Parties Commit to Pay Costs** - The District, Fairfax, WSSC and Non-Party Users are responsible for their respective share of all Capital Costs, O&M Costs, and other direct costs and indirect costs associated with MJUFs at Blue Plains and Other Associated Facilities. The costs include those associated with meeting permit requirements, as well as normal wastewater treatment process and biosolids management requirements for Blue Plains and Other Associated Facilities. These costs shall be developed to ensure full cost-recovery for the O&M, construction or

rehabilitation of the specified facilities. District costs are met through direct ratepayer payments.

3. **DC Water to Recommend Cost Allocations**
   a. DC Water shall utilize a methodology and associated technical tools that the Regional Committee has agreed to for making determinations whether a facility is a MJUF.

   b. DC Water shall make recommendations to the Regional Committee regarding MJUFs, and the proposed cost allocations proposed for those facilities, including providing specific project/program details and cost allocation rationale for making the MJUF determinations.

   c. DC Water shall inform the Regional Committee in a timely manner of the potential magnitude and anticipated timing of the necessary financial commitments to address their share of those commitments.

   d. DC Water shall consider Regional Committee input regarding the proposed amount and timing of those financial commitments. This process shall be an iterative process as regulatory requirements, process impacts, and major capital program requirements are defined and subsequently refined. The costs associated with the O&M, rehabilitation, construction or other use of these facilities shall be allocated among the Parties and Non-Party Users.

   e. The methodology and technical tools to be used in making these determinations shall be set out in **Operating Agreement #2**.

4. **Regional Committee to Endorse Cost Allocations and Identify Policy Issues** – The Regional Committee shall review DC Water's recommendations regarding MJUF designations and proposed cost allocations and, if appropriate, endorse the allocations, and identify any resultant policy issues associated with those recommendations.

5. **Regional Committee to Recommend Cost Allocation** - The Regional Committee shall recommend cost allocations to the Leadership Committee for approval.

C. CAPITAL COST RESPONSIBILITIES

1. **General Requirements - DC Water's Responsibility** - DC Water shall be responsible for addressing all of the obligations in this **Section 5** as they pertain to the Non-Party Users. Once DC Water identifies the need for additional Capital Costs, the other Parties shall be provided the opportunity to comment on the timing and other aspects of the projects. DC Water shall assess Fairfax and WSSC for their proportionate share of the Capital Costs incurred for MJUFs. DC Water shall assess District ratepayers using the same basis and reflecting the District's proportionate share of all costs.
2. **Blue Plains Capital Cost Allocations** - The costs for construction, installation, upgrade or expansion of any facilities which are built to manage wastewater, other

than Captured Stormwater Flow, that is treated at Blue Plains, or the biosolids or other residuals from Blue Plains shall be allocated to the District, Fairfax, WSSC, and Non-Party Users, based on the methodology set forth in **Operating Agreement #2.**

3. **Other Associated Facilities' Capital Cost Allocations** – Except as provided herein, the costs for construction, installation, upgrade or expansion of any Other Associated Facilities shall be allocated to the District, Fairfax, WSSC and Non-Party Users in proportion to their Allocated Flow Capacity or other Usage Allocations.

4. **Capital Equipment Cost Allocations Relating to MJUFs** - Capital Equipment Costs, that are incurred to replace, extend the life of or increase capacity of Blue Plains assets, will be allocated consistent with Allocated Flow Capacity, Actual Flows or other Usage Allocations, as defined in **Operating Agreement #2**.

5. **Basis for Cost Allocations for Fairfax or WSSC MJUFs** - The District, Fairfax, WSSC, and Non-Party Users shall pay the costs for construction, installation, upgrade or expansion of any MJUFs which are built by Fairfax or WSSC for wastewater treatment or biosolids management, or management of residuals from Blue Plains, in proportion to their Allocated Flow Capacity or other Usage Allocations, or as otherwise may be provided by this IMA or Derivative Agreements.

6. **Basis for Non-Standard Cost Allocations** – Projects, whose basis of design or operation DC Water has determined are not inherently linked to standard systems developed for flow or capacity as otherwise set forth in this IMA, may have their Capital Costs allocated based on a Usage Allocation agreed upon by the Parties. Such cost methodologies and rationale shall be consistent with the Key Principles.

D. OPERATING AND MAINTENANCE (O&M) COST RESPONSIBILITIES

1. **Blue Plains O&M Cost Allocations**
   a. **Assessments for Proportionate Treatment Costs** - DC Water shall assess Fairfax and WSSC for their proportionate share of the O&M Costs incurred for MJUFs. DC Water shall assess District ratepayers using the same basis and reflecting the District's proportionate share of all costs. All O&M costs incurred shall include all direct costs and indirect costs as agreed by the Regional Committee.

   b. **Assessments for Blue Plains** -The District's, Fairfax's and WSSC's proportion of the annual Blue Plains O&M Costs shall be as defined in **Operating Agreement #2.**

   c. **Process to Address Differential Treatment Costs** - If it is determined, based on a Jointly Managed Study, that there is a significant financial impact and, therefore, a basis for having differential treatment costs applied to the flows from various Parties and Non-Parties (i.e., based on strength of wastewater or other flow parameters), the Regional Committee shall be responsible for assessing and

recommending how cost allocations should be borne by the Parties, and making recommendations to the Leadership Committee.

d. **Use of Revenue** - Any revenue earned from the by-products from the wastewater treatment and/or biosolids processes at Blue Plains shall be used to offset overall O&M expenses, and be attributed, as appropriate, in proportion to the Capital Cost and/or O&M Cost allocations for those associated MJUFs. Revenue shall include, but not be limited to, any revenue generated by: water reuse, methane gas, electricity, carbon trading, compost and any other biosolids-derived products.

2. **Pipelines and Appurtenances O&M Cost Allocations** – The District, Fairfax and WSSC shall each be assessed by DC Water for their proportionate share of the O&M costs for any MJUFs as defined in **Operating Agreement #2**.

3. **Other Associated Facilities' O&M Cost Allocations** – The District, Fairfax and WSSC shall each be assessed by DC Water for their proportionate share of the O&M Costs associated with these Other Associated Facilities, based on the proportion of their Actual Flow versus Total Flow through facilities, or based on other Usage Allocations as defined in **Operating Agreement #2**.

E. USER FEE RESPONSIBILITIES

1. **Annual User Fee** – Fairfax, WSSC and Non-Party User Loudoun County Sanitation Authority (LCSA or Loudoun Water) shall pay to DC Water an annual User Fee on behalf of the District. The initial fee was set at $1,500,000 per annum, effective July 1, 1986; with subsequent payments compounded annually by one and one half percent (1.5%).

2. **Apportionment** - DC Water shall annually calculate the User Fee for Fairfax, WSSC and LCSA, based in proportion to their share of the Allocated Flow Capacity at Blue Plains.

3. **DC Water's Use of the User Fee** - DC Water shall utilize the User Fee payments from Fairfax, WSSC and LCSA as a credit to the District's share of Blue Plains O&M Costs.

F. FINES, PENALTIES AND CLAIMS RESPONSIBILITIES

1. **Joint Responsibility** - The Parties shall have joint responsibility for and shall pay their respective shares of such fines, penalties or claims in accordance with their agreed shares of the O&M Costs or Capital Costs as appropriate for MJUFs or programs, provided that the following criteria are met:
   a. The fines, penalties or claims are associated with MJUFs;

b. The Party incurring the fines, penalties or claims demonstrated a reasonable effort to avoid imposition of such fines, penalties or claims, and dispute or contest any unreasonable charges; and

c. There is no judicial or adjudicative determination that the fines, penalties or claims are the result of gross negligence or willful misconduct of an employee or agent of the Party incurring the fine, penalty or claim.

2. **Reimbursement of Litigation Costs** - If litigation is filed against a Party for injuries to a third party resulting from operation of a MJUF, the Parties shall share the costs of defense or judgment in accordance with their proportionate shares of the associated O&M Costs or Capital Costs, as appropriate, as long as there is no determination by a court or arbitrator that any such judgment is the result of gross negligence or willful misconduct of an employee or agent of the defendant Party. If a determination is made that there has been gross negligence or willful misconduct of an employee or agent of the defendant Party, the defendant Party shall be solely responsible for the costs of defense and judgment.

3. **Review and Dispute Resolution** - The Regional Committee shall be responsible for reviewing these fines, penalties or claims and their associated costs, when they relate to billing disputes, and concurring with their applicability to the Parties. If there are disagreements regarding the responsibility of any of the appropriate Parties to pay for such costs, the Regional Committee shall address the issues in a timely manner, including, if necessary, referring the matter to the Leadership Committee for resolution.

G. ESTIMATES, BILLINGS, PAYMENTS, AND RECONCILIATION PROCEDURES

1. **General Requirements for Addressing DC Water Capital Costs and O&M Costs** – In accordance with the procedures outlined in Operating Agreement #2, DC Water shall:
   a. Assess costs based on estimated annual expenses;
   b. Prepare quarterly billings;
   c. Receive quarterly payments; and
   d. Reconcile all costs with payments.

2. **DC Water's Responsibility for Assessing Capital Costs and O&M Costs for MJUFs for Party and Non-Party Users** – DC Water is responsible for assessing all Capital Costs and O&M Costs associated with MJUFs for the District, Fairfax, WSSC and Non-Party Users. Assessments for each user will be based on their Allocated Flow Capacity or Billing Flows, or other approved Usage Allocations as appropriate.

3. **Fairfax's and WSSC's Responsibility for Assessing Capital Costs and O&M Costs for MJUFs for Party and Non-Party Users** – Fairfax and WSSC are responsible for assessing all Capital Costs and O&M Costs associated with MJUFs that they construct on behalf of the District, Fairfax, WSSC and Non-Party Users. Assessments for each user will be based on their Allocated Flow Capacity or Billing Flows, or other approved Usage Allocation as appropriate.

4. **Allocation Method for Capital and O&M Costs for MJUFs** - The method for allocating project-specific Capital Costs and O&M Costs associated with all MJUFs, and the associated billing procedures are as defined in **Operating Agreement #2**.

5. **Party Rights to Documents** – The Parties have the right to audit DC Water's or another Party's billings, and access to all existing, relevant financial documents for any billing for which such Party is wholly or partially responsible. Upon written request by a Party, the billing Party shall make the supporting documentation for such billing available for inspection, copy or review by, or on behalf of, the requesting Party.

H. DERIVATIVE AGREEMENT – Operating Agreement #2, Financial Responsibilities of Parties, addresses additional matters set forth in this Section. It may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 6. FLOW AND LOAD MEASUREMENT AND MANAGEMENT

A. WASTEWATER FLOW AND LOAD MEASUREMENT, REPORTING AND MANAGEMENT

1. **Parties' Responsibility to Manage Flows** - The Parties shall take all reasonable actions to maintain their flows within their Allocated Flow Capacity, Peak Flow Limitations, and consistent with any load constraints for Blue Plains, as defined in **Section 4**. These actions shall include, but not be limited to, minimizing extraneous flows and loads in order to preserve capacity at Blue Plains and in the various wastewater collection systems within the BPSA. Based on recommendations from the Regional Committee, the Leadership Committee shall consider and recommend to any or all of the Parties programs, procedures or actions which will minimize wastewater flow and, therefore, preserve these capacities.

2. **Derivative Agreement to Address Procedures** - The methods for measuring monitoring, reporting and assessing Actual Flows within the BPSA and Billing Flows are described in **Operating Agreement #3** and shall include, but not be limited to addressing:
   a. An assessment of the quantity and timing of any flow management actions that any Party has committed to in order to ensure that they do not exceed their Allocated Flow Capacity, as defined in **Section 4,** and consistent with the long-term planning assumptions described in **Section 7**;

   b. The methods and frequency of reporting and assessing Actual Flows and Billing Flows;

   c. The process by which DC Water shall monitor and address any exceedances by the Non-Party Users, and by which Fairfax and WSSC shall monitor and address any exceedances by the Indirect Users as defined in **Operating Agreement #3**; and

   d. The Regional Committee shall routinely monitor and assess these methods and procedures and make recommendations to the Leadership Committee.

3. **Non-compliance** - If the District, Fairfax or WSSC, or Non-Party User does not comply with its Allocated Flow Capacity, Peak Flow Limitations or load allocations, as defined in **Section 4**; or fails to meet its flow management obligations, the Regional Committee shall address these issues on behalf of all of the Parties, including through use of dispute resolution, as necessary.

4. **District Commitment Regarding Management of Captured Stormwater Flows** - The District shall not expand the service area of its combined sewer system or take other actions that result in significantly increased Captured Stormwater Flow to Blue Plains above the amount set forth in **Operating Agreement #3** except as required for DC Water to meet its NPDES permit. If such actions are required, DC Water shall make recommendations to the Regional Committee, and the other Parties shall address any resultant cost implications consistent with **Section 3**.

B. CONTROL OF INFLOW AND INFILTRATION (I/I)

1. **Parties' Responsibility to Manage I/I** - The Parties shall manage their collection systems to minimize the amount of I/I entering their systems. Collection systems shall be maintained so that the I/I volume does not contribute to or cause exceedances of capacities and assumptions defined for:
   a. Blue Plains,

   b. The Potomac Interceptor and other wastewater collection system capacities, and

   c. Facilities associated with the Combined Sewer Overflow Long-term Control Plan.

2. **Non-Party User and Indirect Users' Responsibility to Manage I/I** - DC Water shall work with the Non-Party Users to manage their collection systems to meet the requirements of **Subsection B.1.** above; and Fairfax and WSSC shall work with the Indirect Users to meet the same requirements. Irrespective of arrangements with Non-Party Users or Indirect Users, the Parties shall comply with the flow projection assumptions.

C. DERIVATIVE AGREEMENT – Operating Agreement #3, Flow and Load Measurement and Management, addresses matters set forth in this Section. It may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 7. WASTEWATER PROJECTED FLOW CAPACITY NEEDS AND FUTURE OPTIONS

A. RATIONALE FOR CONDUCTING ANALYSIS OF PROJECTED FLOW CAPACITY NEEDS

1. **Major Regional Investment** - The Parties recognize that the scale of the BPSA and the associated wastewater collection system, the importance of wastewater treatment provided to the region, and the contributions to local water quality improvements that are provided by Blue Plains constitute a major regional investment by the Parties.

2. **Planning Required** - The Parties also recognize that the planning needed to address future wastewater needs for the BPSA, manage wastewater flows to Blue Plains and respond to evolving water quality issues and regulatory developments will require the Parties to continue to work together to address these interdependent matters.

3. **Commitment to District** – The Parties recognize that, due to the limited options available to the District, the Parties have an obligation to ensure that the District's wastewater flow capacity needs are addressed in a timely manner.

B. CONDUCTING PROJECTED FLOW CAPCITY NEEDS ANALYSIS

1. **Analysis and Determination of Options** - In order to assess wastewater flow capacity and loading requirements and define how future flows and loads will be treated, the Regional Committee shall routinely analyze future capacity and loading requirements. Once it has been determined that the facilities and processes at Blue Plains are not sufficient to meet those Projected Flow Capacity Needs, the Regional Committee shall conduct a thorough analysis which includes the following criteria:

   a. Options for managing and/or treating flows at Blue Plains, as well as other sites;

   b. A time frame for triggering management actions (including diverting flows and/or rental/sale of capacity);

   c. A process for notification of all entities potentially affected by those options, and

   d. A basis and formula for compensation, which includes development costs and the allocation of those costs among the Parties, and Non-Party Users, as appropriate.

2. **Process for Adjustments** - The Regional Committee shall analyze options, and recommend to the Leadership Committee any proposed construction or flow management options, associated cost allocations, and any necessary adjustments to this IMA or the Derivative Agreements. These planning elements shall be conducted consistent with the requirements detailed in the following subsection C.

C. DETERMINATION OF PROJECTED FLOW CAPACITY NEEDS

1. **Respective Roles of Regional Committee and DC Water**
   a. **Regional Committee**
      1) Shall address the technical, policy and financial interests of the Parties when defining and assessing the Parties' flow capacity and loading requirements and options.
      2) Shall routinely evaluate and analyze projected flows and loads as compared with Actual Flows, Adjusted Flows and Allocated Flow Capacity, and confirm any potential permit or process implications.

   b. **DC Water** – DC Water shall represent the interests of and assess the future flow capacity and loading requirements of the Non-Party Users, and identify if there are any potential permit or process implications.

2. **Jointly Managed Study of Projected Flow Capacity Needs** - The Regional Committee shall also periodically and at least every five (5) years, assess and determine the individual and collective Projected Flow Capacity Needs of the Parties, and Non-Party Users, through a Jointly Managed Study. This Study shall project the Parties and Non-Party Users' future flow capacity and loading requirements and shall utilize the most recently approved projection methodology for the BPSA. The BPSA flow projection methodology shall be determined and shall include, but not be limited to, application and utilization of:

   a. The latest approved version of the BPSA Flow Forecast Model and COG's latest approved Cooperative Forecast demographic data, or other agreed upon methods; and

   b. The latest agreed upon wastewater flow factors and flow management assumptions of the Parties, including those programs, procedures or actions that minimize wastewater flow and, therefore, preserve capacity.

3. **Time Frame for Assessment of Future Projections** - A Jointly Managed Study for determining Projected Flow Capacity Needs will project both short-term (approximately 5-15 years) and long-term (approximately 20-30 years) flow capacity and loading requirements. This study must confirm all assumptions related to projecting future flows and loads, including but not limited to: growth, flows and loads, flow management, and flow factors. This study shall also evaluate whether projected peak flows may trigger additional capacity needs beyond current limitations. It will also project whether changes in climatalogical, system conditions, or any other conditions might cause potential capacity or permit exceedances.

-END OF PAGE-

D. DETERMINATION OF OPTIONS

1. Flow Management Options to Address Projected Flow Exceedances

a. If, within the time frame of the long-term projections, the District, Fairfax, WSSC, or any Non-Party User's projected annual average flow is anticipated to exceed its Allocated Flow Capacity, or the associated peak flows exceed their Peak Flow Limitations, then the District, Fairfax or WSSC shall have the option of committing to specific flow management actions and a schedule that reconciles its projected flows with its Allocated Flow Capacity and Peak Flow Limitations.

b. These flow management actions may include the temporary or permanent diversion of wastewater flows out of the BPSA.

c. The BPSA flow projections shall then be adjusted to reflect such actions, and the Regional Committee shall be responsible for monitoring and assessing compliance with those actions, as defined in **Section 6**.

2. Additional Options to Address Projected Flow Exceedances

a. If, after all flow management adjustments are accounted for, the projection results of a Jointly Managed Study for projected flow capacity requirements demonstrate that either the overall flows to Blue Plains generated within the BPSA exceed the plant's Design Flow Capacity or that one or more Parties' projected wastewater capacity requirements exceed their individual Allocated Flow Capacity (as defined in **Section 4**), the Regional Committee shall consider alternative technical and/or programmatic options to address these unmet Projected Flow Capacity Needs.

b. These options may include, but are not limited to:
   1) Reduction of or improved management of wastewater flows to reduce I/I or any other flow or load contributions;
   2) Modification of treatment processes at Blue Plains;
   3) Diverting flows from the BPSA to other facilities;
   4) Sale or rental of excess capacity at Blue Plains between the Parties;
   5) Expansion of existing treatment facilities or the addition of new treatment facilities, whether in or out of the BPSA; and
   6) Construction of new wastewater treatment and/or storage facilities, whether in or out of the BPSA.

3. Jointly Managed Studies to Develop Options

a. The development of specific technical and programmatic options and potential construction projects shall generally be based upon a Jointly Managed Study that includes participation of all of the Parties.

b. The Regional Committee may determine, however, that a Jointly Managed Study is not required, and that development of specific technical or programmatic options and potential construction projects may be conducted by one or more of the Parties.

c. If the Regional Committee makes such a determination, the Party(ies) conducting the evaluation shall ensure that the Regional Committee has an opportunity to review and evaluate the resulting options in order to confirm that the proposed approach will adequately address the flow management requirements, and that the Allocated Flow Capacity of the other Parties not involved in the proposed approach are not modified or altered.

d. Each Jointly Managed Study to develop options shall include a recommendation on cost allocations.

4. **Regional Committee to Make Recommendation** – Based on a Jointly Managed Study, the Regional Committee shall recommend to the Leadership Committee those technical and/or programmatic options that address the individual and collective Projected Flow Capacity Needs of the Parties. The Regional Committee's recommendations shall include, but not be limited to, addressing:
   a. The proposed time frame for taking specific actions (whether due to changes in existing facilities or processes, or due to the construction of new facilities);

   b. The estimated cost of these actions;

   c. The proposed flow, load, and cost allocations and implications for each Party (and Non-Party User) associated with any options; and

   d. Whether a facility is to be a MJUF.

5. **Regional Committee to Develop Plan** - Once the Leadership Committee approves the proposed options and resulting allocations, the Regional Committee shall develop a plan to address those Projected Flow Capacity Needs that includes the costs associated with any agreed upon treatment options.

E. COST CONSIDERATIONS

1. The plan developed pursuant to **Section D.5** shall address at a minimum the following criteria:
   a. The estimated Capital Costs and O&M Costs and cost basis of any proposed facilities (whether new or modified at Blue Plains or at any other facilities or sites) shall be consistent with the MJUFs and cost allocations, as defined in **Section 5**;

   b. The proposed allocation of Capital Costs and O&M Costs;

   c. The anticipated schedule for when funds to support these actions are likely to be needed.

2. The rental or sale of Allocated Flow Capacity shall be at the discretion of the Party which is providing the Allocated Flow Capacity for rent or sale.

3. The Parties to the rental or sale transaction shall mutually agree on the cost basis for the rental or sale of Allocated Flow Capacity.

F. IMPLEMENTATION OF PLAN TO ADDRESS PROJECTED FLOW CAPACITY NEEDS

1. The Leadership Committee shall review and consider the Regional Committee's options and allocation recommendations on behalf of the Parties.

2. Once an option or set of options and allocations are agreed upon to meet the future Projected Flow Capacity Needs, the Parties shall, if necessary, amend this IMA, and the Leadership Committee shall create or modify the Derivative Agreement(s). For example, if any of the options that are selected result in revisions to the Design Flow Capacity for Blue Plains, or Allocated Flow Capacity defined in **Section 4**, or to reconcile the associated Capital Costs and O&M Costs, as defined in **Section 5**, and any associated Derivative Agreements, the Parties shall make appropriate amendments to this IMA, and the Leadership Committee shall create or modify the Derivative Agreement(s).

3. Any Party which requests additional Allocated Flow Capacity is responsible for securing additional Blue Plains Effluent Load Allocations, or Blue Plains Effluent Load Offsets in proportion to the additional Allocated Flow Capacity which the Party seeks.

G. DERIVATIVE AGREEMENT – Operating Agreement #4, Wastewater Projected Flow Capacity Needs and Future Options, addresses matters set forth in this Section. It may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 8. PRETREATMENT AND OPERATIONAL REQUIREMENTS

A. PRETREATMENT PROGRAM REQUIREMENTS

1. **Fairfax and WSSC Pretreatment Program Responsibilities**
   a. **Implementation of Programs** - Fairfax and WSSC shall adopt, implement and enforce Pretreatment Programs as required and approved by the United States Environmental Protection Agency (EPA). The Pretreatment Programs shall comply with federally imposed discharge limitations, prohibitions, and controls, as well as any Local Limits defined by DC Water, as needed to protect the collection system and treatment processes at Blue Plains and its biosolids management program requirements. Fairfax and WSSC shall set their Pretreatment Program standards to match or exceed any standards specifically required by DC Water.

   b. **Compliance and Recordkeeping** – Fairfax and WSSC shall conduct annual on-site inspections and obtain samples, and shall maintain documentation to verify compliance with, the Pretreatment Program and shall provide DC Water access to the pretreatment records. They shall also provide DC Water with reasonable access to all pretreatment records required by federal, state, and local regulations.

   c. **Indirect User Compliance** - To the extent applicable, Fairfax and WSSC shall ensure that the applicable Pretreatment Program terms and conditions which they impose on Indirect Users are consistent with those placed on the Parties.

2. **DC Water's Responsibilities**
   a. **Compliance by Fairfax and WSSC** - DC Water shall have the right to conduct sampling of the Fairfax and WSSC collection systems tributary to Blue Plains to ensure compliance with the provisions of these Pretreatment Programs. The Fairfax and WSSC Pretreatment Programs shall provide that, in the event of discovery of a case of noncompliance, they shall take corrective action, and Fairfax and WSSC, as applicable, shall compensate DC Water for the cost of sampling to identify and track resolution of the problem.

   b. **Non-Party User Compliance** - DC Water shall ensure that the applicable Pretreatment Program terms and conditions imposed upon the Non-Party Users are consistent with those placed upon the other Parties.

B. OPERATIONAL REQUIREMENTS

1. **Basis for Requirement** - The Parties recognize that, in addition to formal regulatory Pretreatment Program requirements, additional Operational Requirements are necessary to protect the operation and maintenance of Blue Plains wastewater, biosolids, residuals and other plant processes, facilities, and equipment.

2. **DC Water's Responsibility for Non-Party User Compliance** - DC Water shall ensure that the applicable Operational Requirements and conditions imposed upon the Non-Party Users are consistent with those placed upon the other Parties. Irrespective of such efforts, DC Water shall be bound by the additional Operational Requirements.

3. **Fairfax and WSSC Responsibility for Indirect User Compliance** - Fairfax and WSSC shall ensure that the applicable Operational Requirements terms and conditions imposed upon Indirect Users within the BPSA are consistent with those placed upon the other Parties. Irrespective of such efforts, Fairfax and WSSC shall be bound by the additional Operational Requirements.

C. DERIVATIVE AGREEMENT – Operating Agreement #5, Pretreatment and Operational Requirements, addresses additional matters set forth in this Section. It may be replaced or supplemented by successor and other Derivative Agreements.

-END OF PAGE-

SECTION 9. BIOSOLIDS MANAGEMENT COMMITMENTS

A. BIOSOLIDS UTILIZATION AND DISPOSAL

1. **Collective Commitment to Blue Plains Biosolids Management Program** - The Parties recognize their collective interests in the sound management of all biosolids produced at Blue Plains and its regional implications, and commit to continued planning and coordination in all aspects of biosolids management.

2. **Legislative Support to DC Water** - The Parties shall provide regional coordination and support to DC Water to address proposed legislation, regulations and other related activities that may impact the Blue Plains biosolids management program.

3. **Support for DC Water's Efforts** - The Parties shall actively support DC Water's efforts to ensure that biosolids produced at Blue Plains can be managed in a cost-effective, equitable and environmentally sound manner, and in compliance with all Blue Plains permit requirements and applicable regulations.

4. **Contracting Responsibilities** - DC Water is responsible for the Blue Plains biosolids management program; however, the Parties may determine that Fairfax County or WSSC may also be responsible for portions of the biosolids management. Specific details regarding such contractual or programmatic responsibilities shall be as set forth in **Operating Agreement #6**.

5. **Allocation of Value from Sale of Biosolids or By-Products** - All benefits (including revenue, and cost savings derived from products recycled or generated at Blue Plains) are to first offset the biosolids program and, then to offset Blue Plains operating costs, thereby reducing costs for all Parties.

B. EMERGENCY CONDITIONS

1. **Emergency Conditions** – An "emergency condition" shall mean situations when various actions or events occur (or have the potential to occur) such as acute weather conditions, abrupt changes in regulatory or legal requirements, or unavoidable contract complications, that will or are likely to impact the normal wastewater treatment processes.

2. **Basis for Emergency Planning** - The Parties recognize that emergency conditions require DC Water take prompt action to protect the Blue Plains processes and permit, to quickly implement alternative management or disposal options for Blue Plains biosolids, or to take other actions, in order to ensure that wastewater operations at Blue Plains and Other Associated Facilities, or the biosolids management program, are not compromised and that all permit conditions continue to be met.

3. **Notice** - As part of its their shared biosolids management responsibilities, DC Water and/or any other Party sharing biosolids management responsibilities on behalf of the Parties, shall alert the other Parties when an emergency condition is likely to or has occurred.

4. **Measures to be Taken** - Once the Parties are alerted that an emergency condition has been designated, the Parties shall work collectively, and in a timely manner, to provide active support to DC Water to address the situation and ensure that the Parties' collective and individual wastewater treatment needs at Blue Plains can continue to be provided, including, but not limited to, the following:
   a. Utilizing other existing contract mechanisms to handle management of all or portions of the biosolids;

   b. Working to identify additional land application or other management sites;

   c. Working with local and state regulatory officials to obtain land application or other management permits;

   d. Working with local and state regulatory officials to change regulations, legislation or legal action that are deemed harmful to the effective and environmentally sound management of biosolids; and

   e. Invoking the Parties' political leadership and other elected officials to support actions necessary to mitigate the impact of the designated emergency condition.

C. DERIVATIVE AGREEMENT – Operating Agreement #6, Biosolids Management Commitments, addresses additional matters set forth in this Section. It may be replaced or supplemented by successor or other Derivative Agreements.

-END OF PAGE-

SECTION 10. ADMINISTRATIVE PROVISIONS AND PROCEDURES

A. DURATION OF AGREEMENT

1. This IMA shall become effective upon the date the last Party executes it, as set forth below, subject to any orders of the United States District Court for the District of Columbia in State Water Control Board, et al., vs. Washington Suburban Sanitary Commission, et al., Civil Action No. 1813-73.

2. This IMA may be executed in counterparts, which together shall be regarded as one original.

3. This IMA remains in force and effect until June 30, 2111, unless amended, replaced or terminated earlier by mutual consent of the Parties.

B. SEVERABILITY

Should any provision(s) of this IMA or a Derivative Agreement be deemed illegal or unenforceable by a Court of competent jurisdiction, the remainder of this IMA or the Derivative Agreement shall remain in full force and effect. Provided, however, that within 60 days of the date that such ruling becomes final, including appeals if any, the Signatories or Leadership Committee, as appropriate, shall determine, directly or through the Leadership Committee whether this IMA, or the applicable Derivative Agreement, must be amended to fulfill the original intent of the Parties and to maintain, insofar as possible, the service and financial relationships created by this IMA. Should a determination be made to amend this IMA or the applicable Derivative Agreements, the Parties or Leadership Committee, respectively, shall promptly act on the amendments.

C. AUTHORITY

Each Party represents that it has the authority to enter into this IMA, and that the individuals signing this IMA on its behalf, have the authority to bind the Party to the terms and conditions of this IMA. This IMA shall apply to, and be binding upon, the Parties hereto, their elected officials, officers, agents, employees, successors and assigns, all persons, firms and corporations acting under, through or for them, and upon those persons, firms and corporations in active concert with them in any matter affected by this IMA.

D. AMENDMENTS TO THIS IMA

This IMA may be amended in whole, or in part, by the Parties as follows:

1. Proposed amendments to this IMA may be offered by any Party, directly, or through the Regional Committee, which shall make its recommendations to the Leadership Committee and to the Parties; and

2. If the Leadership Committee unanimously recommends an amendment to this IMA, it shall be submitted in writing to the Parties and shall become effective upon approval and execution by the Signatories of all of the Parties.

E. DISPUTE RESOLUTION

1. **Goal** - On occasion the Parties may differ on matters including but not limited to: a) their interpretation of terms and conditions of this IMA; b) the implementation of this IMA; c) whether any Derivative Agreement should be created, revised or terminated; and d) whether an IMA amendment should be adopted. If the Parties are unable to reach consensus through their normal coordination processes, in order to promote continued regional cooperation, and to avoid litigation when possible, the Parties shall first utilize the informal dispute resolution process. If the Parties are unable to resolve the dispute through the informal process, the formal dispute resolution process set forth herein shall be implemented.

2. **Informal Resolution** - If disagreements regarding the interpretation or implementation of this IMA surface during its routine business, and the Regional Committee cannot reach a consensus, the Regional Committee shall refer the matter to the Leadership Committee for advice, comment or suggested direction, or if appropriate, for direct resolution of the matter.

3. **Formal Resolution** - Any Party may initiate the formal dispute resolution process if it believes an issue has not been adequately addressed through normal coordination processes or an informal dispute resolution process.

   The formal resolution process includes the following requirements:

   a. The aggrieved Party shall provide written notice to the Regional Committee that it has an issue for dispute resolution. The notice must contain the aggrieved Party's rationale, together with the assumptions, supporting documents and computations necessary for an understanding and potential resolution of the dispute.

   b. The Regional Committee must address this issue directly or refer it for non-binding arbitration or third-party mediation within 30 days, or other reasonable time agreed to by the aggrieved Party. The Regional Committee may ask for additional written analysis from the aggrieved Party or from any Party which objects to or disagrees with the aggrieved Party's submission.

   c. The Regional Committee may use a non-binding arbitration or third-party mediation process to resolve the dispute if the aggrieved Party agrees to bear the cost of such non-binding arbitration or third-party mediation services, or the Parties otherwise agree to share costs.

   d. If after consideration by the Regional Committee or, as a result of non-binding arbitration or third-party mediation, agreement is not reached, the Regional Committee shall refer the matter to the Leadership Committee.

   e. If the Regional Committee fails to resolve the issue or refer the matter to non-binding arbitration or third-party mediation within the prescribed time, and the matter is not resolved, the aggrieved Party may then forward the issue to the Leadership Committee for resolution.

f. The Leadership Committee must address the matter within 30 days, or other reasonable time agreed to by the aggrieved Party, after receiving formal notice from the aggrieved Party. This notice should include the documentation previously submitted by the aggrieved Party to the Regional Committee.

g. The Leadership Committee may utilize non-binding arbitration or third-party mediation to assist it in reaching a unanimous decision on the dispute presented; if the aggrieved Party agrees to bear the costs of the non-binding arbitration or third-party mediation services, or the Parties otherwise agree to share costs.

h. If the Leadership Committee cannot resolve the issue within 30 days after presentation, or other reasonable time agreed to the aggrieved Party, the aggrieved Party may then inform the other Parties of the dispute, the inability to reach agreement, and its intention to seek legal or other resolution, including injunctive, declaratory or other relief. Upon receipt of such notice, the Parties agree to meet before any such litigation or other resolution is commenced by any Party or Parties against any other Party. No meeting shall be required as a condition precedent to litigation if such a meeting cannot be held within 30 days after the date on which the written notice was sent to all Parties or within in such other reasonable time agreed to by the aggrieved Party.

i. No Party may seek independent state or federal litigation or other resolution, including federal legislative assistance, of a dispute that has not yet completed this formal dispute resolution process.

F. NOTICES

1. **To Parties** - Whenever any formal notice is required to be given to any Party under this IMA, it shall be in writing and deemed to be given on the date of actual delivery (or rejection) if delivered by nationally recognized overnight service or by personal delivery. Notices shall be directed to the following officials at their officially designated business addresses:
   a. District of Columbia - City Administrator
   b. DC Water – General Manager
   c. Fairfax County, Virginia - County Executive
   d. Montgomery County, Maryland - Chief Administrative Officer
   e. Prince George's County, Maryland - Chief Administrative Officer
   f. Washington Suburban Sanitary Commission, Maryland - General Manager

2. **To Secretariat/Administrative Entity** - A copy of any formal notice shall also be sent to the offices of the secretariat/administrative entity, designated by the Leadership Committee, and to the Regional Committee.

3. **Responsibility** - Where notice is required to be given by this IMA or a Derivative Agreement and a specific Party is not designated to give notice, the notice shall be given by the secretariat/administrative entity.

4. **Timing** - Where time deadlines are given, all days are calendar days unless otherwise indicated.

5. **Electronic Notice** – In addition to service by U.S. mail or hand-delivery, the Parties may be served with notice electronically if the Party to be served has given written notice to the other Parties of its email address. Provided, however, that notices of changes to this IMA or a Derivative Agreement, court action or formal dispute resolution shall also be served in accordance with **Section F.1.**

G. PRIOR AGREEMENTS - As set forth in the introductory paragraphs of this IMA and in the Appendix, certain agreements preceded the 1985 IMA. Those agreements, which are set forth in the Appendix, as well as the 1985 IMA, are extinguished and superseded by this IMA.

H. ANTI-DEFICIENCY ACTS PROVISIONS

1. Relating to the District and DC Water

Notwithstanding any other provisions of this IMA and the Derivative Agreements:

a. Pursuant to the provisions of (i) the federal Anti-Deficiency Act, 31 U.S.C. §§ 1341, 1342, 1349-1351 1511-1519 (2008), and D.C. Official Code §§ 1-206.03(e) and 47-105; (ii) the District of Columbia Anti-Deficiency Act, D.C. Official Code §§ 47-355.01 – 355.08 (collectively, as amended from time to time, the "Anti-Deficiency Acts"); and (iii) Section 446 of the District of Columbia Home Rule Act, D.C. Official Code § 1-204.46, the District and DC Water cannot obligate themselves to any financial obligation or expenditure (including capital obligations and expenditures, operating and maintenance obligations and expenditures, and obligations and expenditures related to fines, penalties, and claims) in any present or future year unless the necessary funds to pay that obligation or expenditure have been appropriated by the Congress of the United States (the "Congress") and are lawfully available for the purpose of the obligation or expenditure. Pursuant to the Anti-Deficiency Acts, nothing in this IMA or the Derivative Agreements creates an obligation of the District or DC Water in anticipation of an appropriation by Congress for such purpose, and the District's or DC Water's legal liability for the payment of any amount under this IMA and the Derivative Agreements does not and may not arise or obtain in advance of the lawful availability of appropriated funds for the applicable fiscal year as approved by Congress. No District of Columbia or DC Water official or employee is authorized to obligate or expend any amount under this IMA or the Derivative Agreements unless such amount has been appropriated by Act of Congress and is lawfully available.

b. The amount of the DC Water Board of Directors', or its successors', annual budget estimate approved by Congress shall serve as the basis for, and the limit on, the billing, payments, and expenditures described in this IMA and the Derivative Agreements. If no appropriation or a smaller appropriation than requested is made by Congress to pay any amount under this IMA, or if appropriated funds for such purposes are not otherwise lawfully available, the legal obligations of all of the Parties under this IMA shall be limited to the amount of any lawfully available appropriation. The District's right to continued use of its Allocated Flow Capacity, nonetheless, remains subject to the limitations provided in Section 4(A)(2)(c) of the IMA.

2. Relating to WSSC

Notwithstanding any other provisions of this IMA and the Derivative Agreements: The financial obligations (including capital obligations and expenditures, operating and maintenance obligations and expenditures, and obligations and expenditures related to fines, penalties, and claims) of WSSC in any present or future year are subject to any applicable laws regarding appropriation by its governing body and any applicable anti-deficiency or non-appropriation laws. WSSC's right to continued use of its Allocated Flow Capacity, nonetheless, remains subject to the limitations provided in Section 4(A)(2)(c) of the IMA.

3. Relating to Fairfax, Montgomery and Prince George's

Notwithstanding any other provisions of this IMA and the Derivative Agreements: The financial obligations (including capital obligations and expenditures, operating and maintenance obligations and expenditures, and obligations and expenditures related to fines, penalties, and claims) of Fairfax, Montgomery or Prince George's counties in any present or future year are subject to any applicable laws regarding appropriation by their respective governing or legislative body and any applicable anti-deficiency or non-appropriation laws. Fairfax, Montgomery and Prince George's counties' right to continued use of their respective Allocated Flow Capacity, nonetheless, remains subject to the limitations provided in Section 4(A)(2)(c) of the IMA.

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SECTION 11. DERIVATIVE AGREEMENTS UNDER THIS IMA

A. USE AND PROCESS FOR DERIVATIVE AGREEMENTS

1. **Purpose** - Derivative Agreements are intended to implement the intent of the Parties in an efficient and effective manner without reopening or renegotiating the terms of this IMA. Derivative Agreements are limited to addressing issues that are authorized by this IMA. A Derivative Agreement shall not modify, negate or adversely impact any right or obligation of the Parties set forth in this IMA.

2. **Types** - Three (3) kinds of Derivative Agreements may implement this IMA: Operating Agreements, Service Agreements and Limited Party Agreements. These agreements are designed to address procedural, technical, operational and service issues.

3. **Amendments to Derivative Agreements or Supplemental or Successor Derivative Agreements** – Where this IMA refers to a Derivative Agreement such reference shall include any amendment(s) to that Derivative Agreement or supplemental or successor Derivative Agreement(s).

B. OPERATING AGREEMENTS

1. **Purpose** - Operating Agreements are made among all the Parties, but deal with a specific function or group of like functions. Specifically authorized functions for Operating Agreements include but are not limited to:
   a. Allocation and management of flow capacity, loads and peak flows and their associated allocations and limitations;
   b. Parties' financial responsibilities;
   c. Flow and load measurement and management;
   d. Pretreatment and operational requirements; and
   e. Biosolids management commitments.

2. **Current Agreements** - The Operating Agreements which are executed simultaneously with the execution of this IMA are:
   a. Blue Plains Flow Capacity, Loads and Peak Flows – Allocations and Limitations;
   b. Financial Responsibilities of Parties;
   c. Flow and Load Measurement and Management;
   d. Wastewater Projected Flow Capacity Needs and Future Options;
   e. Pretreatment and Operational Requirements; and
   f. Biosolids Management Commitments.

3. **Development and Approval Process** - The Regional Committee shall recommend Operating Agreements for Leadership Committee approval. The Leadership Committee must unanimously approve Operating Agreements, amendments thereto, or termination thereof, before they are effective.

4. **Notification to Parties and Effective Date** - Once the Leadership Committee approves a new/amended Operating Agreement, or termination thereof, it shall be forwarded to the Parties by the secretariat entity and be subject to a 60-day review period by the Signatories.

   a. If a Party objects in writing to the Operating Agreement or the amendment or termination thereof within the 60 day period, the Operating Agreement, or the amendment or termination of the Operating Agreement shall not be approved, and, the dispute resolution process may be commenced, as defined in **Section 10.E**.

   b. If no Party objects in writing within the 60 day period, the new or amended Operating Agreement or termination of an existing Operating Agreement shall take effect upon expiration of the 60 day period and the signature of the chair of the Leadership Committee.

C. SERVICE AGREEMENTS

1. **Purpose** - Service Agreements provide for specific function(s) for the benefit of regional wastewater treatment or for implementation of this IMA.

2. **Development and Approval Process** - The Regional Committee shall recommend Service Agreements for Leadership Committee approval. The Leadership Committee must unanimously approve Service Agreements, amendments thereto, or termination thereof, before they are effective.

3. **Effective Date** - Once the Leadership Committee approves a Service Agreement, the Agreement is effective. Service Agreements are not subject to the 60 day review period for Operating Agreements.

4. **Service Agreements -** Include, but are not limited to:

   a. **For Secretariat Services** - A Service Agreement pursuant to **Section 2** with an entity on behalf of the Parties to provide secretariat support; and

   b. **For Regional Water Quality Management Program** - A Service Agreement pursuant to **Sections 2 and 3** with an entity on behalf of the Parties to provide water quality monitoring and evaluation support to address Potomac River estuary, the Anacostia River, and Chesapeake Bay water quality issues.

D. LIMITED PARTY AGREEMENTS

1. **Purpose** – Limited Party Agreements include, but are not limited to, agreements to provide wastewater treatment services and transfers of capacity to satisfy Projected Flow Capacity Needs originating in the BPSA. Such transfers of capacity shall not modify any requirements of or allocations defined under this IMA.

2. **Permitted Limited Party Agreements** – Limited Party Agreements may be between the following entities: a) two (2) or more Parties; b) a Party(ies) and Non-

Party User(s); or c) a Party(ies) and Indirect User(s). These include, but are not limited to:

a. **DC Water and/or the District and Non-Party Users** – Agreements between DC Water and/or the District and Non-Party Users to provide wastewater treatment services using capacity allocated by this IMA, as defined in **Section 4**.

b. **Fairfax and WSSC and Indirect Users** – Agreements between Fairfax or WSSC and Indirect Users to provide wastewater treatment services using capacity within their respective Allocated Flow Capacity, as defined in **Section 4**.

3. **Limited Party Agreements in Effect Upon Execution of this IMA** - Limited Party Agreements between DC Water and/or the District and Non-Party Users, or Fairfax or WSSC and Indirect Users which are in existence as of the execution of this IMA, and the rights given in those agreements, are valid under this IMA.

4. **Limited Party Agreements Convey No Rights in IMA -** Limited Party Agreements with Non-Party Users or Indirect Users do not convey any IMA rights to those Users.

5. **Regional Committee to Review Limited Party Agreements** – Limited Party Agreements shall be submitted to the Regional Committee for review to ensure that the terms and conditions do not negatively impact the other Parties' rights or responsibilities under the IMA.

6. **Notification to Parties and Effective Date for Limited Party Agreements** - Once the Regional Committee reviews a Limited Party Agreement, and does not object, the Agreement is effective. Limited Party Agreements are not subject to the 60 day review period for Operating Agreements. Once the Regional Committee has reviewed a Limited Party Agreement and not objected, the Limited Party Agreement becomes part of the IMA record.

-END OF PAGE-

SECTION 12. GLOSSARY

This Glossary defines terms that have a specific meaning and are used in this IMA.

Actual Flow(s) – Wastewater flow that is contributed by the District, Fairfax and WSSC, as well as by Non-Party Users and Indirect Users, that is delivered through various points of connection (both metered and unmetered flows) to Blue Plains for treatment.

Adjusted Flow(s) – Actual Flows for only the District, Fairfax and WSSC (less Captured Stormwater Flow in the case of the District), that have been normalized to reflect Annual Average Hydrologic Conditions in order to compare the values to their respective Allocated Flow Capacity.

Allocated Flow Capacity – Blue Plains annual average Design Flow Capacity that is apportioned among the District, Fairfax, WSSC, and Non-Party Users (expressed as annual average MGD under Annual Average Hydrologic Conditions).

Annual Average Hydrologic Conditions – Conditions based on an average amount of rainfall in a year developed based upon the available historical rainfall and groundwater level records.

Billing Flow(s) – Actual Flow for the District, Fairfax, WSSC, and Non-Party Users that has been calculated to account for any differential treatment cost impacts as have been defined or permitted in this IMA, and that is billed by DC Water.

Blue Plains - The wastewater treatment plant located at 5000 Overlook Avenue, S.W., Washington, D.C.

Blue Plains Effluent Load(s) – A maximum quantity of pollutants assigned to Blue Plains in its NPDES permit and associated Fact Sheet that may be discharged from Outfall #001 and/or Outfall #002 (generally expressed as pounds/day or pounds/year).

Blue Plains Effluent Load Allocation(s) – Blue Plains Effluent Load(s) that have been sub-allocated into District, Maryland and Virginia portions.

Blue Plains Effluent Load Offset(s) – An allocation of pollutants that can be secured by a Blue Plains User to increase its proportionate share of Blue Plains Effluent Load Allocation to compensate for any additional increase in wastewater flow that it wants to have treated at Blue Plains.

Blue Plains Influent Load(s) – Quantity of pollutants that are conveyed to Blue Plains in the incoming wastewater that may or may not be associated with Blue Plains Effluent Loads or any Blue Plain Effluent Load Allocations.

Blue Plains Service Area (BPSA) – The combined areas of all sewersheds within all jurisdictions that have historically been authorized to discharge wastewater flows to Blue Plains. This includes wastewater sources (metered or unmetered) that flow by gravity, as well as those that may be pumped into the system.

Capital Cost(s) - Costs incurred in the acquisition, construction, modification, replacement, enlargement, rehabilitation, or upgrade of fixed assets. Fixed assets shall include buildings and appurtenances, pipelines, and equipment. Capital Costs must expand facility capacity, improve the efficiency or output of a facility, or extend the useful life of an asset.

Captured Stormwater Flow (CSF) – Stormwater flow in the District's "Combined Sewer System" that is captured within the collection system and conveyed to Blue Plains for treatment in accordance with the CSO LTCP.

Chief Administrative Officers (CAOs) – Highest level non-elected government executive in the District of Columbia, Fairfax, Montgomery, and Prince George's Counties.

Combined Sewer Overflow Long-term Control Plan (CSO LTCP) – The approved plan controlling combined sewer overflows from the District that was prepared pursuant to the 1994 Combined Sewer Overflow Policy (55 Fed. Reg. 18688, issued 4/19/94 by the EPA) and Section 402(q) of the Clean Water Act and any supplements thereto.

Derivative Agreement(s) (DA) - A formal document, authorized by this IMA, which sets forth technical and procedural details as part of the implementation of this IMA.

Design Flow Capacity(ies) – The wastewater flow rates (expressed as MGD) used as the basis of wastewater treatment design for Blue Plains under various flow conditions (e.g., annual average, maximum 30-day, maximum year).

Design Load Capacity(ies) – The maximum quantity of pollutants in influent wastewater (expressed as pounds per day, or pounds per year) that is used as the basis of wastewater treatment design for Blue Plains.

Diversion(s) – Specific management actions taken by DC Water, Fairfax, WSSC, or Non-Party User to cause wastewater flows generated within the BPSA to be rerouted, pumped, or otherwise redirected from a BPSA sewershed with the result that that the Blue Plains User's flows are or will be reduced. These actions are generally taken to ensure that a Blue Plains User's flow does not or will not exceed either its Allocated Flow Capacity and/or its Peak Flow Limitations, but may also become appropriate to ensure the District's long-term wastewater treatment needs can be met at Blue Plains.

General Managers – Highest level executive in DC Water and WSSC.

Indirect User(s) – Those entities that send wastewater flow to Blue Plains pursuant to service agreements with WSSC or Fairfax. These entities have no direct rights under this IMA, but the Parties have the responsibility to ensure that any agreements and activities associated with the Indirect Users do not infringe or threaten the rights of the Parties under this IMA.

Intermunicipal Agreement (this IMA) – The formal agreement that defines the rights, obligations, and relationships of the Parties.

Jointly Managed Study(ies) – A formal study that is conducted in order to address issues related to the interests of the Parties under this IMA where the Regional Committee: a) has direct input on preparing the scope of work; b) has input on selection of consultant/contractor (whether through contracting mechanisms of the Regional Committee, DC Water or any Party); and c) is actively involved in the review and acceptance of the work products from that study (e.g., the BPSA Long-term Planning Study, 2003).

Key Principle(s) - Statements of general philosophy and intent that govern this IMA and Derivative Agreements, and shall be used to guide any interpretation or dispute resolution process.

Leadership Committee – A committee established pursuant to **Section 2** of this IMA to oversee the implementation of this IMA, the members of which are the Chief Administrative Officer or General Manager of each Party.

Local Limit(s) – Specific discharge limits developed and enforced by DC Water, Fairfax and WSSC upon industrial or commercial facilities to implement the general and specific discharge prohibitions listed in 40 CFR 403.5(a)(1) and (b), as amended.

Multi-Jurisdiction Use Facility(ies) (MJUFs) – A term that recognizes that more than one jurisdiction's flows are treated by or pass through a facility(ies) and that the costs associated with those facilities are shared among the Parties. It is comprised of those facilities that have something to do with wastewater collection or treatment or biosolids management that have some relationship to Blue Plains. Although such facilities are generally managed by DC Water, some facilities are operated by Fairfax or WSSC on behalf of the Parties. The term refers to any facilities that any of the Parties are operating/managing on behalf of all or some subset of the Parties.

Non-Party User(s) - Those entities that contribute wastewater flows to Blue Plains that are managed through separate service agreements either by DC Water directly or on behalf of the District. These include: Loudoun County Sanitation Authority (LCSA or Loudoun Water), Virginia; Town of Vienna, Virginia; Dulles Airport, Virginia; National Park Service, Maryland; and Naval Ship Research and Development Center, Maryland. These entities do not have contractual rights under the IMA; and their interests under this IMA are represented by DC Water.

Operating Agency(ies) – DC Water, Fairfax and WSSC (i.e., those Parties that have operational responsibility for wastewater collection and/or treatment within the BPSA, and the associated billing and payment responsibilities).

Operating Agency Representative(s) – The members of DC Water, Fairfax and WSSC on the Leadership or Regional Committee, as applicable.

Operating and Maintenance Cost(s) (O&M) - Costs incurred by DC Water, Fairfax or WSSC in providing wastewater collection, treatment, and biosolids management and disposal services. Such costs include labor, materials and the repair and upkeep of equipment, but do not include Capital Costs. Costs shall be recognized in accordance

with generally accepted accounting principles. These costs include direct costs, indirect costs and overhead costs.

Operational Requirements – Constraints placed on the wastewater sent to Blue Plains that DC Water has determined are required in order to protect DC Water's wastewater collection system, or equipment, or the processes and equipment at Blue Plains, with which the District, Fairfax, WSSC and, as appropriate, the Non-Party Users and Indirect Users, must comply. These are in addition to any regulatory Pretreatment Program requirements.

Other Associated Facilities – All the other facilities, pipelines, and appurtenances within the District, and the Potomac Interceptor sewer system which are managed by DC Water, and are used for the storage and collection of wastewater sent to, or the management of biosolids generated by Blue Plains.

Party(ies) – Collectively those entities governed by and signatory to this IMA, being: the District of Columbia (District), the District of Columbia Water and Sewer Authority (DC Water), Fairfax County, Virginia (Fairfax), Montgomery County, Maryland (Montgomery), Prince George's County, Maryland (Prince George's), and the Washington Suburban Sanitary Commission (WSSC).

Peak Flow Limitation(s) – Maximum wastewater flow rate (MGD) allowed to be transmitted between the wastewater collection systems of two (2) of the Parties using Blue Plains, i.e. the District, Fairfax or WSSC.

Potomac Interceptor (PI) - The major wastewater interceptor built as a result of Public Law 86-0515 passed by Congress (June 12, 1960) that conveys wastewater from portions of suburban Virginia and Maryland to the District boundary and hence to Blue Plains for treatment.

Potomac Interceptor User(s) – Fairfax, Loudoun County Sanitation Authority (LCSA or Loudoun Water), Town of Vienna, and Dulles Airport, in Virginia; and WSSC, the National Park Service, the Naval Ship Research and Development Center, in Maryland, which utilize portions of the PI to transmit their wastewater flows to Blue Plains.

Pretreatment Program(s) – Formal programs established by the District, Fairfax and WSSC in compliance with the Clean Water Act, as amended, to reduce the amount of pollutants or that alter the nature of pollutant properties in wastewater to a less harmful state prior to discharging such wastewater into the sewer system discharging to Blue Plains.

Projected Flow Capacity Need(s) – The formal determination, based on a Jointly Managed Study, of the long-term wastewater flows and associated treatment requirements (in MGD) that the District, Fairfax and WSSC and Non-Party Users are anticipated to generate within the BPSA, during or at the end of the agreed upon planning period. These projected wastewater flows are calculated as annual average flows under Annual Average Hydrologic Conditions and therefore do include an inherent contribution from Inflow and Infiltration, but do not include any Captured Stormwater Flow contributions, which are determined through separate processes.

Regional Committee - A committee established for the purpose of assisting in the interpretation, administration and implementation of this IMA and to resolve issues pertaining to Blue Plains and Other Associated Facilities that are within the scope of this IMA, its amendments and its associated Derivative Agreements.

Signatory(ies) – The representatives for the Parties that have the legal authority to bind their entities to the terms and conditions of this IMA.

Usage Allocation(s) - The basis for apportioning Capital Costs and O&M Costs of Multi-Jurisdiction Use Facilities (MJUFs) to the District, Fairfax, WSSC or Non-Party User that is not linked directly to the user's share of Allocated Flow Capacity or measured flow. This basis may include consideration of flow rates, percentage volume, modeled contributions, pollutant loadings (such as nutrients), or other methods for determining the District's, Fairfax's, WSSC's, or Non-Party User's portion of facilities, pipelines, and appurtenances and their associated costs.

User Fee(s) – A fee paid by Fairfax, WSSC and Non-Party User Loudoun County Sanitation Authority (LCSA or Loudoun Water) to DC Water, on behalf of the District, in accordance with **Section 5** of this IMA.

-END OF PAGE-

SIGNATORIES

WITNESS the following signatures of the Parties by their duly authorized representatives:

District of Columbia

Vincent C. Gray 4/2/13

Mayor Date:

DC Water

04/02/13

Chairman, Board of Directors Date:

Fairfax County, Virginia

3/27/13

Chairman, Board of Supervisors Date:

Montgomery County, Maryland

3/2/13

President, County Council Date:

4/2/13

County Executive Date:

Prince George's County, Maryland

Andrea C. Harrison 4/2/13

Chair, County Council Date:

4/3/13

County Executive Date:

Washington Suburban Sanitary Commission

3/20/2013

Chair Date:

3/20/13

Vice Chair Date:

APPENDIX

HISTORICAL AGREEMENTS (These agreements are inapplicable as of the execution of this IMA. They are mentioned here solely for historical context)

1. The 1985 Blue Plains Intermunicipal Agreement (IMA).

2. Accordingly, except as otherwise provided herein and subject to any orders of the U.S. District Court for the District of Columbia in State Water Control Board, et al. vs. WSSC, et al., Civil Action No. 1813-73, this Agreement shall extinguish and supersede the following agreements, which were also previously suspended, extinguished or superseded by the 1985 IMA:
   a. Agreement No. DCF-A-766, dated August 12, 1954, between the District and WSSC;
   b. Agreement No. DCF-A-1357, dated April 28, 1959, between the District and Fairfax County;
   c. Memorandum of Understanding on Washington Metropolitan Regional Water Pollution Control Plan of October 1970 among the District, WSSC and Fairfax County;
   d. Interim Treatment Program Agreement, dated October 18, 1971, among the District, WSSC and Fairfax;
   e. The 1974 Blue Plains Sewage Treatment Plant Agreement, as amended;
   f. Agreement No. DCF-A-766, dated February 11, 1965, between the District and Fairfax County;
   g. Agreement No. DCF-A-2824, dated July 6, 1967, between the District and WSSC; and
   h. Agreement No. DCF-A-145-DES, dated April 21, 1976, between the District and WSSC.

-END OF PAGE-

2012 IMA
LIST OF DERIVATIVE AGREEMENTS

OPERATING AGREEMENTS		
NO.	**TITLE**	**EFFECTIVE DATE**
1.	BLUE PLAINS FLOW CAPACITY, LOADS AND PEAK FLOWS - ALLOCATIONS AND LIMITATIONS	4/3/13
2.	FINANCIAL RESPONSIBILITIES OF PARTIES	4/3/13
3.	FLOW AND LOAD MEASUREMENT AND MANAGEMENT	4/3/13
4.	WASTEWATER PROJECTED FLOW CAPACITY NEEDS AND FUTURE OPTIONS	4/3/13
5.	PRETREATMENT AND OPERATIONAL REQUIREMENTS	4/3/13
6.	BIOSOLIDS MANAGEMENT COMMITMENTS	4/3/13

OPERATING AGREEMENT #1

PARTIES' AGREEMENT REGARDING: BLUE PLAINS FLOW CAPACITY, LOADS, AND PEAK FLOWS - ALLOCATIONS AND LIMITATIONS

THIS OPERATING AGREEMENT ("Agreement"), made among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, the Parties have agreed to comply with the Allocated Flow Capacity values for the Blue Plains Wastewater Treatment Plant (Blue Plains), which apportion capacity among the District, Fairfax, WSSC and Non-Party Users, as set forth in the 2012 IMA, **Section 4**; and

WHEREAS, the Parties agree to comply with nutrient loads for Blue Plains effluent discharged through two Blue Plains effluent points, designated Outfall #001 and Outfall #002; and

WHEREAS, the Parties agree to routinely monitor their Actual Flows, Adjusted Flows and the associated nutrient loads to Blue Plains to ensure that all allocations and/or limitations for Blue Plains are not exceeded; and

WHEREAS, the Parties have agreed to regularly monitor all wastewater process, permit, regulatory and other developments that have the potential to impact either flow capacity, nutrient loads or other parameters that may affect Blue Plains and its ability to comply with its permit or process requirements as defined in **Section 6**; and

WHEREAS, the Parties recognize that the Blue Plains NPDES permit, applicable Total Maximum Daily Load (TMDLs) for the Potomac River Watershed, and associated state Watershed Implementation Plans (WIPs) must all be complied with, and that the load limits in Blue Plains' permit are applied to Outfall #001 and #002; and

WHEREAS, the Parties have agreed to regularly monitor their peak flows at the point of connection to the collection system owned by the District and operated by DC Water, and to comply with their Peak Flow Limitations, as set forth in the 2012 IMA, **Section 6**; and

WHEREAS, the Parties acknowledge their responsibility to ensure that the Non-Party Users and Indirect Users also comply with the terms of this Agreement as applicable;

and

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the IMA consistent with **Section 11.**

NOW, THEREFORE, the Parties agree as follows:

PURPOSE: The purpose of this Agreement is to address matters relating to **Section 4** of the 2012 IMA

A. BLUE PLAINS EFFLUENT LOADS AND ALLOCATIONS

1. The Blue Plains Effluent Loads and Blue Plains Effluent Load Allocations (for Outfalls #001 and #002) are defined in **Table OA 1-A** below**.**

2. The Parties acknowledge that these Effluent Load Allocations are based on various state and District flow and concentration assumptions.

Table OA 1-A

BLUE PLAINS EFFLUENT LOADS[1],[2]		
ENTITIES WITH ALLOCATIONS	**LOAD ALLOCATIONS (LBS/YR)**	
	Total Nitrogen	**Total Phosphorus**
District of Columbia's Blue Plains Load Allocation[3] - Total	**2,114,542.00**	**87,993.54**
WSSC	*Not specified*	*Not specified*
Naval Ship Research & Development Center	*Not specified*	*Not specified*
National Park Service	*Not specified*	*Not specified*
Maryland's Blue Plains Load Allocation-Total[4]	**1,993,000.00**	**89,694.91**
Fairfax County	*Not specified*	*Not specified*
Loudoun County Sanitation Authority	*Not specified*	*Not specified*
Dulles Airport	*Not specified*	*Not specified*
Town of Vienna	*Not specified*	*Not specified*
Virginia's Blue Plains Load Allocation-Total	**581,458.00**	**26,166.00**
Blue Plains Effluent Loads (Grand Total)[1]	**4,689,000.00**	**203,854.45**

[1] Loads for Blue Plains and sub-allocations are as documented in EPA's Final TMDL (December 29, 2010), Section Q.
[2] Use of Allocated Flow Capacity is contingent on providing an allocation equivalent to at least 4.0 mg/L for TN and 0.18 mg/L for TP for Allocated Flow Capacity plus Captured Stormwater Flow, i.e. all flow out of Outfall 002. The District must also provide an allocation for flow discharged to Outfall 001.
[3] The load allocations shown for the District only address that portion associated with District flows to Blue Plains. Allocations for other Non-Party Users are reflected in the respective state allocations.
[4] WSSC use of allocated flow capacity is limited to 163.6 mgd due to diversion of nitrogen and phosphorus load allocations to the Seneca WWTP (i.e., loads associated with 6 mgd).

B. BLUE PLAINS INFLUENT DESIGN LOAD CAPACITY

1. Influent loads to Blue Plains must be limited so that the Blue Plains effluent loads meet permit requirements. The Parties agree that the Design Load Capacities are set forth in **Table OA 1-B**. If there are potential problems with meeting plant permits then the load capacities set forth in **Table OA 1-B** will apply.

2. The Design Load Capacity reflects Complete Treatment requirements for those flows that are discharged through Outfall #002, under Maximum Design Flow Capacity flows.

Table OA 1-B

BLUE PLAINS DESIGN LOAD CAPACITY FOR INFLUENT FLOWS[1]		
Parameters	**Loads (lb/day)**	
	Annual Average	**Maximum 30-Day Rolling Average**
BOD	525,977	694,290
TSS	562,282	747,836
TKN	104,940	137,471
NH_3,	55,390	64,252
TP	14,108	18,340
Associated Maximum Design Flow Capacity – Basis (mgd)		
Flow, Average Year	**384**	**485**
Flow, Maximum Year	**431**	**485**

GLOSSARY TERMS FOR OPERATING AGREEMENT #1

This Glossary identifies terms that have a specific and defined meaning for purposes of interpreting this Operating Agreement. Additional terms that are also used in the 2012 IMA Core Agreement are defined in the Glossary included in the IMA.

Complete Treatment – Flow that is discharged out of Outfall #002 and receives the following treatment: screening, grit removal, primary treatment, secondary treatment, nutrient reduction, disinfection, and de-chlorination.

Maximum Design Flow Capacity – Design flow capacity figures, used to develop design loads for complete treatment out of Outfall #002, that reflects flow assumptions during specific wet weather conditions (i.e., 60 inch Rain Year and after full implementation of the CSO LTCP and the Total Nitrogen and Wet Weather Plan).

[1] *Source: "Design - Level Plant Influent Flows and Loads Technical Memorandum", AECOM May 2009 and "Projected Flows and Sources – NT/Wet Weather Plan", Greeley and Hansen, July 2010.

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm the authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

6/6/13

City Administrator Date

DC WATER

3/21/13

General Manager Date

FAIRFAX COUNTY, VIRGINIA

3/25/13

County Executive Date

MONTGOMERY COUNTY, MARYLAND

4/3/2013

Chief Administrative Officer Date

PRINCE GEORGE'S COUNTY, MARYLAND

4/2/13

Chief Administrative Officer Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

3/21/13

General Manager Date

Approved by Leadership Committee: 4/3/13

Chair **Date**

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: 4/3/13

Chair **Date**

OPERATING AGREEMENT #2

PARTIES' AGREEMENT REGARDING: FINANCIAL RESPONSIBILITIES OF PARTIES

THIS OPERATING AGREEMENT (Agreement), made among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, the Parties recognize their collective and mutual interests under the 2012 IMA include the authorization, review, or approval of actions that have a potential fiscal impact on the Parties, including, but not limited to billing, auditing and fiscal management; and

WHEREAS, the Parties agree to their collective and individual responsibility for complying with the fiscal allocations for Capital Costs, Operating and Maintenance (O&M) Costs, billing and payment procedures, User Fees, as well as fines, penalties and claims; and

WHEREAS, the Parties agree that their financial responsibilities and payment obligations for Capital Costs and O&M Costs of facilities include those implemented by DC Water and by Fairfax or WSSC, to the extent that those facilities are deemed to be Multi-Jurisdiction Use Facilities (MJUFs); and

WHEREAS, the Parties agree to work with DC Water and, as applicable, Fairfax and WSSC, to ensure that MJUF determinations and associated cost allocations are consistent with the 2012 IMA; and

WHEREAS, the Parties recognize that any significant changes in the wastewater flows, peak flows, and/or loads could require modification to the terms of the 2012 IMA, **Section 5,** and this Operating Agreement**;** and

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the IMA consistent with **Section 11.**

NOW, THEREFORE, the Parties agree as follows:

PURPOSE: This Operating Agreement shall set forth additional matters implementing **Section 5** of the 2012 IMA:

A. General Cost Responsibilities;
B. Capital Cost Responsibilities;
C. Operation and Maintenance Costs Responsibilities;
D. User Fees Responsibilities;
E. Fines, Penalties and Claims Responsibilities; and
F. Billing and Payment Procedures.

A. GENERAL COST RESPONSIBILITIES

1. **Timing** - Following agreement of the directly involved Operating Agency Representatives regarding the needs, location, size, allocation of capacity, and allocation of cost for new or expanded collection facilities, such facilities shall be constructed as promptly as needs require.

2. **Contingent Obligations**
   a. Construction of new or improved MJUFs shall be contingent on funding; however, failure to fund will result in a loss of allocation to the non-paying Party.

   b. No Operating Agency shall be obligated to commence construction or installation of any additional pipelines and appurtenances until:

      1) DC Water, Fairfax and WSSC have made their share of the cost available to the constructing Operating Agency or have otherwise satisfied the constructing Operating Agency that funds will be available as expended; and

      2) The constructing Operating Agency has available sufficient funds, including funds which the other Operating Agencies have made available or will make available as expended, to pay for all estimated costs of such facility.

3. **Cost Basis** – The cost basis for Capital Costs shall be actual incurred Capital Costs associated with the MJUFs. The cost basis for O&M costs shall be actual incurred O&M costs associated with the MJUFs.

4. **Billing Disputes** – If disputes regarding billings cannot be resolved through routine procedures, the affected Operating Agency Representatives shall endeavor to reach a consensus with DC Water and/or others involved. If a consensus cannot be reached, the dispute resolution process outlined in **Section 10** of the 2012 IMA will be used.

-END OF PAGE-

B. CAPITAL COST RESPONSIBILITIES

1. **Blue Plains Capital Cost Allocations** - Capital Costs for Blue Plains and Other Associated Facilities shall be allocated proportionate to the District, Fairfax, WSSC, and Non-Party Users' Allocated Flow Capacity or other Usage Allocations as defined in the 2012 IMA **Section 5**. Cost allocations for all Blue Plains wastewater treatment and biosolids management are as set forth in **Table OA 2-A** below.

TABLE OA 2-A

BLUE PLAINS ALLOCATED FLOW CAPACITY AND RESULTING COST ALLOCATIONS		
ENTITIES	**CAPACITY ALLOCATIONS (MGD)**	**COST ALLOCATIONS (Percent)**
District of Columbia	152.50	**41.216**
Non-Party Users:		
LCSA, Virginia	13.80	**3.730**
Dulles Airport, Virginia	1.50	**0.405**
Town of Vienna, Virginia	1.50	**0.405**
Naval Ship Research & Development Center, Maryland	0.07	**0.019**
National Park Service, Maryland	0.03	**0.008**
Sub-total	16.9	N/A
District of Columbia - Total[1]	**169.40**	45.783
WSSC[2] (for Prince George's County & Montgomery County), **Maryland – Total**	**169.60**	**45.838**
Fairfax County, Virginia[3] **- Total**	**31.00**	**8.378**
Grand Total	**370.00**	**100.000**

[1] Pursuant to the 2012 IMA, the District is responsible for costs on behalf of the Non-Party Users, which it then recovers through separate agreements with those entities.

[2] The Allocated Flow Capacity for WSSC is on behalf of Prince George's and Montgomery; with any sub-allocations determined by separate agreements between those entities. The WSSC allocation also includes wastewater from other political jurisdictions, including some within those Counties with which WSSC has separate agreements.

[3] The Allocated Flow Capacity for Fairfax also includes wastewater from other political jurisdictions with which Fairfax has separate agreements.

2. **Pipelines and Appurtenances Capital Cost Allocations Methodology for Determining MJUF Portions of Pipelines & Appurtenances** - Capital Costs associated with constructing, replacing, or rehabilitating the wastewater collection systems and facilities shall be allocated utilizing the MJUF capital cost allocation methodology. This methodology uses a computer model to calculate a percentage of use by each entity for each project, and for each portion of the facility being evaluated (i.e., node-to-node). This assessment determines the MJUF portion for every project and its components.

3. **CSO Long-term Control Plan (LTCP) Capital Cost Allocations**
   a. **Parties Agree to Pay MJUF Portion** - The Parties agree to pay proportionate shares of the Capital Costs of that portion of the CSO LTCP that has been determined to be a MJUF, as defined in **Table OA 2-B**.

   b. **Basis for Determining MJUF Portion of CSO LTCP Cost Allocations** - The MJUF portion of the approved CSO LTCP and resulting Capital Cost allocations are based on the modeling used in the development and assessment of the CSO LTCP**.** These Capital Cost allocations shall apply to the District, Fairfax, WSSC and Non-Party Users. Sub- allocations of those Capital Cost allocations for Fairfax, WSSC and the Non-Party Users shall be in proportion to their Allocated Flow Capacity.

   c. **Modification of the CSO LTCP** - DC Water shall evaluate performance assumptions associated with any modifications to the CSO LTCP to determine if the Capital Cost allocations should be modified; and present the findings to the Regional Committee.

   d. **Leadership Committee to Approve Modifications** - The Leadership Committee, after reviewing recommendations from the Regional Committee and determining that such modifications are desirable or required, shall approve and adopt revisions. The revisions may supplant the established Capital Cost allocations.

TABLE OA 2-B

COMBINED SEWER OVERFLOW LONG-TERM CONTROL PLAN CAPITAL COST ALLOCATIONS FOR MJUF DESIGNATED PORTIONS ONLY	
USER	**PERCENT**
District of Columbia	92.90
Fairfax County	1.01
WSSC	5.54
Non-Party Users	0.55
Sub-Total: Fairfax, WSSC & Non-Party Users	7.10
TOTAL	100.00

4. **Capital Equipment Capital Cost Allocations**
   a. Cost allocations for all capital equipment are set forth in **Table OA 2-C.**

   b. Those capital equipment assets which reflect capital that has a shorter life span (such as information technology equipment and fleet, etc.), will be allocated using capacity or flow rates. See **Table OA 2-C** for a list of items included in capital equipment costs and designation as to the cost allocation basis.

   c. Funding of the MJUF portion of capital equipment is derived by first allocating each pool of capital equipment costs to one or more agreed upon cost drivers. (These cost drivers include the number of full time employees, departmental budgets, etc.)

   d. Changes to these cost drivers can be proposed by DC Water, Fairfax or WSSC and are subject to future evaluation by the Regional Committee.

-END OF PAGE-

TABLE OA 2-C

CAPITAL EQUIPMENT COST ALLOCATION METHODOLOGY		
SERVICE AREA	**PROJECT**	**ALLOCATION METHODOLOGY**
Wastewater Treatment	Plant Model	Allocated Capacity
	Laboratory Equipment	Allocated Capacity
Maintenance Services	Maintenance	Allocated Capacity
	Pump Repairs/Replacement	Allocated Capacity
	Turbine, Aerator & Methanol	Allocated Capacity
	Maintenance Management System	Actual Flows
	Large Electric Motors	Allocated Capacity
	Potomac Sewage Pumping Station	Allocated Capacity
	High Priority Rehabilitation Program	Allocated Capacity
	Large Meter Testing	Allocated Capacity
	Centrifuge Repair/Replace	Allocated Capacity
Fleet	Vehicles	Actual Flows
	Indirect Fleet Allocation	Actual Flows
Information Technology	Financial Management	Actual Flows
	Radio Equipment	Actual Flows
	General IT Infrastructure	Actual Flows
	Payroll/HR System	Actual Flows
Facilities & Security	HVAC at Various Locations	Actual Flows
	Doors, Signage, Fencing, etc.	Actual Flows

-END OF PAGE-

5. **Other Capital Cost Allocation Calculations - Indirect Labor Cost Pools** – DC Water will segregate its Blue Plains indirect labor cost pool from its non-Blue Plains indirect labor cost pool. The Blue Plains indirect labor cost pool's allocation base will be the total costs of Blue Plains project/activities managed by DC Water's Engineering Department or its successor. The non-Blue Plains indirect labor cost pool's allocation base will be the total cost of all non-Blue Plains projects/activities managed by DC Water's Engineering Department or its successor.

C. OPERATION AND MAINTENANCE (O&M) COST RESPONSIBILITIES

1. **Determination of Billing Flow**
   a. Each of the District, Fairfax and WSSC's proportion of the annual MJUF O&M Costs shall be its Billing Flow divided by the Total Billing Flow. The Billing Flow will be the Actual Flow for each entity; except that the District Actual Flow is adjusted to account for any differential treatment cost impacts to calculate the District Billing Flow. The procedures for calculating these Billing Flows are set forth below in **Table OA 2-D**. For purposes of this calculation, all Actual Flows reflect Allocated Flow Capacities, and the Captured Stormwater Flow represents total estimated flows once the CSO LTCP is fully implemented.

   b. **Differential Treatment Cost Impacts** - Consistent with 2012 IMA **Section 5**, the calculation of Billing Flow from Actual Flow shall take into account any differential treatment cost impacts that have been determined based on a Jointly Managed Study.

   c. **District Billing Flows** - As of the date of this Agreement, the only agreed upon differential treatment cost applies to the District's CSF. The cost of treating CSF has been determined to be 49.28% of the cost of treating average strength wastewater (consistent with a technical review of DC Water analysis, 3/22/10). This percentage will be reviewed and updated periodically for changed conditions.

   d. **Annual Adjustment of Billing Flow** - The Billing Flow for any year will, therefore, be adjusted as follows:
      1) DC Water will calculate the CSF treated at Blue Plains using the measured rainfall and the CSO LTCP model. The CSO LTCP model, this calculation, and the nomograph in the **Appendix of OA #3** will be reviewed periodically by the Regional Committee.
      2) The calculated CSF will be subtracted from the Actual Flow.
      3) The CSF will be multiplied by the CSF cost ratio (i.e. the cost per gallon of treating CSF divided by the cost per gallon of treating average strength wastewater). This is the Adjusted CSF.
      4) The Billing Flow is calculated by adding the Adjusted CSF to the Actual Flow less the CSF.

-END OF PAGE-

NOTE: For purposes of this calculation, all Actual Flows reflect Allocated Flow Capacities, and the Captured Stormwater Flow represents total estimated flows once the CSO LTCP is fully implemented. Numbers are rounded for purposes of the example.

TABLE OA 2-D

Actual Flow			
Flow Sources	Flows (MGD)	Outfalls	
		#001	#002
MD			
WSSC	169.60		
Navy	0.07		
NPS	0.03		
Sub-Total MD	**169.70**		
VA			
Fairfax	31.00		
Loudoun	13.80		
Dulles	1.50		
Vienna	1.50		
Sub-Total VA	**47.80**		
Suburb Total	**217.50**		
DC			
DC	152.5		
CSF	21		
Total DC	173.5		
Grand Total	**391.00**	**7.30**	**383.70**

2. **Blue Plains & Associated Facility O&M Cost Allocations**
   a. The District, Fairfax and WSSC and Non-Party Users shall be assessed by DC Water for their proportionate share of the cost of operating and maintaining Blue Plains.

   b. The DC Water Central Operations Facility (COF) building O&M Costs allocated to wastewater services shall be 54%. However, all Parties have the right to request a detailed analysis of this agreed allocation percentage if a circumstance occurs that materially changes the assumptions used in developing this ratio. Where practicable, DC Water will continue to segregate COF related costs from other cost pools in the Facilities Department or its successor.

3. **Pipelines and Appurtenances O&M Cost Allocations**
   a. The District, Fairfax and WSSC and Non-Party Users shall be assessed by DC Water for their proportionate share of the cost of operating and maintaining the interceptors (including the Potomac Interceptor) and appurtenances, and including wastewater pumping stations at locations other than Blue Plains which are determined to be MJUFs.

   b. WSSC shall assess DC Water, as appropriate, for its proportionate share of the cost of O&M of the interceptors, wastewater pumping stations, screen chambers and wastewater Flow meters that are operated and maintained by WSSC or any of the other parties to handle BPSA flows that are directed to Blue Plains.

   c. The District, Fairfax and WSSC's share of these O&M Costs shall be based on a node-to-node assessment methodology.

4. **CSO LTCP O&M Cost Allocations** – The District, Fairfax, WSSC and Non-Party Users shall be assessed by DC Water for their proportionate share of the cost of operating and maintaining that portion of the CSO LTCP that has been determined to be a MJUF by the Regional Committee based on the proportion of their Actual Flow versus Total Flow through the facility or based on other Usage determinations. Any methodology used shall be approved by the Regional Committee.

Billing Flow – Example Calculation		
1	Metered Plant Flow (Actual Flow), MGD	391
2	Metered **WSSC** (Actual Flow = Billing Flow), MGD	169.6
3	Metered **Fairfax** (Actual Flow = Billing Flow) MGD	31
4	Metered **Loudoun** (Actual Flow = Billing Flow)MGD	13.8
5	**Other PI Users** (Actual Flow = Billing Flow), MGD	3.1
6	Total Suburban (Actual Flow = Billing Flow), MGD	217.5
7	**District** (Actual Flow), MGD	391 – 217.5 =173.5
8	Captured Stormwater Flow (CSF) (from LTCP model), MGD	21
9	CSF Cost Ratio (from AECOM cost study)	49%[1]
10	Adjusted CSF Flow, MGD	(21)(.49) = 10.3
11	District Billing Flow, MGD	173.5 - 21 + 10.3 = 162.8
12	Total Billing Flow, MGD	217.5 + 162.8 = 380.3

[1] Cost ratio applied to Captured Stormwater Flow is based on determination cited in **Subsection C.1.c**.

D. USER FEE RESPONSIBILITIES

1. **Payment** - The WSSC and Fairfax shall pay to the District an annual User Fee in accordance with **Section F.2**. of this Agreement. This fee shall be proportionately adjusted if the Allocated Flow Capacities defined in **Section 4** of the 2012 IMA are reduced.

2. **Annual Estimate** - In accordance with **Section 5** of the 2012 IMA, DC Water shall prepare an estimate of the User Fee prior to the beginning of each DC Water fiscal year and include it in the next billings rendered to Fairfax, Loudoun County Sanitation Authority (LCSA or Loudoun Water) and WSSC.

E. FINES, PENALTIES AND CLAIMS RESPONSIBILITIES

1. **Proportionate Allocation for Capital Projects** - Except as otherwise provided in the 2012 IMA, all fines, penalties and claims relating to Capital Projects will be allocated proportionately to the District, Fairfax and WSSC, and Non-Party Users based on Allocated Flow Capacity.

2. **Proportionate Allocation for O&M Activities** -Except as otherwise provided in the 2012 IMA, all fines, penalties and claims relating to O&M Activities will be allocated based on the Actual Flows of District, Fairfax, WSSC and Non-Party Users.

F. BILLING AND PAYMENT PROCEDURES

1. **DC Water to Annually Estimate Costs** - Before October 1 of each year, DC Water shall prepare an annual estimate of the Capital Costs and O&M Costs expected to be incurred during the following year and the estimated share of these costs for the District, Fairfax and WSSC. These estimates will be allocated in accordance with **Section 5.C. and 5.D**. As appropriate, the estimated share of the annual costs for each of these Parties shall be offset by each Party's estimate of the costs that it will incur in operating and maintaining its share of MJUFs for managing BPSA flows, or its share of managing Blue Plains biosolids or other residuals.

2. **Billing and Payment** - DC Water shall bill Fairfax and WSSC quarterly for Capital Costs and O&M Costs. Fairfax and WSSC shall remit quarterly payments to DC Water to cover 25% of their share of estimated annual Blue Plains O&M Costs and User Fees. Payments shall be made within 30 days of receipt of the invoices. If quarterly payments are not made on time, interest shall be charged at the Federal Reserve Bank's Discount Rate in effect on the due date of the bill. The Federal Reserve Bank Discount Rate will be determined quarterly at the end of each quarter.

3. **Reconciliation of Annual Bills**
   a. **Capital Costs** – DC Water shall submit a reconciled quarterly invoice, including the estimate for the following quarter.

b. **O&M Costs -** No later than 90 days after the completion of the annual independent audit or March 31st, DC Water shall prepare an annual bill for the purpose of reconciling payments made during the year by Fairfax and WSSC. This bill shall be based upon the actual costs incurred by each Party; such information to be provided to DC Water by Fairfax and WSSC within 30 days after the close of each DC Water fiscal year.

c. **Capital Costs and O&M Costs** - Any overpayments or underpayments shall be equally prorated to each quarterly payment date and simple interest calculated from the date the quarterly payment was paid until the overpayment is refunded or the underpayment is paid. See **Table OA 2-E** for an example of the computation of the interest discussed in this sub-section

TABLE OA 2-E

FEDERAL RESERVE DISCOUNT RATE INTEREST CALCULATION EXAMPLE
(For illustrative purposes only)

Quarter	Interest Rate[1]	In Thousand Dollars			Period Outstanding[2] (Months)
		Payment[3]	Over/ <Under>[4]	Interest Owed[5]	
1	2.00%	7,500.00	625.00	14.06	13.5
2	2.00%	7,500.00	625.00	10.94	10.5
3	2.50%	7,500.00	625.00	9.77	7.5
4	3.00%	7,500.00	625.00	7.03	4.5
Total Annual Payment		30,000.00	2,500.00	41.8	
Total Annual Actual		(27,500.00)			
Over/<Under>[4]		2,500.00			

* ** Assumes refund/payment received end of subsequent year Quarter 1.

4. **Maintenance and Review of Records -** DC Water, Fairfax and WSSC shall maintain books, accounts, records, documents and other evidence, employing generally accepted accounting principles and practices sufficient to show properly

[1] Federal Reserve Discount Rate in effect at end of each Quarter.
[2] Number of months between making payment and time of refund/payment (true up). Assumes quarterly payment made in mid-quarter. Assumes true up received end of subsequent year Quarter 1. This would be 13.5 months for Quarter 1, 10.5 months for Quarter 2, etc.
[3] Quarterly payments based upon annual budget.
[4] Over or Underpayment equally prorated over each quarter. Annual difference is divided evenly between the quarters.
[5] Example interest calculation for the first quarter: (625) x (0.02) x (13.5/12) = 14.06

all direct and indirect costs of whatever nature they claim to have incurred or anticipate incurring. The foregoing records shall be subject at reasonable times to audit, examination, inspection or reproduction by DC Water, Fairfax or WSSC or a duly authorized representative of these Parties. Upon request, the Party shall provide a mutually acceptable electronic data processing medium containing all available computerized cost data to support the billing. Records shall be preserved for a period of at least three (3) years from the end of the fiscal year in which payment was made.

5. **Right to Audit** - All cost elements charged to DC Water, Fairfax, WSSC, or any Non-Party User may be audited by any Party. These cost elements include, but are not limited to: Capital Costs, O&M Costs, direct costs, indirect costs and flow data. Any adjustments made to DC Water, Fairfax or WSSC's bill as the result of an audit shall also automatically be made, as applicable, to other entities.

6. The right of any Party to any sum due pursuant to this Agreement shall not be barred by any statute of limitations.

7. **Biosolids Management Cost Procedures** - WSSC will incur Blue Plains biosolids management costs in accordance with **Operating Agreement #6, Biosolids Management Commitments**. The payment procedures for these costs shall be as follows:
   a. DC Water shall credit WSSC for all Blue Plains related biosolids costs incurred by WSSC less the share allocated to WSSC.
   b. DC Water shall then collect the share of these costs allocated to Fairfax by adding these costs to the regular payments due from Fairfax.
   c. DC Water shall also recover the costs paid on behalf of the Non-Party Users.

-END OF PAGE-

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm the authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

040213
City Administrator Date

DC WATER

3/21/13
General Manager Date

FAIRFAX COUNTY, VIRGINIA

3/25/13
County Executive Date

MONTGOMERY COUNTY, MARYLAND

4/3/13
Chief Administrative Officer Date

PRINCE GEORGE'S COUNTY, MARYLAND

4/2/13
Chief Administrative Officer Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

3/20/13
General Manager Date

Approved by Leadership Committee: 4/3/13
Chair **Date**

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: 4/3/13
Chair **Date**

OPERATING AGREEMENT #3

PARTIES' AGREEMENT REGARDING: FLOW AND LOAD MEASUREMENT AND MANAGEMENT

THIS OPERATING AGREEMENT (Agreement), among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, the Parties agree to routinely monitor and assess their Actual Flows, Adjusted Flows, and the associated Pollutant/Nutrient Loads to Blue Plains to ensure that all allocations and/or limitations for Blue Plains are not exceeded, as set forth in **Section 4** of the 2012 IMA; and

WHEREAS, the Parties agree to regularly monitor and assess their Peak Flows at the point of connection to the BPSA's collection system; and comply with Peak Flow Limitations, as set forth in **Section 4** of the 2012 IMA and **Operating Agreement #1**; and

WHEREAS, the Parties acknowledge their responsibility to ensure that the Non-Party Users and Indirect Users also comply with the terms of this Operating Agreement; and

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the 2012 IMA consistent with **Section 11.**

NOW THEREORE, the Parties agree as follows:

PURPOSE: The purpose of this Agreement is to address matters related to **Section 6** of the 2012 IMA, including:

A. Flow Measurement, Reporting and Assessment;
B. Load Measurement, Reporting and Assessment; and
C. Load Management.

A. FLOW MEASUREMENT, REPORTING AND ASSESSMENT

1. Flow Measurement

a. For each sewer of a Party that has, or is expected to have, a discharge of 60,000 GPD or greater which discharges from a sewer of the District, Fairfax or WSSC into a sewer owned or operated by the District, DC Water, Fairfax or WSSC; the owner/manager of such discharging sewer(s) shall provide and install wastewater flow meters of the maximum practicable accuracy, at its own expense. The receiving Party directly involved shall mutually approve all such meter installations, shall designate who shall read, test, operate and maintain all such meters, and shall determine the methods and procedures to be followed. DC Water, Fairfax and WSSC may jointly read, test and inspect such meters at reasonable times at the request of any Party.

b. DC Water shall provide, operate and maintain metering of the total Blue Plains wastewater Flow, as well as Intra-plant Flows[1], in order to implement this agreement. DC Water, Fairfax and WSSC may jointly read, test and inspect such meters at reasonable times at the request of any Party.

c. In case a wastewater flow meter fails to function for any reason, the meter shall be repaired as expeditiously as possible. Wastewater flow for the period of such failure shall be deemed to be equal to the flow during the most recent equivalent period that the meter was in satisfactory operation. If there is no such corresponding period, the flow shall be determined or estimated in such a manner as shall be agreed upon by the Parties involved.

d. **Wastewater Units** - For each sewer that has, or is expected to have, a discharge of less than 60,000 GPD which discharges from a sewer of the District, Fairfax or WSSC into a sewer of another entity, the total annual estimated wastewater flow shall be calculated based upon the number of wastewater units connected to or discharging into such sewer. A wastewater unit shall equate to an annual discharge of 125,000 gallons. Each service connection shall be counted as one or more wastewater units depending upon the use of the premises served through such connections as follows:
   1) Each single family dwelling unit, whether detached or attached, shall constitute one (1) wastewater unit;
   2) Each apartment unit shall constitute one-half (0.5) of a wastewater unit;
   3) Wastewater units for premises used for other than residential purposes shall be determined by multiplying the annual water consumption by one and one-half (1.5)[2] and dividing by 125,000 gallons[3].

---

[1] Wastewater flow meters that are located within the Blue Plains WWTP that are used to help calculate District Flows.

[2] Ratio of 1.5 accounts for contributions from I/I sources to the estimated flows.

[3] 125,000 gallon figure reflects conversion of flows (water consumption and I/I) to estimated wastewater units.

e. The monthly computation of the District, Fairfax, WSSC, and Non-Party User's Actual Flow shall include both its metered and unmetered flow entering the District's sewer system.
f. The District's Actual Flow shall be calculated by subtracting the sum of Fairfax, WSSC and Non-Party Users' Actual Flows from the total plant Actual Flow.

g. Additional long-term flow meters to monitor flows to the Potomac Interceptor are critical to ensuring that there is adequate and detailed flow data to evaluate how well the PI system is functioning under various flow conditions; and to ensure that individually and collectively that the flows into and through the PI are consistent with those values set forth in **Section 4** of the IMA.

h. In order to address flow limitations necessary to ensure the proper performance of the Potomac Interceptor, the Regional Committee shall evaluate the need for developing a long-term rain gauge network, adding meters near Manholes #7 or #18 (i.e., section of PI where surcharging occurs), and addressing any other technical issues that would aid in this effort. The Regional Committee shall develop a plan to identify, fund, and implement this evaluation; which shall include defining specific tasks, roles and responsibilities, and a schedule for accomplishing this work.

2. **Flow Reporting**
   a. No later than 15 days after the end of each month, Fairfax, WSSC and each Non-Party User shall prepare and send to DC Water a report on the status of its Actual Wastewater Flows and commitments. DC Water shall compile these reports into a single report and distribute this report to the Parties no later than 30 days after the end of the month. DC Water shall also prepare an annual summary report for each calendar year and distribute this report to the Parties no later than February 15th of the following year.
   b. Fairfax, WSSC and Non-Party Users' report shall include at least the following information:
      1) The measured average flow and Peak Flow rate and duration during the month of the report for each metered point of connection between two (2) entities in the wastewater collection systems;
      2) The measured Actual Flow and the Peak Flow rate and duration for each metered point of connection between two (2) entities' wastewater collection systems for the 12 month period ending with the month for which the report is prepared;
      3) The estimated Actual Flow for the unmetered points of connection between the two (2) entities' wastewater collection systems, and the method used to estimate the annual average;
      4) The User's total daily average of all Actual Flows (i.e. the sum of all metered and unmetered flows) during the month for which the report is prepared;
      5) The total rainfall, as measured at Washington National Airport, during the 12 months ending with the month for which the report is prepared;
      6) The Highest Rolling Annual Average for its Actual Flow during the 12 months ending with the month for which the report is prepared;

7) Such other related information/data as may be deemed necessary to implement the 2012 IMA.

c. DC Water shall be responsible for ensuring that the Non-Party Users comply with these reporting requirements.
d. DC Water's monthly and annual summary reports shall include Actual Flow data at Blue Plains, including total flow through the plant, and the distribution of the flow to Outfall #001 and Outfall #002; and such other related information/data as may be deemed necessary to implement the 2012 IMA.

e. The District's Actual Flow for the purposes of flow management within the context of this Agreement shall be the total flow to Blue Plains less flows reported by Fairfax and WSSC and the Non-Party Users. The Parties recognize that a portion of the District's Actual Flow to Blue Plains is stormwater flow from its Combined Sewer area.

3. **Flow Assessment**
   a. DC Water shall monitor reported flows and calculate Adjusted Flows from Actual Flows provided by Fairfax, WSSC and Non-Party Users (i.e., to present normalized flows that reflect average hydrologic conditions). **Table OA 3-A** shows Adjusted Flow –Calculation Example.
   b. DC Water shall monitor the flow trends and any potential allocation or limit exceedances and alert the Parties each month if any reported flows or peak flow values indicate problems.
   c. DC Water shall prepare an annual BPSA flow report for the Regional Committee that assesses flow trends, as well as noting any instances where Adjusted Flows and/or Peak Flow values indicate that flows are or have the potential to exceed Allocated Flow Capacity and/or Peak Flow Limitations, as defined in **Section 4** of the 2012 IMA**.**
   d. DC Water shall also be responsible for assessing all flows, analyzing data and modeling flows as needed to make recommendations what and where peak flow reductions are required in the system and for potential modifications to the Peak Flows in the Potomac Interceptor defined in the **Section 4** of the 2012 IMA.
   e. The Regional Committee is responsible for reviewing the BPSA flow report and assessing what actions, if any, are required. These actions may include, but are not limited to, determining if additional flow management or documentation of flow management efforts are required from the District, Fairfax, WSSC and/or the Non-Party Users; and determining whether a comprehensive BPSA Long-term Planning Study and updated BPSA Flow Projections are needed in advance of their regularly scheduled 5-year update. These efforts will be used to formally assess Adjusted Flow and Peak Flow trends against Allocated Flow Capacity and Peak Flow Limitations, as well as flow management actions. The procedures for conducting this BPSA work are outlined in **Operating Agreement #4**.
   f. The Regional Committee shall report to and make recommendations to the Leadership Committee based on the results of the BPSA Long-term Planning Study.

4. **Flow Management**
   a. The District's, Fairfax's, WSSC's and Non-Party Users' Adjusted Flow shall at no time exceed its Allocated Flow Capacity as defined in **Section 4** of the 2012 IMA.
   b. If the Adjusted Flow of the District, Fairfax or WSSC exceeds the Allocated Flow Capacity for any reason, the District, Fairfax or WSSC shall immediately stop making any further commitments for hookups, connections and extensions to its sewage system tributary to Blue Plains until three (3) consecutive months have passed during which the sum of the entity's Adjusted Flow shall not have exceeded its Allocated Flow Capacity. The sole exceptions to this prohibition shall be:
      1) To eliminate an alternative method of wastewater disposal that has been certified by a duly constituted health officer in the District, Fairfax or WSSC's BPSA, or his designated local representative, to constitute a public health hazard. This certification shall be on a parcel by parcel basis;
      2) For public service buildings, which include schools, hospitals, nursing homes, medical and dental clinics, and other structures used by public agencies in providing essential services for public health and welfare;
      3) If the User has a plan approved by the Regional Committee to bring its Adjusted Flow within its Allocated Flow Capacity.

B. LOAD MEASUREMENT, REPORTING AND ASSESSMENT

1. DC Water shall be responsible for sampling, monitoring and assessing the influent flows to Blue Plains. If there are exceedances that create problems with the Blue Plains permit or other issues, then the Load Capacities set forth in **Table OA 1-B** of **Operating Agreement #1** will apply.

2. DC Water shall be responsible for providing annual reports to the Regional Committee regarding the results of these assessments and recommending any potential actions, including conducting detailed strength of influent wastewater studies.

3. The Regional Committee shall participate in DC Water-required Jointly Managed Studies to assess the strength of influent wastewater and to determine what changes, if any are required to Allocated Flow Capacity, Peak Flow Limitations or any Load Limitations in order to ensure that Blue Plains continues to have the ability to comply with all of its process and permit requirements.

4. Based on the results of such studies, the Regional Committee shall make recommendations to the Leadership Committee regarding changes that may be required to the flow, load and/or financial obligations of the Parties.

A. LOAD MANAGEMENT

1. The Regional Committee shall review options for managing loads in influent wastewater flows, including but not limited to, assessing the increase in loadings that

result from extensive Inflow/Infiltration reductions in sewer collection system, use of garbage disposals, and potential Pretreatment requirements for commercial, household or other activities.

2. Based on the results of such studies, the Regional Committee may make recommendations to the Leadership Committee regarding any potential changes to the Flow Management responsibilities, Pretreatment obligations, and any other obligations of the Parties.

APPENDIX

Table OA 3-A

Adjusted Flow - Calculation Example
(for comparing to Allocated Flow Capacity)

1) **Actual Flows, Rainfall and Well Depths**

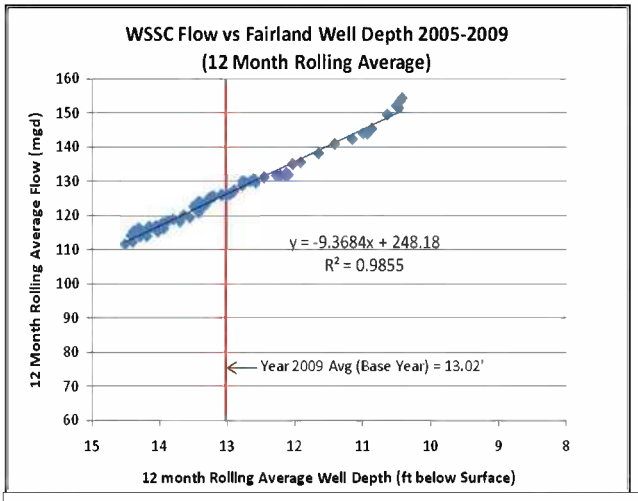
a) Assume it was a wet year and annual averages of Actual Flows were measured as follows:

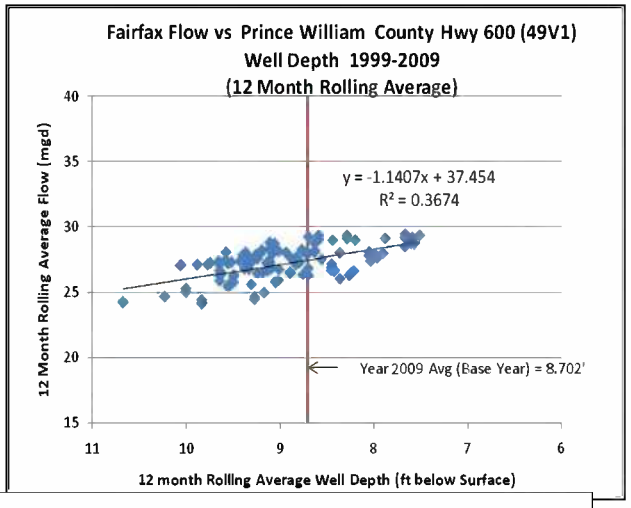
Line	Item	Value (MGD)	Calculation
1	Blue Plains Outfall #002	400.00	
2	Blue Plains Outfall # 001	8.00	
3	Total Blue Plains	408.00	Lines 1 + Line 2
4			
5	Maryland		
6	WSSC	175.00	
7	Navy	0.07	
8	NPS	0.03	
9	**Sub-Total Maryland**	175.10	Sum of Lines 6,7,9
10			
11	Virginia		
12	Fairfax	30.00	
13	Loudoun	13.80	
14	Dulles	1.50	
15	Vienna	1.50	
16	**Sub-Total Virginia**	46.80	Sum of Lines 12 to 15
17			
18	**Total Suburban Flow**	221.9	Line 9 + Line 16
19			
20	**Total District Flow**	186.10	Line 3 minus Line 18

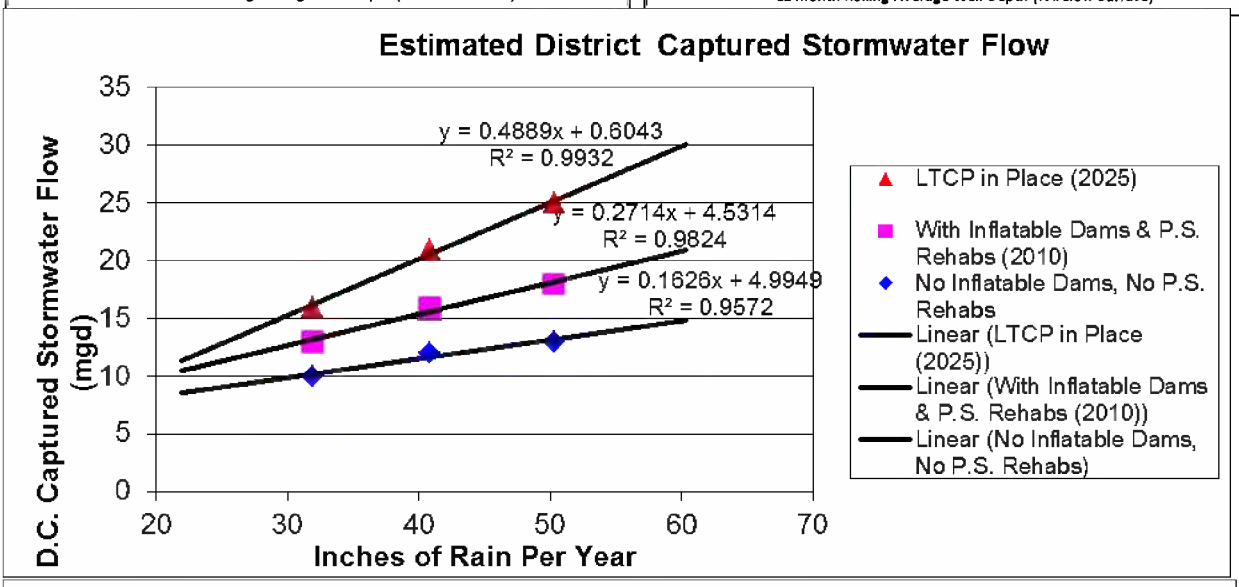
b) **Rainfall and Well Depths**
Assume 12 month rolling average rainfall and well depths were as follows:

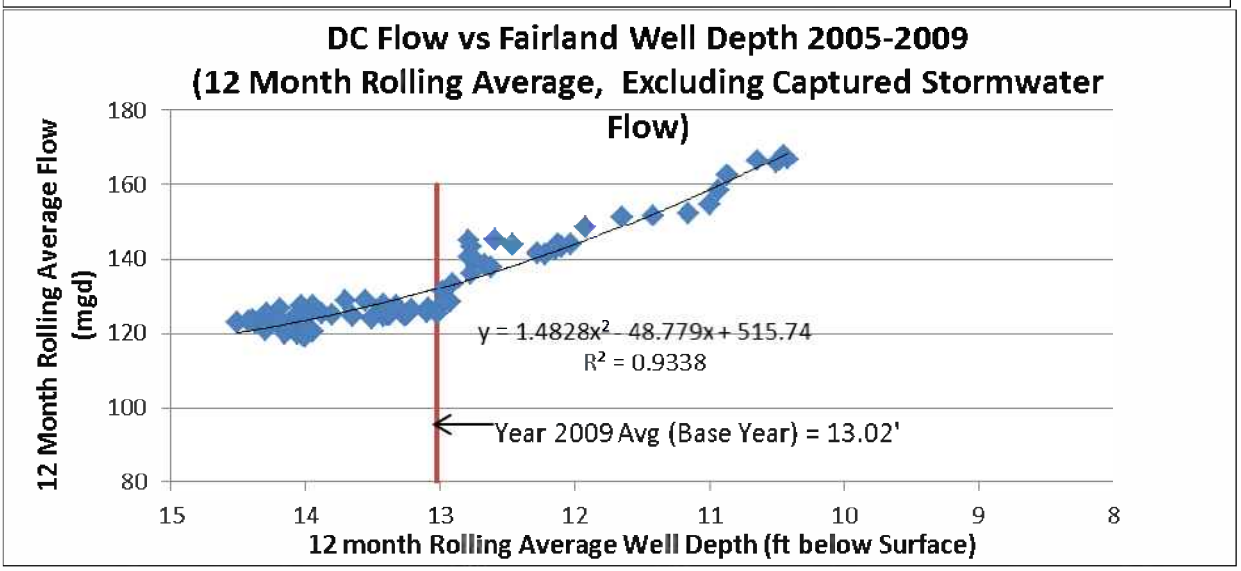
Item	Value	Notes
Rainfall at National Airport	48 in.	12 month rolling average
Fairland Well Depth	11.5 ft	12 month rolling average
Prince William County Highway 600 Well Depth	7.50 ft	12 month rolling average

Nomographs Used to Calculate Flow Adjustments[1]









[1] These nomographs shall be reviewed periodically by the Regional Committee for accuracy and adjusted accordingly.

SAMPLE CALCULATIONS

2) **WSSC Flow Calculation**
   a) Assume Actual Flow = 175.00 MGD (metered)

   b) Make adjustment to average hydrologic conditions using Fairland Well depth
      i) Assume actual 12 month rolling average Fairland well depth = 11.50 ft
      ii) Nomograph flow: y = - 9.3684 *(11.50) + 248.18 = 140.4 MGD
      iii) Base year (2009) 12 month rolling average Fairland well depth = 13.02 ft
      iv) Nomograph flow: y = - 9.3684 *(13.02) + 248.18 = 126.2 MGD
      v) Adjustment = 126.2-140.4 = - 14.2 MGD

   c) WSSC Adjusted Flow = 175.00 – 14.2 =160.8 MGD

3) **Fairfax Flow Calculation**
   a) Assume Actual Flow = 30 MGD (metered)

   b) Make adjustment to average hydrologic conditions using Prince William County Highway 600 Well depth
      i) Assume actual 12 month rolling average Prince William County well depth = 7.50 ft
      ii) Nomograph flow: y = -1.1407*(7.5) + 37.454= 28.9 MGD
      iii) Base year (2009) 12 month rolling average Prince William County well depth = 8.702 ft
      iv) Nomograph flow: y = -1.1407*(8.702) + 37.454= 27.5 MGD
      v) Adjustment = 27.5 – 28.9 = - 1.4 MGD

   c) Fairfax Adjusted Flow = 30 – 1.4 = 28.6 MGD

4) **District Flow Calculation**
   a) Assume Actual Flow = 186.1 MGD

   b) Make adjustment to average hydrologic conditions using Fairland Well depth
      i) Assume actual 12 month rolling average Fairland well depth = 11.50 ft
      ii) Nomograph flow: y = 1.4828*(11.50^2)-48.779*(11.50)+515.74 = 150.9 MGD
      iii) Base year (2009) 12 month rolling average Fairland well depth = 13.02 ft
      iv) Nomograph flow: y = 1.4828*(13.02^2)-48.779*(13.02)+515.74 = 132.0 MGD
      v) Adjustment = 132.0 – 150.9 = - 18.9 MGD

   c) Make adjustment for Captured Stormwater Flow (CSF)
      i) Assume LTCP is in place and 48" rainfall
      ii) CSF = 0.4889 *(48)+0.6043 = 24.1

   d) District Adjusted Flow = 186.1 – 18.9 - 24.1 = 143.1

5) Comparison of Actual Flow and Adjusted Flow

Line	Item	Actual Flow (MGD)	Adjusted Flow (MGD)
1	Blue Plains Outfall #002	400.00	
2	Blue Plains Outfall #001	8.00	
3	**Total Blue Plains**	408.00	349.40
4			
5	Maryland		
6	WSSC	175.00	160.80
7	Navy	0.07	0.07
8	NPS	0.03	0.03
9	**Sub-Total Maryland**	175.10	160.90
10			
11	Virginia		
12	Fairfax	30.00	28.60
13	Loudoun	13.80	13.80
14	Dulles	1.50	1.50
15	Vienna	1.50	1.50
16	**Sub-Total Virginia**	46.80	45.40
17			
18	**Total Suburban Flow**	221.9	206.30
19			
20	**Total District Flow**	186.10	143.10

-END OF PAGE-

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm the authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

City Administrator Date 4/6/13

DC WATER

General Manager 3/21/13 Date

FAIRFAX COUNTY, VIRGINIA

County Executive 3/25/13 Date

MONTGOMERY COUNTY, MARYLAND

Chief Administrative Officer 4/3/13 Date

PRINCE GEORGE'S COUNTY, MARYLAND

Chief Administrative Officer 4/2/13 Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

General Manager 3/20/13 Date

Approved by Leadership Committee: 4/3/13

Chair **Date**

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: 4/3/13

Chair **Date**

1

OPERATING AGREEMENT #4

PARTIES' AGREEMENT REGARDING: WASTEWATER PROJECTED FLOW CAPACITY NEEDS AND FUTURE OPTIONS

THIS OPERATING AGREEMENT (Agreement), among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery County), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, the Parties recognize their collective and mutual interests under the 2012 IMA, which includes the management of Wastewater flows generated in the Blue Plains Service Area (BPSA) and sent to the Blue Plains Wastewater Treatment Plant (Blue Plains); and

WHEREAS, the Parties recognize that the District has limited options available to it to address its own Projected Flow Capacity Needs; and

WHEREAS, the Parties agree to work together to address their individual and collective Projected Flow Capacity Needs for flows generated within the BPSA, including development of Jointly Managed Studies to determine these Projected Flow Capacity Needs and to develop alternatives for addressing these Projected Flow Capacity Needs as defined in **Section 7**; and

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the IMA consistent with **Section 11.**

NOW, THEREFORE, the Parties agree as follows:

PURPOSE: The purpose of this Agreement is to address matters relating to **Section 7** of the 2012 IMA, including:

A. Long-term Planning for BPSA;
B. Development of Options and Proposed Actions; and
C. Assessment and Notification Requirements.

A. LONG-TERM PLANNING FOR BPSA

1. **Jointly Managed Study** - The Regional Committee shall be responsible for conducting a Jointly Managed Study to produce a BPSA Long-term Planning Study at least every five (5) years, unless flow or load or other issues require this

assessment to be done sooner. It is anticipated that 5-year updates for an approximately 30-year planning horizon are adequate to assess and take necessary actions to protect the Parties' rights under this Agreement. As flows to the Blue Plains approach its Design Flow Capacity, the frequency of conducting such assessments may be increased.

2. **Flow Projection Methodology**
   a. The BPSA Long-term Planning Study shall address at a minimum:
      1) Updated flow projections for the District, Fairfax and WSSC, as well as for Non-Party Users and Indirect Users as well as for the overall BPSA, including:
         a) Incorporation of MWCOG's most recently adopted Cooperative Forecast, which includes regionally developed demographic data, or other mutually agreed forecast;
         b) Updates to all Parties' wastewater flow management actions and plans;
         c) Confirmed or updated wastewater flow factors;
         d) Confirmed or updated Inflow and Infiltration assumptions; and
         e) Updated base year flow figures (i.e. flow defined or calculated that best reflects annual average flows under average hydrologic conditions), that are used to develop Projected Flow Capacity Needs of the BPSA for each jurisdiction/entity that contributes flow to Blue Plains;

      2) Updated information regarding water quality issues, loading limits, state or federal regulations, and any other activities or initiatives that will or have the potential to impact the Blue Plains' permit and/or treatment process requirements;

      3) Updated information and assessments about peak flows generated in the BPSA; and

      4) Trend data and analysis as needed to assess the potential impacts all of these factors will or could have on the Allocated Flow Capacity, Peak Flow Limitations and/or load assumptions for the BPSA.

   b. As a result of this periodic assessment, the Parties agree to reconcile any differences between the total and individual projected Annual Average Design Capacity requirements and with each of the Parties' and Non-Party User's Allocated Flow Capacity. This reconciliation may include, but is not limited to, the application of the following:
      1) Flow management projects/programs that reduce and/or increase flows;
      2) Load management programs that reduce or increase loads; and
      3) Reallocation (via sale or rental) of Allocated Flow Capacity.

   c. Evaluation of projected Annual Average Design Flow Capacity requirements will address the associated flow allocations, limitations, definitions, and assumptions set forth in the Derivative Agreement(s), to determine if any flow parameters, allocations, and/or limitations require modification to reflect the new projections.

B. DEVELOPMENT OF OPTIONS AND PROPOSED ACTION

1. Based on the results of any Jointly Managed Study, as defined in **Section 7** of the 2012 IMA, the Regional Committee shall develop options (for the Parties and Non-Party Users, as appropriate) that address at a minimum the following elements and criteria:
   a. Provide wastewater capacity at Blue Plains to meet the District's Projected Flow Capacity Needs unless other options better meet the District's Projected Flow Capacity Needs;

   b. Give priority to the reallocation of annual average wastewater flow capacity that is not expected to be needed for more than 15 to 20 years;

   c. Use the following hierarchy for considering the location of any proposed new or expanded treatment options: at Blue Plains, at WSSC's facilities, or at Fairfax's facilities, all of which shall be deemed to be Multi-Jurisdiction Use Facilities (MJUF) as defined in **Section 5** of the 2012 IMA, unless the Regional Committee agrees to alternative site considerations;

   d. Evaluate storage options to identify any potential impacts on the peak flows and Allocated Flow Capacity defined in **Section 4** of the 2012 IMA;

   e. Evaluate the rental or sale of capacity to ensure it would be consistent with the terms and assumptions in **Sections 4** and **6** of the 2012 IMA, and the associated Derivative Agreement(s), considering that the rental or sale of capacity shall be at the discretion of the Party allocated the capacity.

   f. Consider that rental of capacity shall be viewed as a short-term solution and must be reassessed at least every five (5) years;

   g. Consider that the Non-Party Users' Projected Flow Capacity Needs may have unique contractual agreements and there may be limited options available for them to address their capacity requirements outside of Blue Plains;

2. The options developed during a Jointly Managed Study shall address the following elements for each Party and Non-Party User, as appropriate:
   a. The resulting Allocated Flow Capacities;
   b. The resulting Peak Flow Limitations; and
   c. The impact on Design Flow Capacities and Design Load Capacities.

3. The Regional Committee shall recommend to the Leadership Committee technical and/or programmatic options that address the individual and collective Projected Flow Capacity Needs of the Parties under **Section 7** of the 2012 IMA. These recommendations shall include, but not be limited to, addressing:
   a. The proposed time frame for taking specific actions (whether operational or construction);
   b. The estimated cost of these actions; and

c. The proposed flow, load, and cost allocations and implications for each Party (and Non-Party User) associated with any options.

4. If suburban flows are diverted, nutrient loads associated with the diverted flows go with those flows and the District is responsible for finding nutrient offsets.

5. Any jurisdiction that requires additional flow capacity shall be responsible for finding nutrient offsets for that flow.

C. ASSESSMENT AND NOTIFICATION REQUIREMENTS

1. The Regional Committee shall periodically assess the Adjusted Flows set forth in **Section 6** and the flow projections set forth in **Section 7** of the 2012 IMA, and as set forth in this Agreement, to determine if the timing or the scope of the agreed upon actions are being implemented in a manner that protects the interests of all the Parties.

2. The Regional Committee shall develop an implementation plan that outlines the proposed actions to be taken and associated schedule and defines the Parties' responsibilities. For those options which require that additional flow or load capacity be provided at Blue Plains or at other sites, this implementation plan shall include, but not be limited to:
   a. A timeline with periodic milestones (generally every 5 to 10 years) that ensures that the necessary flow and/or load capacity is available when the Projected Flow Capacity Need is required;

   b. A reassessment of Projected Flow Capacity Needs versus agreed upon actions, whether addressed via flow management, rental/sale of capacity, or construction projects;

   c. A minimum 15-year advance notification period for any proposed action that requires capital funding.

3. Any Party that requires additional capacity in the BPSA in order to meet its Projected Flow Capacity Needs, which it cannot meet through its own flow management actions or are not being addressed through a Jointly Managed Study, shall provide 15-year advance notification to the Regional Committee that it requires such capacity, define those actions it must undertake to manage its future flows, and outline a schedule for those actions.

4. Unless otherwise agreed to by the Regional Committee, any diversions or reallocation of flow capacity by Fairfax or WSSC greater than five (5) MGD to meet District Projected Flow Capacity Needs shall occur at least one (1) year before the projected requirement for those flows.

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm their authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

City Administrator Date 04 02 13

DC WATER

General Manager 3/21/13 Date

FAIRFAX COUNTY, VIRGINIA

County Executive 3/25/13 Date

MONTGOMERY COUNTY, MARYLAND

Chief Administrative Officer 4/3/13 Date

PRINCE GEORGE'S COUNTY, MARYLAND

Chief Administrative Officer 4/2/13 Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

General Manager 3/20/13 Date

Approved by Leadership Committee: Chair 4/3/13 Date

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: Chair 4/6/13 Date

OPERATING AGREEMENT #5

PARTIES' AGREEMENT REGARDING: PRETREATMENT & OPERATIONAL REQUIREMENTS

THIS OPERATING AGREEMENT (Agreement), among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, the 2012 IMA authorizes and requires the IMA Leadership Committee (the Leadership Committee), to set forth specific pretreatment and operational requirements, as well as monitoring and reporting processes, that they determine are appropriate to implement the provisions of **Section 8**;

WHEREAS, the Parties recognize their legal obligations to comply with all state, federal and local pretreatment requirements applicable to the Blue Plains Wastewater Treatment plant (Blue Plains) and its collection systems and their need to establish operational requirements for wastewater coming into Blue Plains as necessary to preclude damage to Blue Plains' wastewater and biosolids processes and equipment, to meet permit requirements, to avoid contributing any pollutants which cause or have the ability to cause wastewater, air, and/or biosolids permit exceedances, or that have any negative impacts at the plant;

WHEREAS, the Leadership Committee hereby agrees on behalf of the Parties to set forth specific requirements and monitoring and reporting processes necessary to protect the wastewater collection lines within the Blue Plains Service Area (BPSA), as well as the wastewater treatment processes and biosolids management programs at Blue Plains; and

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the IMA consistent with **Section 11.**

NOW, THEREFORE, the Parties agree as follows:

A. SCOPE

The requirements of this Agreement are intended to apply to only those regulations, requirements, and discharges in the BPSA and/or to the Blue Plains WWTP.

B. REGULATORY AUTHORITY

The Parties recognize their legal obligations to comply with all state, federal and local pretreatment requirements applicable to Blue Plains and its collection systems.

C. EXISTING AGREEMENTS

In addition to the 2012 IMA, the following agreements are applicable to this Agreement

1. **Agreements among Parties**
   a. **District & Fairfax,** *Wastewater Pretreatment Agreement* (June 27, 1986)
   b. **District & WSSC,** *Wastewater Pretreatment Agreement* (June 30, 1986)

2. **Agreements among Parties and Non-Party Users, and Parties and Indirect Users**

   Indirect User Agreements
   a. **Fairfax Co. & Herndon**, *Interjurisdictional Wastewater Pretreatment Agreement* (October 10, 1995)
   b. **Fairfax Co. & Arlington Co.,** *Sewage Conveyance, Treatment and Disposal* (October 03, 1994)
   c. **Fairfax Co. & Arlington Co.,** *Interjurisdictional Pretreatment Agreement* (June 17, 1994)

   Non-Party User Agreements
   a. **District & LCSA,** *Wastewater Pretreatment Agreement* (September 12, 1989)
   b. **District & LCSA**, *Amendment to the Agreement* (November, 11, 1998)
   c. **District & Vienna,** *Wastewater Pretreatment Agreement* (April 20, 1986)
   d. **District & US FAA,** General Agreement (January 1966)
   e. **District & the Navy,** General Agreement (April 27, 1965)
   f. **District & Fairfax County Park Authority,** General Agreement (January 23, 1964)
   g. **District & National Park Services,** General Agreement (August 18, 1964)

Copies of these agreements and all future agreements relating to Pretreatment and operational requirements between and among the Parties and Non-Party Users shall be maintained at the offices of DC Water and the IMA Secretariat. As these agreements are replaced or amended, their successor agreements will be appended to and incorporated by reference into this Derivative Agreement.

D. PRELIMINARY TREATMENT AND OPERATING REQUIREMENTS

1. Coarse screening shall be provided at any pumping station pumping more than an average of 2.5 mgd of flow, unless coarse screening is provided at a downstream facility. Screenings shall not be ground and returned to the wastewater flow under normal operations.

2. If necessary to bypass screens for more than four (4) hours, DC Water shall be notified within 24 hours.

3. If conditions arise requiring screening to be ground and returned to the wastewater flow, DC Water shall be notified within 24 hours.

4. Fairfax and WSSC shall generate a screenings report semi-annually which documents the location and total tonnage of screenings removed during each month within the six (6)-month period (January to June and July to December). The reports shall be due by the 30th of the month following the end of the reporting period (i.e., by July 30 and January 30) and shall be submitted to the DC Water Wastewater Treatment Manager:
   DC Water Wastewater Treatment Manager
   5000 Overlook Ave., SW, Washington, DC 20032
   202-787- 4008

E. TRUCKED WASTE MONITORING REQUIREMENTS

1. Trucked waste shall only be discharged at monitored location(s). Access control or surveillance cameras shall be required for unmanned stations.

2. Within 12 months of the 2012 IMA Agreement, all septage receiving stations that send waste to the BPSA shall have access control or surveillance cameras in operation, except when units are out of service for routine maintenance – a time period not to exceed one (1) week.

3. Surveillance camera records or gate records shall be reviewed as necessary to verify discharge activity. Camera records shall be maintained for 72 hours.

4. After proper notification and review, DC Water reserves the right to prohibit any wastes that are deemed to cause, or have the potential to cause, operational or system problems, and/or which cause or have the ability to cause wastewater, air, and/or biosolids permit exceedances.

5. DC Water shall be notified prior to the establishment of any new septage receiving sites in the BPSA.

6. Periodic self-monitoring data shall be required for existing discharges of non-domestic trucked waste, landfill leachate, or trucked waste containing sludge or other residuals. The Party shall determine the list of requested parameters and frequency of self-monitoring. Data shall be submitted to DC Water in the quarterly pretreatment program reports.

7. Each Party shall conduct random sampling of the trucked wastes at least semi-annually for all parameters. Data shall be submitted to DC Water in the quarterly pretreatment program reports.

F. PROHIBITED TRUCKED WASTES

Prohibited wastes shall not be discharged to the BPSA unless conditionally authorized under the terms outlined in Subsection G of this Agreement. Prohibited wastes include:

1. Trucked wastes that are generated outside of the counties included in the BPSA (i.e., out-of-state and out-of-county wastes), unless the out-of-state and/or out-of county waste is incidental to other waste collected from within the counties included in the BPSA;

2. Hazardous waste, as defined by EPA in 40 CFR 261 and/or in District of Columbia Code § 8-1302(2);

3. Wastes that are specifically prohibited by DC Water's prohibited discharge standards;

4. Wastes that exceed DC Water's local discharge standards or EPA's gas/vapor toxicity screening levels (EPA 812-B92-001), if measured in mg/L; or wastes that exceed EPA's Part 503 biosolids quality standards or applicable State biosolids standards, if measured in mg/kg; and

5. Portable toilet waste, where formaldehyde and 1,4-dichlorobenzene are used in deodorizer/sanitizer products. The prohibition of these products shall be implemented within 90 calendar days from the effective date of this Agreement.

G. CONDITIONALLY AUTHORIZED TRUCKED WASTES

DC Water may conditionally accept the following trucked wastes:

1. Grease trap waste – if no blockages or significant grease accumulation in the collection system or other issues arise;

2. Car wash waste – if no blockages or significant solids accumulation in the collection system or other issues arise;

3. Non-hazardous non-domestic waste - if characterized and approved by DC Water in advance;

4. Leachate from domestic landfills – if characterized and approved by DC Water in advance; and

5. Sludge or other residuals - if characterized and approved by DC Water in advance, and no blockages or significant solids accumulation in the collection system or other issues arise.

H. AUTHORIZED TRUCKED WASTES

DC Water will accept the following trucked wastes:

1. Portable toilet waste, where formaldehyde and 1,4-dichlorobenzene are not used in deodorizer/sanitizer products; and

2. Domestic septage.

I. CHARACTERIZATION AND MONITORING OF NEW TRUCKED WASTES

Any Party proposing to accept hauled waster from a new non-domestic source (i.e., those that have not already been approved by DC Water) shall submit a request for approval to DC Water for new discharges of non-domestic trucked waste, landfill leachate, or trucked waste containing sludge or other residuals. DC Water shall respond with a determination on such a request within 30 calendar days. DC Water shall hold Non-Party Users to these same conditions for requesting new discharges of non-domestic trucked waste, landfill leachate, or trucked waste containing sludge or other residuals. The request may include:

1. Analytical data representative of the discharge, including, but not limited to:
   a. pH,
   b. Total Solids,
   c. Total Suspended Solids,
   d. Volatile Suspended Solids,
   e. Biochemical Oxygen Demand,
   f. Total Phosphorus,
   g. Total Kjeldahl Nitrogen,
   h. Total Metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, and zinc),
   i. Total Petroleum Hydrocarbon/Oil and Grease, and
   j. Polychlorinated Biphenyls (PCBs).

2. Estimates of volume and frequency of discharge that DC Water will use to evaluate the effect of the loading on the wastewater and sludge treatment plant processes.
   a. If the sewage strength and/or load impacts warrant consideration of differential treatment cost, this will be negotiated among the Parties.
   b. If the discharge is accepted, periodic monitoring may be required, with frequency and parameters to be agreed upon by the affected Party and DC Water.
   c. If the discharge is prohibited, the limitations of **Subsection F.** apply.

J. TREATMENT PLANT RESIDUALS

Other Wastewater Treatment Plants or Water Treatment Plants within the BPSA shall not directly discharge sludge or other residuals into the Blue Plains sewage system, unless characterized and approved by DC Water in advance.

K. PRETREATMENT PERMITS

1. Significant Industrial Users (SIU) in the BPSA must obtain a pretreatment permit from DC Water, Fairfax, or WSSC, unless the SIUs are regulated through Limited Party Agreements with Non-Party Users or Indirect Users.

2. Permits must contain, at a minimum, effluent limitations that match or exceed DC Water's discharge standards, monitoring and reporting requirements, a statement of duration, a statement of non-transferability, a statement of applicable civil and criminal penalties, and any other conditions requested to be included in the permit by DC Water.

3. Permits shall require immediate notification to DC Water of a spill, slug, or other unplanned emergency discharge (such as decontamination Wastewater) to the sewer at 202-612-3400 (24 hours per day, 7 days a week), and written notification to the DC Water Pretreatment Supervisor within five (5) days following the event, to the:

   DC Water Pretreatment Supervisor
   5000 Overlook Ave., SW, Washington, DC 20032
   202-787- 4177

4. Such notification shall include:
   a. Name and address of the premises where the discharge occurred or is occurring;
   b. The precise location of the discharge at the premises;
   c. Type of waste discharged or being discharged;
   d. Volume and concentration of Wastewater discharged;
   e. Corrective actions conducted or planned to mitigate the incident and prevent reoccurrence; and
   f. Contact name and phone number.

5. Permits shall require immediate notification to DC Water of any changes at its facility affecting the potential for a slug discharge.

6. Permits shall indicate that DC Water has right of entry and inspection of pretreatment and sewer facilities, observation, measurement, sampling, testing, and access to (with the right to copy) all pertinent compliance records located on the premises of the SIU. Whenever DC Water exercises this right, advance reasonable notice shall be given to the Operating Agencies. The Operating Agencies shall make all necessary legal and administrative arrangements for these inspections.

L. REPORTING

1. Quarterly Pretreatment Program Reports

a. Reports shall be due to DC Water 45 days following the last day of the quarter for the 1st, 2nd, 3rd and 4th quarters. However, the 4th quarter report due date may be extended an additional 30 days (if necessary, to allow additional time for completing the annual report).
b. Reports shall be prepared in accordance with a format to be developed by DC Water. For example, report all violations during the quarter, compliance status of each SIU, the date enforcement action is taken or is anticipated to be taken, identify any SIUs with a substantial change in volume or character of pollutants, etc.
c. Each Operating Agency/Jurisdiction shall submit all requested hauled waste documentation to DC Water in the quarterly report. Documentation shall include, but not be limited to:
   1) A current list of haulers (or changes to the list from the previous report), including approved sources (types) of waste, permitted vehicle information, and truck volume for each hauler;

2) Results of all analytical monitoring done on the hauled waste during that quarter (either by the Operating Agency/Jurisdiction or the waste hauler);
3) Where possible, flow estimates or number of loads of each waste type received during the quarter; and
4) If requested, gate records or security camera records, for verification of discharge activity.

2. **Annual Pretreatment Program Reports**
   a. In addition to the quarterly reports, an annual report shall be prepared. However, if the fourth quarter report is expanded to incorporate all the requirements of the annual report noted below, that report will suffice to meet both reporting obligations
   b. Reports shall be prepared in accordance with instructions from EPA Region III. If a Party does not receive 'new or updated' guidance from DC Water by January 5, the same report format/procedures used the previous year shall apply.
   c. The annual report shall include a master list of permitted waste haulers. At a minimum, the list shall include hauler name, contact information, list of vehicles, permitted truck capacities, and permitted waste type. The master list can reference the list provided in the fourth quarter report, as long as it notes any subsequent changes.
   d. Reports shall be due to DC Water 45 days following the last day of the year (i.e., by February 15th), unless an alternate date is established in writing by DC Water.
   e. Reports shall be accurate and complete upon submittal. Allowable exceptions to this include the following:
      1) Significant Non-Compliance (SNC) for the July to December period shall be submitted no later than March 15).
      2) The publication of the SNC violators shall occur no later than June 30, when required, and proof of publication shall be submitted to DC Water immediately following publication.

3. Follow-up comments from DC Water and/or EPA Region III shall be addressed as soon as practicable or as required by a comment letter.

M. ENFORCEMENT

1. The Parties shall, in accordance with their approved Enforcement Response Plans, take escalating enforcement action against any industrial user or waste hauler in the BPSA that violates any provision of the approved DC Water or Parties' pretreatment program. If EPA Region III, or the delegated state agency for the Parties, reviews the enforcement action taken by the Party and requests further action, the Party shall comply with the request or show just cause why such action is not warranted.

2. If DC Water does not agree with a decision made by a Party regarding specific enforcement action against a SIU or waste hauler, the issue shall be raised to the Regional Committee for dispute resolution pursuant to the 2012 IMA.

N. REVISIONS TO LEGAL AUTHORITY

1. DC Water shall forward a copy of proposed revisions to its legal authority (DC Code § 8-105) and/or implementation regulations (21 DCMR Chapter 15), to the Parties prior to or at the time of submittal to EPA Region III. Similarly, whenever the Parties revise their legal authority and/or implementation regulations, they shall forward a copy of the proposed revisions to DC Water prior to or at the time of submittal to their state approval authority. If there are significant changes to the regulations, EPA Region III review and approval may also be required.

2. Adopted Final Rulemaking or regulations shall be submitted to the Parties (or to DC Water, if the Parties adopted new regulations) within 30 days of the adoption date.

3. As necessary, the Parties shall adopt revisions (either directly or by reference) to their Sewer Use Ordinances (SUOs) pertaining to industrial waste pretreatment that are at least as stringent as those adopted by DC Water pertaining to industrial waste pretreatment. Proposed SUO revisions will be forwarded to DC Water within 180 days of receipt of DC Water's Final Rulemaking. If this schedule cannot be met, the Party shall notify DC Water in writing, and provide an alternate due date and reason why the schedule cannot be met. The Party shall then proceed to adopt the final regulations.

4. DC Water shall provide the Parties an opportunity to provide comments prior to making any revisions or additions to its Local Limits. Once DC Water makes any revisions or additions to its Local Limits, the Parties shall adopt any such revisions or additions and incorporate the new limits into all applicable SIU permits as soon as practical following receipt of the Final Rulemaking.

O. COMPLIANCE BY NON-PARTY USERS

DC Water shall require and enforce the same compliance by Non-Party Users, as applicable, with the substantive provisions of Subsections C through M**,** above, as is required of the Parties.

P. PERIODIC REVIEW OF PRETREATMENT AND OPERATIONAL REQUIREMENTS

1. The Regional Committee, as part of the review for its Annual Report, shall consider the efficiency and effectiveness of the practices and procedures of this Agreement. This review will include technical input from any appropriate Regional Committee work group(s). The Regional Committee will also consider, in a timely manner, any concerns that are raised by DC Water or any other Party over these practices and procedures or proposed modifications required by EPA or any state agency.

2. If the Regional Committee determines these requirements, practices or procedures should be modified, the Regional Committee shall recommend to the Leadership Committee any revisions that may be required to this Operating Agreement, the 2012 IMA or any associated Derivative Agreements.

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm the authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

0402 B

City Administrator Date

DC WATER

3/21/13

General Manager Date

FAIRFAX COUNTY, VIRGINIA

3/25/13

County Executive Date

MONTGOMERY COUNTY, MARYLAND

4/3/13

Chief Administrative Officer Date

PRINCE GEORGE'S COUNTY, MARYLAND

4/2/13

Chief Administrative Officer Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

3/20/13

General Manager Date

Approved by Leadership Committee: 4/3/13

Chair **Date**

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: 4/3/13

Chair **Date**

OPERATING AGREEMENT #6

PARTIES' AGREEMENT REGARDING: BIOSOLIDS MANAGEMENT COMMITMENTS

THIS OPERATING AGREEMENT (Agreement), among the **DISTRICT OF COLUMBIA** (the District), the **DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY** (DC Water), **FAIRFAX COUNTY, Virginia** (Fairfax), **MONTGOMERY COUNTY, Maryland** (Montgomery), **PRINCE GEORGE'S COUNTY, Maryland** (Prince George's), and the **WASHINGTON SUBURBAN SANITARY COMMISSION** (WSSC),

Witness:

WHEREAS, the Parties have entered into the Blue Plains Intermunicipal Agreement (2012 IMA); and

WHEREAS, DC Water, Fairfax and WSSC recognize their obligations to comply with all state, federal and local biosolids preparation and land application regulations applicable to the Blue Plains Wastewater Treatment plant (Blue Plains); and the need to remove biosolids from the sewage generated within the Blue Plains Service Area (BPSA); and

WHEREAS, DC Water, Fairfax and WSSC recognize the need to establish operational requirements for the manufacturing of biosolids products at Blue Plains or offsite; and

WHEREAS, the Parties desire to manage the biosolids resource by the most practical, sustainable, environmentally sound, and economically beneficial means;

WHEREAS, the 2012 IMA authorizes and requires the Leadership Committee to set forth specific operational processes and contractual support for biosolids management that they determine are appropriate to implement the provisions of **Section 9** of the 2012 IMA;

WHEREAS, Section 2 of the 2012 IMA authorizes the Leadership Committee to create, modify or terminate an Operating Agreement to implement the terms of the IMA consistent with **Section 11.**

NOW, THEREFORE, the Parties agree as follows:

PURPOSE: The purpose of this Agreement is to address matters relating to **Section 9** of the 2012 IMA. This Agreement confers no rights upon any person other than the Parties to this Agreement.

A. REGULATORY AUTHORITY

The Parties recognize their legal obligations to comply with all state, federal and local biosolids preparation and land application regulations applicable to Blue Plains.

B. REGIONAL COMMITTEE ASSIGNMENT AND REPORTING RESPONSIBILITIES

The Regional Committee shall periodically review and analyze the biosolids management activities of the Parties. The Regional Committee may request the assistance of Party experts and biosolids contractors in performing these analyses. The Regional Committee shall make recommendations to the Leadership Committee to maintain or improve the management of biosolids, including:

1. Utilizing contract mechanisms to handle management of all or portions of the biosolids;

2. Identification of additional land application or other management sites;

3. Working with local and state officials to obtain land application or other management permits;

4. Working with local and state officials to change regulations, legislation, or legal actions that are deemed harmful to the effective and environmentally sound management of biosolids;

5. Requesting support of the Leadership Committee and elected officials as necessary to support these efforts; and

6. Contracting for research that supports the biosolids management activities of the Parties.

C. BIOSOLIDS REUSE AND DISPOSAL OPTIONS – ALLOCATION, MATERIAL RESPONSIBILITY AND CONTRACTS

1. DC Water and WSSC shall independently contract for services related to reuse or disposal (if necessary) of biosolids produced at Blue Plains. The percentage of biosolids reuse and disposal managed by DC Water shall be no less than 50% and no greater than 70%. WSSC will manage the remainder. The percentages within these limits are to be based on a balance between financial and contractual security, and on programmatic needs as determined by the Regional Committee.

2. DC Water and WSSC may also, with concurrence of the Regional Committee, allocate tonnage to a user or a regional entity that has the opportunity to contract for sustainable reuse of biosolids. DC Water and WSSC shall separately issue one or more contracts for the sustainable reuse of biosolids resources for use in agriculture, mine reclamation, silviculture, composting, soil blending, energy production, or any other sustainable and economically feasible technology.

3. Other options, such as landfilling, may also be included in contracts by DC Water and WSSC for backup and emergency purposes or as recommended by the Regional Committee. In all scenarios, the Parties shall meet the biosolids management commitments set forth in the 2012 IMA. The Parties may consider regional contractual coordination, if another entity outside of DC Water is willing and interested in such collaboration. A recommendation in this direction would allow for

diversification of reuse options and geography, but should only be done if it furthers the biosolids commitments in the 2012 IMA.

D. PREPARATION OF CONTRACT SOLICITATIONS

1. DC Water and WSSC shall be responsible for the issuance and administration of their contract solicitations for the reuse of biosolids generated at Blue Plains.

2. The specifications, terms, conditions, and evaluating criteria for any biosolids reuse contract solicitations shall be developed by DC Water and WSSC with input from the Regional Committee.

3. The Regional Committee, either directly or through technical staff, may participate in the review of technical proposals or other contract documents for the hauling and reuse of biosolids received, pursuant to contract solicitations issued by DC Water and WSSC, and make recommendations for award to the respective contracting officers.

E. CONTRACT REVIEW

1. DC Water and WSSC shall each execute contracts awarded pursuant to the contract solicitations. They shall appoint contracting officers for such contracts and, in consultation with the other participating parties, administer all aspects of contract performance in accordance with their respective procurement laws and regulations.

2. With respect to DC Water and WSSC's contracts, the Regional Committee's functions and responsibilities shall include the following:
   a. Provide information, recommendations and requests to the contracting officer to remedy or avoid existing or potential problems caused by any contractors or subcontractors operating within any of the Parties' jurisdictions or caused by their operation in other areas that are or will adversely impact a Party; and

   b. Monitor the performance and administration of all contracts awarded and provide the contracting officer with the recommendations of the other participating jurisdictions on administrative actions that should be taken to protect the interests of such other parties in all such biosolids contracts; and

   c. Receive and assess progress and other relevant reports relating to the performance and administration of all biosolids contracts and reports on proposed actions contemplated by the contracting officers in the administration of such contracts; and

   d. Review research findings funded through the Regional Committee.

F. COST AND PAYMENT

All costs, including administrative costs, of managing the biosolids program will be borne by the Parties and shared based upon the methods and procedures described in **Section 5** of the 2012 IMA. The Parties will receive monthly reports of tonnage allocations to each contract and a final cost accounting at the end of the DC Water fiscal year.

G. EMERGENCY PROVISIONS

1. If any contractors for Blue Plains biosolids reuse and/or disposal service unexpectedly cease operations for any reason, all Parties shall cooperate in order to continue transportation and management of the quantities of Blue Plains biosolids defined in the 2012 IMA and this Agreement.

2. All Parties shall assist in making available, to the extent possible, disposal and reuse options in the region (landfills, incinerators, etc.). If necessary, all Parties shall commit to investigating regional cooperation on biosolids reuse with other parties. This investigation shall include, but not be limited to, other land application programs, composting, incineration, soil blending, etc., and emergency plans shall consider all these options.

3. Separately, or as part of the BPSA Emergency Operating Plan, the Parties shall include emergency back-up contingency plans for removal and transport of biosolids generated at Blue Plains.

H. PRODUCT MARKETING AND REVENUE

1. DC Water will produce into the foreseeable future a Class B stabilized biosolids cake products, as well as a Class A biosolids cake suitable (with further conditioning or mixing) for marketing. DC Water and WSSC shall market and reuse this material for all of the Parties in a manner advantageous to DC Water, Fairfax and WSSC. This marketing will promote the product's use and, if successful, will generate revenue. Potential products from the Blue Plains biosolids program include compost, blended soil, dried product, green energy/carbon credits, and electrical power. DC Water and WSSC will use all revenue to first offset biosolids program and, then, Blue Plains' operating costs thereby reducing costs for all Parties.

2. Each Party shall provide data monthly regarding the revenue or credits generated by DC Water and WSSC. At the end of each fiscal year, DC Water and WSSC shall calculate annual totals for each product, and calculate the percentage of each product for which each Party may take credit. These credits are not for monetary purposes (as the revenue will be used to offset biosolids program costs) but for the purposes of informing rate payers and regulators of efforts to produce valuable products, clean energy, and carbon credits.

3. DC Water and WSSC shall separately be responsible for preparing, negotiating and managing all contracts and agreements related to the sale or use biosolids products. Other products such as steam, electricity, and/or carbon/renewable energy credits produced at Blue Plains shall be managed by DC Water.

4. The Regional Committee shall cooperate in these distribution and marketing efforts with the DC Water biosolids manager to determine if there are markets and/or distribution points in their respective jurisdiction. The region has many potential uses for a Class A biosolids product, and the Parties shall work to maximize reuse within the BPSA. All users will work to inform end-users of the benefits and limited risks of using these products.

5. DC Water shall develop an agency-wide carbon footprint model and establish a baseline for registration with a certified entity. This model will be updated and audited, as necessary, to maintain certification. As improvements occur at Blue Plains (digesters, fine bubble diffusers, energy efficiency projects, etc.) the DC Water carbon footprint will shrink, possibly making carbon credits available for sale or trade. The production of energy from a renewable source (biosolids) may also make available Renewable Energy Credits (REC's) for sale or trade.

-END OF PAGE-

EXECUTION

This Agreement is executed on behalf of the Parties by the Members of the IMA Leadership Committee who, by affixing their signatures, confirm the authorization of their respective Party to be bound thereby. It shall be effective on the date indicated by the Chair below.

DISTRICT OF COLUMBIA

04/02/13
City Administrator Date

DC WATER

3/21/13
General Manager Date

FAIRFAX COUNTY, VIRGINIA

3/25/13
County Executive Date

MONTGOMERY COUNTY, MARYLAND

4/3/13
Chief Administrative Officer Date

PRINCE GEORGE'S COUNTY, MARYLAND

4/2/13
Chief Administrative Officer Date

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND

3/20/13
General Manager Date

Approved by Leadership Committee: 4/3/13
Chair **Date**

All Parties have been notified, 60 days have passed from notification, no objection has been made by any Party, this Agreement is, therefore,

EFFECTIVE: 4/3/13
Chair **Date**

Case Study #2: Philadelphia CSO LTCP
Attachment 2-1
PWD's 2009 FCA

11 FINANCIAL CAPABILITY

11.1 INTRODUCTION

The United States Environmental Protection Agency (US EPA) suggests that a financial capability assessment should be included in the CSO Long Term Control Plan (LTCP) in order to establish the burden of compliance on both ratepayers and the permittee. The assessment in this section follows the guidelines and methodology as described in the US EPA's "Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development," published February 1997. The purpose of the financial capability assessment is twofold.

First, the affordability process contemplates balancing the pace of environmental improvement with the financial and economic capability of the permittee. The process allows flexibility in scheduling completion of CSO compliance measures, based on the financial capability of the area served. Second, a financial capability can support the determination of funding needs by agencies providing loan and grant monies for capital projects.

The financial capability assessment is a two phased process. The residential indicator is the percentage of median household income (MHI) expended on wastewater management. The financial capability indicator is an assessment of the permittee's debt burden, socioeconomic conditions, and financial operations. These two measures are subsequently entered into a financial capability matrix, suggested by US EPA, to determine the level of financial burden that the existing wastewater management system and the CSO control measures will place on residential customers and the permittee. The US EPA matrix appears in Table 11-8 at the end of this section.

In addition to following guidelines for these two measures, US EPA encourages inclusion of any information that would have a financial impact on CSO compliance by the permittee in the capability report. This assessment, therefore, includes extensive discussion of socioeconomic trends in the Philadelphia area because of the financial challenges that the City and the region faces.

11.2 PHASE 1 - CALCULATION OF THE RESIDENTIAL INDICATOR

PWD has projected future revenue requirements and associated rates, taking into account current and future costs to operate, maintain, and replace the PWD's system, currently outstanding debt service, and future debt service resulting from anticipated and identified capital improvements. The focus for evaluating the impact of the residential indicator is the next 20 years (FY 2029)[1], however it is anticipated that elements of the LTCPU implementation program will continue well beyond this 20 year timeframe.

PWD has developed its financial projections consistent with the manner in which it develops rate projections, with expenses, revenues and capital costs stated in future year dollar terms

1 The City of Philadelphia's fiscal year runs from July 1st through June 30th.

(*i.e.*, inflated to the future year). Thus, household bills in 2015 (for example), reflect what PWD estimates households are projected to pay in that year. For purposes of the affordability analysis, these future household rates are compared to projected household incomes (also projected to future year dollars) in those specific years. The approach keeps all cost figures on a consistent basis and provides PWD with a realistic picture of actions required to raise needed revenue and comply with its ultimate requirements.

In developing these projections, PWD has sought to estimate the future burden of the LTCPU in addition to the full utility system's long term needs for wastewater and water service, as currently understood. Although PWD provides both water and wastewater (including stormwater) service, they have traditionally maintained separate water and wastewater rates, in accordance with standard cost-of-service criteria. PWD has evaluated the impact of the LTCPU by estimating those capital and operation and maintenance (O&M) costs in conjunction with an estimate of other costs anticipated to be incurred by the utility over the next 20-plus years. The associated rates for wastewater and stormwater are then estimated on an average household basis. The residential indicator is based on that average annual cost per household relative to projected MHI for each year over the forecast period.

11.2.1 Key Assumptions

The key assumptions used to develop these projections are:

- The combined sewer area is located within the City limits of Philadelphia, therefore the determination of the residential indicator is based on the retail cost of wastewater service for households in the City of Philadelphia served directly by PWD. The cost of contract sales to wholesale customers outside of the City is anticipated to increase in response to increased costs of service for non-LTCPU related activities
- The projected average growth in MHI is 2.29%. Since 1989, MHI in Philadelphia has grown at a rate which is below both those of the state (2.94%) and national (3.18%) levels. This appears to be a consistent and long-term trend resulting from structural elements of the Philadelphia's demographic and economic makeup, rather than just being the result of cyclical or outlying occurrences. Metered sales (for water/wastewater customers) and associated billable discharges to the wastewater system have been trending downward (*e.g.*, billed water consumption declined approximately 5.4% for FY 2000 to FY 2008). To provide for a conservative estimate, the residential indicator projections assume that consumption will stabilize at current levels
- Costs associated with O&M (including labor and materials) are anticipated to grow at rates experienced in recent years. The costs for O&M of PWD's existing wastewater system are estimated to increase at 4.7% per year throughout the planning period. The inflation rate for the O&M costs for LTCPU related projects is projected to be 3.87%
- Future costs for capital projects are inflated at an annual rate of 3.87%. For the most recent 10 year period, the Engineering News Record City Cost Index – Philadelphia construction cost index and the building cost index have increased at an average annual rate of 4.1% and 3.9% respectively

- The PWD's capital improvement program for non-LTCPU related projects reflects continued investments in facility upgrades and replacements throughout the entire system. The estimated costs for the non-LTCPU capital improvements are approximately $3.7 billion (water and sewer - 2009 dollars) through Philadelphia's FY 2029 (ending June 30, 2029). The primary capital expenditures generally consist of the following: improvements to water and wastewater treatment plants; rehabilitations and replacement of water mains; rehabilitation and replacement of old sewers and construction of new sewers to relieve unsanitary conditions; and construction of new storm flood relief sewers and storage tanks
- PWD assumes the funding for its capital program will be financed primarily through the issuance of revenue bonds through the municipal bond market, supplemented through PennVest financings. PWD will also utilize pay-as-you-go funding and, to the extent available, miscellaneous grants. Best practices vis-à-vis the municipal bond market requires that PWD's capital debt be structured with various interest rates and maturities. Therefore, rather than specifying an assumed interest rate and bond duration, PWD's Financial Capability analysis utilizes long term experience in defining an annual cost per unit of principal borrowed. PWD has determined that a capital cost factor of 8.059% is appropriate. Costs of O&M associated with the LTCPU were synchronized with the implementation schedule and with escalation factors generally resembling historical cost escalation for PWD's overall O&M program
- Revenue projections for this financial capability assessment rely on PWD's existing cost-of-service based rate structure with forecast revisions reflecting the proportional increase in wastewater and stormwater costs due to implementation of the LTCPU as well as a continuation of the non-rate revenues the City currently generates

As detailed in Section 10 of this report, PWD is proposing green infrastructure with targeted traditional infrastructure as its preferred alternative. The recommended plan seeks to reduce CSO frequency and volume through a range of land-based stormwater management techniques or source controls. As described in previous sections, this option will be implemented in stages through 2029. The total capital need for the LTCPU program is $902 million (Table 11-1), and the total O&M need through 2029 for the LTCPU as it is implemented is $98 million, both stated in 2009 dollars.

The LTCPU capital program will be implemented within the context of PWD's overall capital improvement program, also summarized in Table 11-1. Total capital expenditures through 2029 of approximately $4.6 billion (2009 dollars) for improvements to the water and wastewater systems are projected. Of these projected capital expenditures, around $3.4 billion or 73 % are projected for wastewater and wet weather; including $902 million for the implementation of the recommended LTCPU through 2029. The remaining projected wastewater expenditures go towards system renewal, replacement, rehabilitation and improvements necessary for adequate and compliant services.

PWD assumes the continuation of its ongoing program related to water main and sewer rehabilitation and replacement and treatment plant upgrades throughout the 20 year period. PWD will also pursue an aggressive storm flood relief program that is intended to be completed within the next decade. The cost of that program is not included in the estimate

Table 11-1 PWD Capital Improvements Program (in billion $) 2010-2029

Capital Program	Present Dollar Value (2009 Dollars)
Water Treatment and Distribution	$1.22
Wastewater Treatment and Collection	$2.12
Storm Flood Relief	$0.36
Long Term Control Plan	$0.90
Total Capital Cost	**$4.60**

for the LTCPU, although it is expected to have a beneficial impact on the City's ability to manage wet weather flows in the future.

11.2.2 Projected Revenue Requirements and Rate Impacts

For FY 2009 through FY 2029, the annual revenue requirement for PWD's wastewater system is expected to increase by about $720 million, from approximately $350 million to $1.07 billion in 2029. Annual wastewater system debt service in 2029 is projected to be approximately $366 million. This amount compares to current (2009) annual wastewater system debt service costs of approximately $130 million.

PWD is empowered and required under the Philadelphia Home Rule Charter to establish rates for water, wastewater and stormwater at levels that provide sufficient revenue to meet all operating expenses of the water, wastewater and stormwater systems, including interdepartmental charges for services provided to the PWD, and debt service requirements on all obligations issued for the PWD, including specific bond ordinance covenants.

PWD estimates that the typical household in the City currently pays approximately $400 annually for wastewater services, including stormwater. The most recently available U.S. Census data for MHI in Philadelphia is $35,431 for 2007. Based upon the projected annual MHI growth of 2.29%, the estimated 2009 MHI would be $37,072. PWD customers are currently (2009) paying approximately 1.10% of their income for wastewater charges. In addition to the general rates, special rates are applicable to certain properties or customer groups as prescribed by ordinance. Charges are also administered for municipal fire protection and private fire protection and for industrial dischargers of high strength wastewater. Service to customers located outside the City is on a wholesale basis through contracts with various municipalities, authorities and townships. Each wholesale contract has been negotiated on a case-by-case basis, and has a different cost structure and variations in the method for adjusting those wholesale charges to reflect changes in their cost of service.

Under the US EPA guidance, a key measure of affordability is the residential indicator: the ratio of the wastewater cost per household to MHI. The residential indicator is compared to US EPA-defined criteria to determine whether costs impose a low, mid-range, or high impact on residential users. Table 11-2 shows US EPA's residential indicator criteria, which define a "low" impact as a cost per household less than 1.0% MHI, a "mid-range" impact between 1.0 and 2.0%, and "high" impact as greater than 2.0% of MHI.

Table 11-2 US EPA Residential Indicator

Residential Indicator	Cost per Household
Low	Less than 1.0% of MHI
Mid-Range	1.0-2.0% of MHI
High	Greater than 2.0% of MHI

Implementation of the PWD's LTCPU projects along with other necessary wastewater system capital improvements require wastewater system rates to be increased at an annualized rate of approximately 6.18%. The cumulative effects of these increases are shown graphically on Figure 11-1. The primary measure of the affordability (wastewater cost as percent of MHI), the residential indicator, is currently around 1.1%. The residential indicator is expected to rise to approximately 2.27% by 2029); based upon projected average annual household wastewater costs of approximately $1,321 and a projected MHI of approximately $58,305. As may be noted in Figure 11-1, the cost, demographic and economic trends will result in continued increases in the percentage of household income to be expended on wastewater services well beyond 2029.

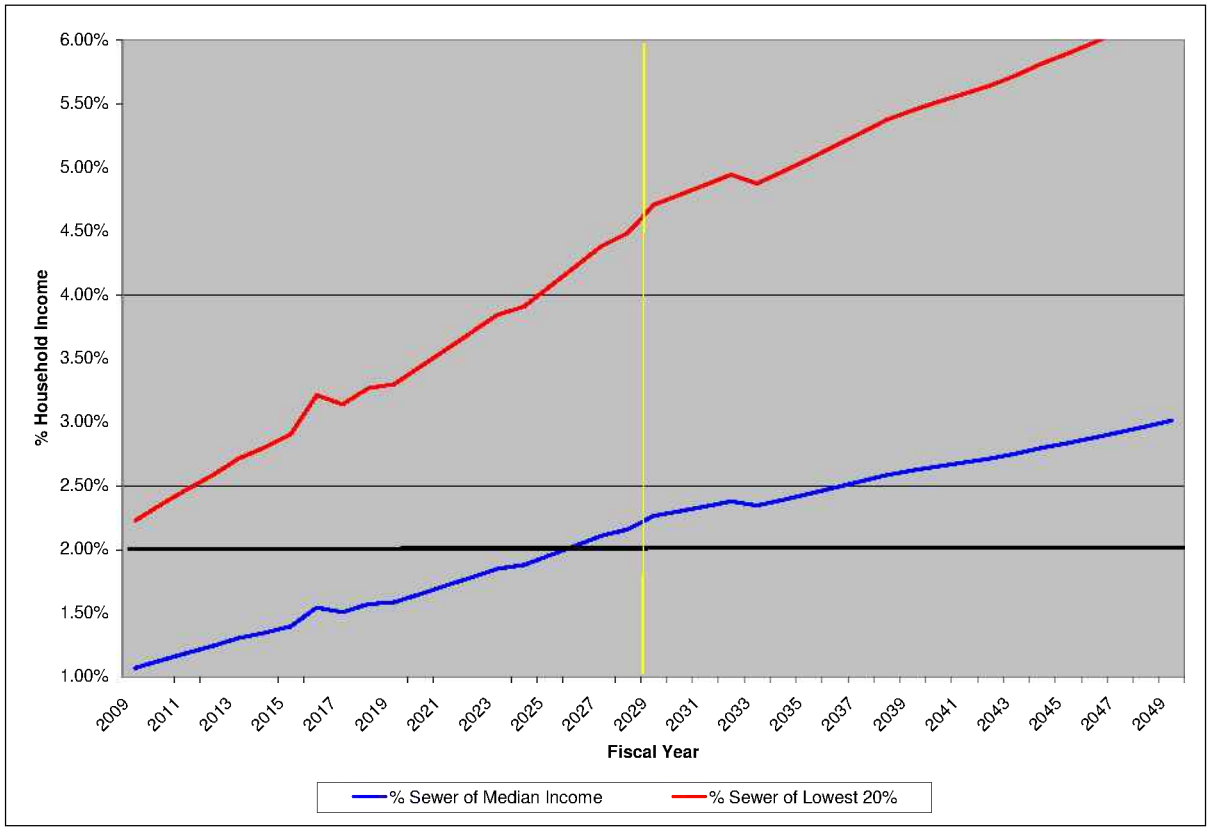


Figure 11-1 Residential Indicator, 2009-2029 Recommended Plan, 2009-2020 Implementation

US EPA's residential indicator is based upon the City's MHI. By definition, one half of the households (approximately 279,000) have household incomes that are less than the current $37,072 median and will be less than the $58,305 MHI that is projected for 2029. At an average of approximately 2.5 residents per household, the lower half of the MHI population for the City would total approximately 698,000. Therefore, a group that would comprise the 16th largest cities within the U.S., (exceeding major cities such as Boston, Baltimore, Washington D.C., and Seattle), would be paying more than 2.27% of their incomes for wastewater services in 2029.

The financial impact of the LTCPU implementation and other LTCPU costs on the lower income population of Philadelphia will be significant. The projected 2029 MHI for the lowest 20% MHI group is less than $38,000. This group would be paying between 3.5% of their MHI (upper limit of the second quintile) to 7.0% MHI (first quintile) in 2029. This group includes around 158,000 households representing a population of around 396,000. This number is larger than the populations of major cities such as Cincinnati, Minneapolis, Honolulu, Pittsburgh, and Toledo. The disparate impact of the implementation of the LTCPU and other necessary wastewater capital improvements upon the City's varying income areas is shown on Figure 11-2. The map shows the projected Residential Indicators for the 368 census tracts within the City of Philadelphia in 2029.

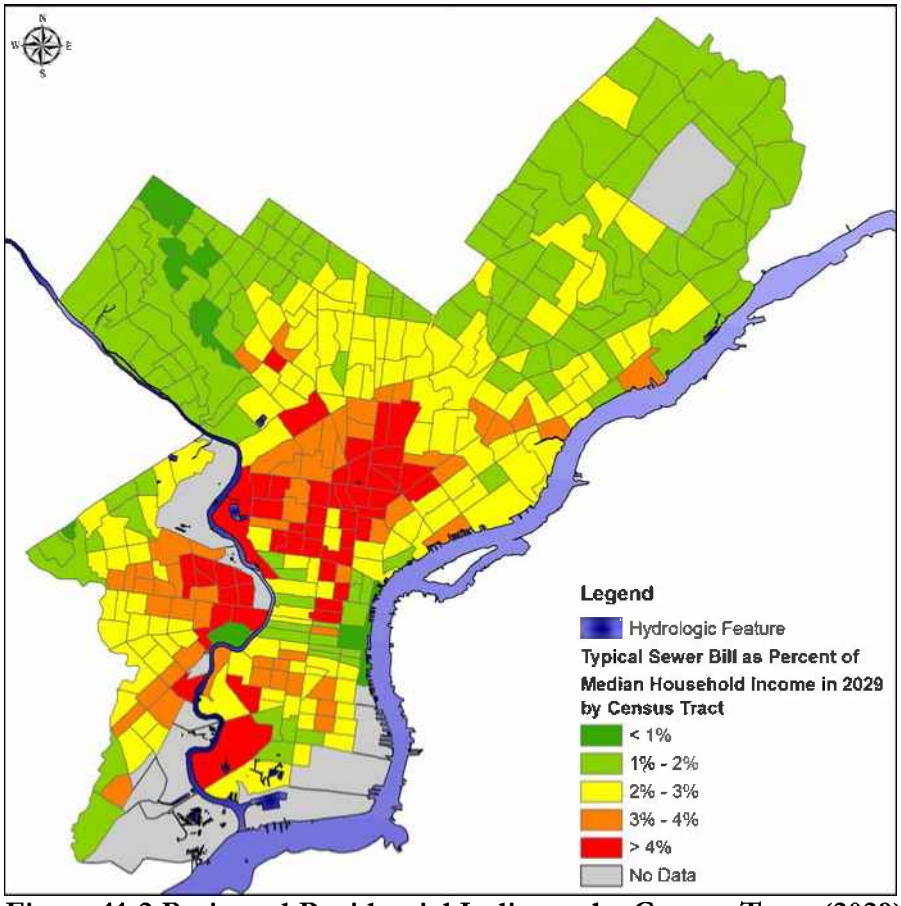


Figure 11-2 Projected Residential Indicator by Census Tract (2029)

11.2.3 Financing Assumptions

The projections of burden and the residential indicator are sensitive to assumptions regarding debt financing. PWD has traditionally funded its capital programs with a combination of traditional debt (revenue backed bonds), existing reserve funds, grant funding (when available), and the state revolving fund (PennVEST). Although this combination of funding mechanisms may continue to be available, it is assumed that the predominant funding source will be traditional debt (revenue bonds issued through the municipal bond market) supplemented by pay as you go funding and limited grants.

11.2.4 Grant Availability

Although PWD will pursue available grant programs, the financial analysis does anticipate grant funding for CSO controls. The amount of grant funding that may become available is expected to be relatively minor in comparison to the projected capital expenditures for the LTCPU.

11.3 PHASE 2 - CALCULATION OF PERMITTEE FINANCIAL CAPABILITY INDICATORS

The second phase of the financial capability assessment - calculation of the financial capability indicator for the permittee – includes six items that fall into three general categories of debt, socioeconomic, and financial management indicators. The six items are:

- Bond rating
- Total net debt as a percentage of full market real estate value
- Unemployment rate
- MHI
- Property tax revenues as a percentage of full market property value
- Property tax revenue collection rate

Each item is given a score of three, two, or one, corresponding to ratings of strong, mid-range, or weak, according to US EPA-suggested standards. The overall financial capability indicator is then derived by taking a simple average of the ratings. This value is then entered into the financial capability matrix to be compared with the residential indicator for an overall capability assessment). Table 11-3 contains the six criteria and the ratings that categorize the permittee as strong, mid-range, or weak in each category. Shaded areas of this table indicate the City of Philadelphia's position in each category. Indicators with shading in two ratings such as the bond rating category reflect a score between the two ratings. A discussion of each item follows.

Table 11-3 US EPA Permittee Financial Capability Indicator Benchmarks

Indicator	Strong	Mid-Range	Weak
Bond rating	AAA-A (S&P) or Aaa-A (Moody's)	BBB (S&P) Baa (Moody's)	BB-D (S&P) B-C (Moody's)
Overall net debt as a percent of full market property value	< 2%	2% to 5%	> 5%
Unemployment rate	> one percentage point below the national average	± one percentage point of national average	> one percentage point above the national average
MHI	More than 25% above adjusted national MHI	± 25% of adjusted national MHI	> 25% below adjusted national MHI
Property tax revenues as a percent of full market property value	< 2%	2% to 4%	> 4%
Property tax collection rate	> 98%	94% to 98%	< 94%

(Blue areas indicate City of Philadelphia ratings)

Bond Rating – Indicator 1

General obligation debt, which is debt backed by the full faith, credit, and taxing power of the City of Philadelphia, has been rated by Moody's Investors Service at Baa1, by Standard & Poor's Corporation at BBB, and by Fitch Investors Service at BBB+.

The PWD issues debt pursuant to the City's Restated General Water and Wastewater Revenue Bond Ordinance of 1989 ("General Ordinance"), which superseded the General Water and Wastewater Revenue Bond Ordinance of 1974 ("Prior Ordinance"). PWD's debt is a special obligation of the City, secured along with previously issued water and wastewater revenue bonds, by a pledge of and security interest in all project revenues established in various funds and accounts, all as defined in the General Ordinance.

PWD's debt is currently rated as A3 by Moody's Investors Service, A by Standard and Poor's and A- by Fitch.[2] Based on the current credit rating of the City and PWD the overall bond rating is between strong and mid-range.

Net Debt as Percent of Full Market Value – Indicator 2

Total net debt includes overlapping debt, which is the indebtedness of the School District of Philadelphia and the City of Philadelphia General Bonded Debt in addition to the City of Philadelphia. School District debt totaled $2,634 million and bonded debt totaled $4,136 million on June 30, 2008, for total overlapping debt of $6.77 billion. The percent of total net debt to full market value was 37.30%. The calculation of the above percentage is based on a deduction of $255.7 million in sinking fund monies from outstanding debt. Self-sustaining debt (*i.e.*, revenue-backed bonds) are also excluded from total debt outstanding. Overall net debt as a percent of full market property value places the City of Philadelphia in the weak range on this measure.

[2] Source: OFFICIAL STATEMENT relating to $140,000,000 City of Philadelphia, Pennsylvania Water and Wastewater Revenue Bonds, Series 2009A (page 59)

Unemployment Rate – Indicator 3
The unemployment rate for the City of Philadelphia was 7.2% in 2008. The unemployment rate for the Commonwealth of Pennsylvania in 2008 was 5.4%, and the national rate for 2008 was 5.8%.

According to US EPA guidelines, a local variance of greater than 1% from the national rate indicates a weak financial capability. Philadelphia maintained an unemployment rate greater than 1% of the national average for the year 2008. Most recent data from the Department of Labor, Bureau of Labor Statistics shows the unemployment rate for Philadelphia to be as high as 9.7% in March 2009, its highest rate since 1993 and remaining ahead of the state and national averages.

MHI – Indicator 4
The most recent data (2007) from the Census Bureau estimate Philadelphia's MHI to be $35,431. US EPA guidelines suggest that a variance of greater than 25% below the national MHI figure constitutes a weak rating. Pennsylvania's MHI estimate was $47,913 and the national estimate was $50,007 over the same period of time, percent differences of nearly 32 and 36%, respectively.

Property Tax Revenues as a Percent of Full Market Property Value – Indicator 5
The City of Philadelphia assessed valuation is 29.22% of the full market value of real estate. A tax of 33.05 mills is levied on the assessed valuation. Therefore, the property tax levy is 3.305% of assessed valuation, or approximately 1.0% of full market value set by the State Tax Equalization Board. The projected full market value for 2008 was $41.67 billion. The result shows current year real estate collections to be approximately 0.85% of full market value. Table 11-4 shows assessed valuation, full markets value, tax levy and current year tax collections for real estate taxes.

The US EPA financial capability assessment makes no provision for measuring a local tax burden other than the real estate tax. This gives Philadelphia an artificially strong rating in the property tax revenues as a percent of full market value category.

However, the City of Philadelphia is somewhat unique in that real estate collections are not its primary source of income. The earned income tax levied by the City comprised 23% of the operating revenues in FY 2008, while the property tax only accounted for 6% of revenue. The City's current earned income tax rate is 4.22% of residents' wages. Although real estate taxes are comparatively low, Philadelphia taxpayers are heavily burdened by other local levy, including a Philadelphia sales tax.

Analysis by a Pew Foundation study[3] documents that the total tax burden per household in Philadelphia are about double the average for comparable large cities. For a family of three earning $50,000 annually, the tax burden in Philadelphia is 17.3% compared to the large city average of 8.8%. The total tax burdens for ten cities in the Pew study are shown on Table 11-5.

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[3] Philadelphia 2009 – The State of The City. The Pew Charitable Trusts – Philadelphia Research Initiative; page 13 (http://www.pewtrusts.org)

Table 11-4 City of Philadelphia, 2003-2008 Adjusted Real Estate Valuation, Real Estate Taxes Levied, and Collection Rates (in millions $)

Year	Total Taxable Assessed Valuation	Full Market Value based on State Tax Equalization Board	Adjusted Gross Real Estate Taxes Levied	Amount Collected in Year of Levy	Current Year Property Tax Revenue Collection Rate	Real Estate Tax Collected as Percent of Full Market Value
2008	12,175	41,667	391.1	355.901	91.0%	0.85%
2007	11,615	39,696	391.1	347.5	88.9%	0.88%
2006	11,431	39,600	385.6	339.6	88.1%	0.86%
2005	11,032	37,153	373.5	350.3	93.8%	0.94%
2004	10,946	36,856	372.5	340.9	91.5%	0.92%
2003	10,621	35,384	359.4	326.8	90.9%	0.92%

Source: Pennsylvania State Tax Equalization Board, FY 2008 CAFR, and City of Philadelphia Yearly Supplemental Reports

Table 11-5 Comparison of Large City Tax Burdens (Family of Three with $50,000 Income)

City		Tax Burden	% Income
1	Philadelphia	$8,629	17.3
2	Baltimore	$7,105	14.2
3	Detroit	$6,180	12.4
4	Columbus	$5,589	11.2
5	Houston	$4,398	8.8
6	New York	$4,259	8.5
7	Boston	$3,892	7.8
8	Washington	$3.590	7.2
9	Chicago	$3,547	7.1
10	Phoenix	$3,403	6.8
	Average	**$4,423**	**8.8**

Source: Philadelphia 2009 – The State of The City The Pew Charitable Trusts – Philadelphia Research Initiative; page 13 (http://www.pewtrusts.org)

The residential indicator is a national screening parameter and does not account for localized factors which erode the effective household income. The high total tax burden facing Philadelphia households reduces their effective household income. Consequently, measuring the household burden imposed by wastewater costs as a percentage of the MHI (estimated in 2009 to be $37,072 and projected to be $58,305 in 2029) may underestimate the financial burden of the projected wastewater costs per household. As was noted in an analysis of the impacts of CSO controls in the Boston region:

> *"The greater are the costs of other necessities as a share of MHI, the greater will be the economic burden associated with sewer charges equal to a given percent of MHI."* [4]

[4] Assessment of the Economic Impact of Additional Combined Sewer Overflow Controls in the Massachusetts Water Resource Authority Service Area (page 13) prepared by Robert N. Stavins, Genia Long, and Judson Jaffee. Analysis Group Incorporated, August 2004.

The impacts of the tax burden in Philadelphia are further exacerbated by the relatively high cost of living in Philadelphia. The American Chamber of Commerce Researchers Association Cost of Living Index for Philadelphia was 1.249 in 2006[5] (*i.e.*, the cost of living in Philadelphia is approximately 25% higher than the national average). The estimated U.S. MHI in 2009 is approximately $52,500 or 41% higher than the Philadelphia MHI. Thus, the household at the median Philadelphia income faces costs of living that are 25% higher than the national average while earning an income that is about 71% of the national median income.

Property Tax Collection Rate – Indicator 6
Real estate tax collections had shown a pattern of increase since the rate was lowered to 34.74 mills on assessed valuation in 2003, however, the collection rate dropped below 90% for 2006 and 2007. The US EPA criterion for a strong rating in this category is a collection rate of more than 98%. Philadelphia's rate is estimated to be 91%, which places it in the weak range for real estate tax collections.

Summary of the Six Municipal Financial Capability Indicators
The City of Philadelphia received a financial capability rating of 1.58, according to the scores on the six items included in the assessment. This is based on a strong-to-mid-range rating of "2.5" on its bond rating; weak ratings of "1" on overall net debt as a percent of full market property value, unemployment rate, MHI, and property tax collection rate; and the strong rating of "3" on its property tax revenues as a percent of full market value of real estate. The 1.58 rating represents the simple average of those scores.

11.4 ADDITIONAL SOCIO-ECONOMIC TRENDS IN THE PWD SERVICE AREA

In addition to following US EPA guidelines for completion of the financial capability assessment matrix, a discussion of socioeconomic trends in the PWD service area is essential to the consideration of scheduling and compliance levels with CSO guidelines. Approximately 70% of the service area population consists of City of Philadelphia residents, and neighboring counties served are limited in the flows that can be sent to PWD's wastewater treatment plants. Therefore, this discussion includes socioeconomic trends in Bucks, Delaware, and Montgomery Counties, but it is focused primarily on demographic and employment conditions and projections for Philadelphia.

Philadelphia's Demographic and Economic Trends
This section advances an analysis of demographic and economic changes that have taken place in Philadelphia and the surrounding suburban counties during the years 1980 to 2008 and for the forecast period of 2010 to 2035. Emphasis is placed upon demographic and economic changes as they impact Philadelphia County. Demographic and economic trends that are analyzed include population, age of population, the number of households, household composition, and income levels.

5 American Chamber of Commerce Research Association Cost of Living Index, http://www.coli.org.

Population

Population levels are a significant indicator in any analysis of demographic and economic changes. Philadelphia's population is depicted in Table 11-6 for the historic period 1980 through 2007 and the forecast period of 2010 through 2035. During the period 1990 to 2000, the population of Philadelphia decreased significantly from 1,585,577 to 1,517,549, a 4.5% decline. As illustrated in Table 11-6, the Delaware Valley Regional Planning Commission (DVRPC) has projected a small increase in the City of Philadelphia's population for the forecasted period 2010-2035. However, most recent census data indicates that the City's population has continued its dramatic decline with a currently estimated population of 1,454,382. Therefore, unless there is a reversal of this trend, the estimated projections for the year 2035 would need to be adjusted significantly downward. In this event, the PWD would anticipate a reduction in the number of residential customers and a corresponding increase in the burden on the remaining households. The Philadelphia County population trend is a reasonable basis for predicting that residential demand for wastewater service in Philadelphia County is not likely to increase significantly during the forecast period.

Table 11-6 Philadelphia County Population Levels 1980-2035

1980 Census	1,688,210
1990 Census	1,585,577
2000 Census	1,517,549
2005 – 2007 Census Estimate	1,454,382
2010 Forecast	1,475,613
2020 Forecast	1,474,268
2030 Forecast	1,478,065
2035 Forecast	1,480,023

Source: DVRPC, Analytical Data report "Regional, County, and Municipal Population and Employment Forecasts, 2005-2035," July 2007

Minority Population

The proportion of minority population in the PWD service area varies between 8.9% in Bucks County and 57.3% in Philadelphia based on most recent Census data. Philadelphia's minority population is over 31% higher than the national average and over 41% higher than the state average. A portion of that population experiences lower incomes, slower growth in income, and greater difficulty meeting the increased burden of utility costs.

Age of Population

The age of the local population is also a significant factor in this analysis. In this regard, it should be noted that in 1980, approximately 14% of all Philadelphians were 65 years of age or older (elderly), and in 1990 the number rose to 15.2%. In 2000, the percentage of elderly in the local population decreased to 14.1%, and the most recent data estimate a 13.0% elderly population. The national average is estimated to be 12.5%, so despite the decrease in elderly population within the City, it still remains above average.

An increase in the elderly population is evident in the suburban counties served by the permittee. The elderly population in the surrounding counties increased from 13.8% to

14.3% during the 1990 to 2000 time period. According to the DVRPC[6], based on population forecasts and the current age distribution, the percent of elderly within Philadelphia and its surrounding communities will increase to roughly 19% of the population by 2025. The DVRPC estimates that the elderly population within Philadelphia will be around 15%, and as high as 22% in Bucks County. As the baby boomer generation ages, the percentage of elderly should increase dramatically.

This trend of the locally aging population is alarming since there appears to be a historic positive correlation in Philadelphia between the percentage of the elderly population and the percentage of the population living in poverty. This is evident in Philadelphia County, based upon population and demographic trends observed between 1970 and 2000. Along with the increased percentage of elderly population, the number of residents living in poverty went from just less than 12% to more than 22%.[7]

It can be reasonably projected, based on the foregoing, that the permittee's customer base will consist of an increasing number of elderly persons, who in many instances are living on limited incomes. Further, an aging customer base indicates limits on future economic expansion.

Number of Households

Another significant factor in this analysis of demographic and economic trends is the number of established households in Philadelphia County. In 1980, 1990, and 2000, there were 634,665, 600,740, and 590,238 households in Philadelphia, respectively. Most recent Census data estimates 557,985 households. The consistent decrease in the number of households is not surprising given the general decline in Philadelphia's population. However, this trend is more alarming when viewed in conjunction with the changes in local household composition, addressed in the following section. These factors suggest that significant income growth in Philadelphia will be unlikely during the forecast period.

Household Composition

Family households in Philadelphia numbered 352,331 in 2000, compared to 378,048 in 1990 and 415,891 in 1980. In 2000, 189,291 such households were headed by two parents, compared to 227,187 in 1990 and 280,619 in 1980. The number of female-headed households in this mix was 131,332 in 2000, compared to 122,370 in 1990 and 113,489 in 1980. This is significant because two parent households tend to have higher incomes than non-family households and family households headed by single parents[8]. Illustrative of this point is in the 12 months prior to the last census estimates, 34% of female-headed families in Philadelphia were below the poverty line compared to only 8.5% of married couple families.

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6 DVRPC, "The Aging of the Baby Boomers: Elderly and Near-Elderly Population Characteristics," January 2007.

7 In this same context, it should be noted that a significant percentage of children in Philadelphia County live in poverty. In 2006, roughly 35 percent of all children in Philadelphia lived in poverty. This is also an indicator that many households served by the permittee operate under severe economic constraints at present.

8 US Census Bureau, "Income, Poverty, and Health Insurance Coverage in the United States: 2007."

As noted previously, recent trends reflect a drop in total number of households, which includes an 18% decrease in family households. However, most recent census data estimates that the decrease in the number of married couple families is over 16% since 2000, while the female-headed households have barely dropped 10%. Combined with an increase in non-family households of nearly 17%, the result is a proportional increase in households with historically lower earning potential.

Taken together with the above average population of elderly in the service area, these household composition trends do not forecast significant income growth. An examination of the historical and recent income levels further illustrates this point.

Income Levels

Personal income per capita in Philadelphia decreased from $17,430 in 1990 to $16,509 in 2000, compared to a regional increase from $18,383 to $27,789 over the same period of time. Recent census estimates show that Philadelphia's per capita income has increased to $19,875, still significantly lower than the regional and national per capita income estimates of $34,019 and $26,178, respectively. Despite the increase in per capita income, 16.5% of the families in Philadelphia, including 136,277 households, must sustain themselves on incomes below $15,000.

As shown in Figure 11-3, MHI in Philadelphia has significantly lagged behind the national level since the 1970s. Since 1989, MHI in Philadelphia has grown at a rate which is below both those of the state (2.94%) and national (3.18%) levels. This appears to be a consistent and long-term trend resulting from structural elements of the Philadelphia's demographic and economic make-up, rather than being the result of cyclical or outlying occurrences. It is reasonable to expect that this trend in income levels and growth will continue into the future.

From 1990 to 2000, the percentage of all persons with incomes below the poverty level in Philadelphia increased from 20.3% to 22.9%. This trend has continued with the most recent census figure at 24.5%. Given the local increase in unemployment due to the recent economic climate, it is possible that in the near future the number of Philadelphians living in poverty could increase dramatically.

Employment Trends in Philadelphia

Future income growth in Philadelphia is dependent upon prospective economic trends, driven in large part by employment. The affordability of PWD's LTCPU is tied to such economic trends.

The data assembled by the DVRPC in their study entitled "Regional, County, and Municipal Population and Employment Forecasts, 2005-2035", indicates that Philadelphia will experience minimal growth in employment during the forecast period. This estimate focuses on long-term trends and assumptions, and should be evaluated with actual data as available to address any potential long-term shifts that may occur due to the current economic climate and eroding job market. The projected changes in job numbers by employment sector for Philadelphia appear in Table 11-7.

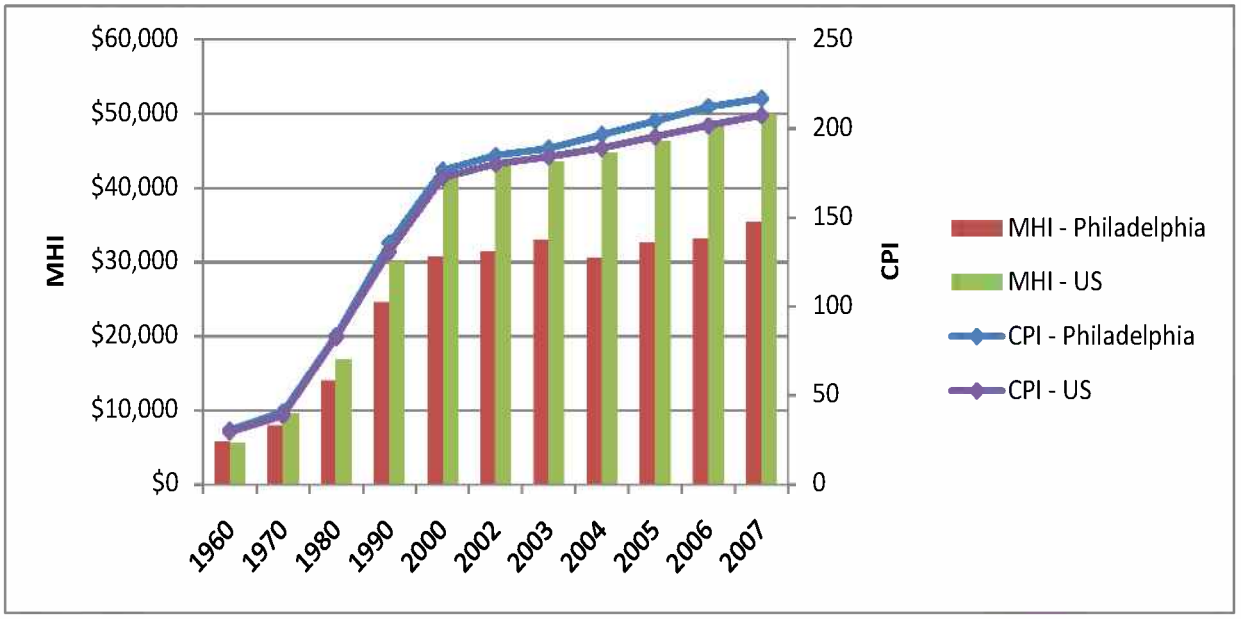


Figure 11-3 MHI Trends and Comparisons

Employment composition in Philadelphia is also not substantially changed in any employment sector during the forecast period, as shown in Table 11-7, although small increases and decreases are shown in some job sectors. Total job forecasts and employment sector forecasts indicate a reversal of past trends, in which employment levels dropped overall. It bears emphasis, however, that Philadelphia County has yet to experience the sizable upward employment trend projected in the above data and the current uncertainty in the job market will negate short-term growth estimates and may potentially hinder long term employment level growth.

11.5 THE FINANCIAL CAPABILITY MATRIX

It was established previously in the Phase One (Residential Indicator) analysis that Philadelphia's residential indicator is projected to fall into the high-range category on the financial capability matrix. The Phase two analysis on the assessment of the financial capability indicators placed Philadelphia in the mid-range category for current conditions. The intersection of these two ratings on the EPA financial capability matrix places the City of Philadelphia in the category of high financial burden, as shown on Table 11-8.

In addition to these strictly numerical measures, socioeconomic trends in the Philadelphia area require careful consideration as level and scheduling of CSO control expenditures are determined.

11.6 CONCLUSIONS AND IMPLICATIONS

PWD will be implementing the innovative approach to combined sewer overflow controls detailed elsewhere within this document within the context of its financial and demographic reality. This reality may be summarized by the unprecedented needs for capital reinvestments in the City's water and sewer systems juxtaposed with structural economic and

Table 11-7 Philadelphia County Employment Forecasts by Sector

Sector	2005	2010	2015	2020	2025	2030	2035
Agriculture & Mining	977	919	866	848	806	765	764
Construction	24,172	20,895	20,302	21,436	21,022	20,504	20,557
Manufacturing	50,335	50,077	48,118	49,208	47,549	45,819	45,805
Transportation / Utilities	33,892	33,515	32,770	31,995	31,502	30,941	31,026
Wholesale	23,505	22,881	22,373	22,092	21,706	21,261	21,275
Retail	97,010	91,230	89,277	87,867	86,642	85,260	85,365
FIRE	61,588	54,847	53,678	53,644	53,217	52,406	52,767
Services	318,831	335,615	346,195	342,303	351,950	360,385	361,570
Government	117,048	112,106	110,674	117,046	116,745	116,015	116,454
Federal/Military	677	715	709	700	692	683	685
Total	**728,035**	**722,800**	**724,962**	**727,139**	**731,831**	**734,039**	**736,268**

Source: DVRPC Employment Forecasts by Sector, based on 2009 economic model run by DVRPC.

Table 11-8 The Financial Capability Matrix at Year 2029

Permittee Financial Capability Indicators Score (Socioeconomic, Debt and Financial Indicators)	Residential Indicator		
	Low (Below 1.0%)	Mid-Range (Between 1.0 and 2.0%)	High (Above 2.0%)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	**High Burden**
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

(Blue areas indicate City of Philadelphia ratings)

demographic changes that will continue to erode both PWD's ability to finance required capital investments and the citizen's ability to afford them.

As noted above, PWD's current capital improvements for its water and sewer systems total $4.6 billion through 2029. This includes $3.7 billion for its current systems required to maintain current levels of service and regulatory compliance; and approximately $900 million (2009 dollars) in new capital expenditures for the implementation of the LTCPU recommended alternatives.

The anticipated tripling of the PWD's annual wastewater system revenue requirements from approximately $350 million in 2009 to over $1 billion in 2029 will be paid for by a rate base whose income is projected to increase by less than 60% during the same period. The results of this will be burden measured as the residential indicator of 2.27% of the median income. A population equivalent to cities larger than Boston, Washington D.C., Baltimore and Seattle will pay more than 2.27% of their household income for wastewater services. The lowest quintile of the households, a population larger than cities such as Cincinnati, Minneapolis,

Pittsburgh or Toledo will face annual wastewater costs totaling between 3.55 to upwards of 7% of their household incomes.

It is reasonable to expect that an implementation schedule (through 2029) imposing residential burdens well above 2.27% for populations the size of major American cities is untenable. The municipal financing market likely would agree with such a conclusion. PWD might face insurmountable difficulties in financing their capital needs as outlined above.

These realities suggest an implementation schedule extending beyond the 2029 deadline. Indeed, through its Green Infrastructure approach to CSO control, PWD fully intends to continue to expand the green features within the City so that control levels will increase and improve well beyond 2029. PWD's Green Infrastructure approach is uniquely suited for incremental and modular implementation and the scheduling context is a completely different paradigm than that of a traditional infrastructure control strategy. A storage and conveyance tunnel, for example, would be of little or marginal benefit before it is fully constructed and operated. CSO control and the resulting water quality benefits would not occur until initiation of operation of at least large portions of the program. In such cases, the regulatory and environmental imperatives might push towards a discrete short term (ten to twenty) year timeframe. PWD's approach however provides for immediate compliance and water quality benefits that will grow annually. The proposed implementation schedule will allow the City of Philadelphia and its watersheds to achieve these benefits within the constraints that the nation's changing economics and demographics have dealt it.

Case Study #3: Indianapolis CSO LTCP
Attachment 3-1
Indianapolis 2006 FCA

6.0 Financial Capability Assessment

Contents:

6.1 Introduction
6.2 Key Assumptions
6.3 Projected Revenue Requirements, Financing and Rate Impacts
6.4 U.S. EPA Financial Capability Analysis
6.5 Summary

6.1 Introduction

Financial capability is a significant factor affecting a community's CSO long-term control plan (LTCP). According to U.S. EPA's 1994 *CSO Guidance for Long-Term Control Plan:*

> As part of LTCP development, the ability of the municipality to finance the final recommendations should be considered. The CSO Control Policy[1] "...recognizes that financial considerations are a major factor affecting the implementation of CSO controls...[and]...allows consideration of...financial capability in connection with the [LTCP] effort...and negotiation of enforceable schedules." The CSO Control Policy also specifically states that "...schedules for implementation of the CSO controls may be phased based on...financial capability."[2]

This section describes the methodology and results of applying U.S. EPA's financial capability process to the Indianapolis long-term control plan. The focus of this effort is to estimate the cost per household for Indianapolis' customers, assess how that cost will compare to future household income, and then determine and discuss financial capability factors set forth in the U.S. EPA guidance document. This guidance document is not binding and the resulting analysis may not fully capture the fiscal stress and/or ability of Indianapolis residents to fund CSO controls. The city has projected future revenue requirements and associated rates, taking into account current costs to operate the city's system, how those costs will change over time, existing debt service, and future debt service resulting from anticipated and identified capital improvements. The city's planning horizon for evaluating the impacts of the LTCP exceeds 20 years.

The city has developed its financial projections consistent with the way it will develop rate projections, with expenses, revenues and capital costs stated in future year dollar terms. Thus, household bills in 2015 reflect what the city estimates households will actually pay in that year. For purposes of the affordability analysis, these future household rates are compared to projected household incomes in those specific years. This is consistent with the approach used by a number of other municipal sewer agencies. The approach keeps all cost figures on a consistent basis and gives the city a realistic picture of actions required to raise needed revenue.

In developing these projections, the city has sought to estimate the future burden of the CSO program in addition to the full wastewater system's long-term needs, as currently understood by the city. The city has evaluated the impact of the long-term control plan and other wastewater needs by estimating long-term revenue requirements and then estimating typical household sanitary sewer costs based on estimated rates. The residential indicator is based on that average annual cost per household relative to projected median household income for each year over the forecast period.

6.2 Key Assumptions

The key assumptions used to develop these projections are:

- Using U.S. Census data for the Consolidated City best captures the city's retail service area. Most customers outside the Consolidated City are served through wholesale contracts, which hinder the ability of the city to readily pass through rate increases and where the wholesale customer has little or no responsibility for combined sewers. See Section 6.3.1 for further discussion of the Consolidated City and wholesale customers.
- Based on a review of historical flow data, the city does not anticipate increases in billable flows over the forecast period due to the historic trend of commercial and industrial conservation measures being implemented as rates increase. But the city does anticipate that the number of households connected to the system will increase slowly as the city moves forward with septic conversions, and experiences limited infill of undeveloped areas.
- Labor costs for the existing system are projected to increase at an average annual rate of 2.5 percent, except for the period from 2008 to 2018, when they are expected to increase at 4.5 percent. The period 2008 to 2018 is anticipated to be a peak construction period in the Indianapolis area. The city anticipates increased labor price competition due to concurrent and significant infrastructure programs occurring in the city during this period, which will increase costs beyond industry standard escalation. Pension costs are assumed to increase at a 5.8 percent rate. Contract operations costs are assumed to increase at a 4 to 6 percent an-

[1] 59 Fed Register, 18688
[2] U.S. EPA, Office of Water, EPA 832-B-95-002, September 1995, p. 3-66.

nual rate, consistent with the city's history under the existing agreements. In addition, it is assumed that there will be a step up in costs of approximately 5 percent at the time operations contracts are renewed, based upon experience with these types of operational contracts.

- Capital costs are projected to increase consistent with the 25-year average national Engineering News Record (ENR) construction cost index. However, during the peak construction period of 2008 to 2018, the city assumes that the costs will increase at 2 percent per year above the historical national ENR index due to the very high anticipated level of construction.
- The city's repair and replacement and capital maintenance activities are assumed to increase over time, reflecting the increased attention the systems will require as they age.
- The city's capital improvement program assumes that the city will move forward during the forecast period with the following plans and projects: LTCP, the Large and Mid-Diameter Combined Sewer Master Plans, the Sanitary Sewer Master Plan, the Basin Master Plan, septic conversion program, as well as other projected wastewater improvements and maintenance needs within the collection system and at the city's two treatment plants. The current estimated cost of this capital improvement program (CIP) is approximately $5.5 billion at the time of construction, including LTCP costs. The above costs do not include the costs of complying with state and federal stormwater management requirements, which are expected to become more stringent during the 20-year planning period.
- The city assumes that it will finance this CIP with a combination of State Revolving Fund (SRF), revenue bonds and 'pay-as-you-go' funds. The city is hoping to obtain SRF financing for 10 percent of this CIP. Over the 20-year LTCP implementation period, the city has assumed that all debt issued will have a term of 20 years with an average interest rate of 6.0 percent.
- Consistent with revenue bond requirements, it is assumed that the city will set rates to comply with a debt service coverage ratio of 130 percent. This has no impact on future rates, since the revenues generated through coverage are used to fund pay-as-you-go capital and other system expenses.
- Operating and maintenance costs for new infrastructure were incorporated based on projects that would directly result in new system components or improved performance. These costs were summarized into five major categories: labor, power, chemicals, infrastructure, and materials and supplies. The indexed annual costs were synchronized with the capital program implementation schedule and were compared to historical expenses and published rates for accuracy and consistency.
- Revenue projections for this Financial Capability Assessment rely on the city's current rate policy and structure and assume that the share of revenues derived from industrial and commercial customers remains stable, despite a history of declines in base flow over time.

The total capital needed by the City of Indianapolis over the next 20 years is estimated at nearly $5.5 billion (future dollars) to fund both CSO improvements required by this LTCP and other projected wastewater collection and treatment needs. The details of the long-term control plan are described in Section 7.0 of this report. For purposes of the financial capability analysis, the city analyzed LTCP Plan 1 at 97 percent capture on Fall Creek and 95 percent capture on the remaining streams, implemented over 20 years. The total capital needed for the LTCP is estimated at $1.6885 billion in current dollars or $2.459 billion in future dollars (**Table 6-1**).

The Wastewater Improvements CIP assumes that the city implements the various master plans that have been prepared for the city, together with other wastewater improvement and maintenance needs. These include unspent por-

Table 6-1
CIP Capital Costs by Program

Capital Program	Present Dollar Value (2004 dollars)	Future Dollar Value (at time of construction)
Long-Term Control Plan	$1.6885 billion	$2.459 billion
Wastewater Improvements CIP	$1.546 billion	$2.548 billion
Septic Tank Elimination Program	$319 million	$474 million

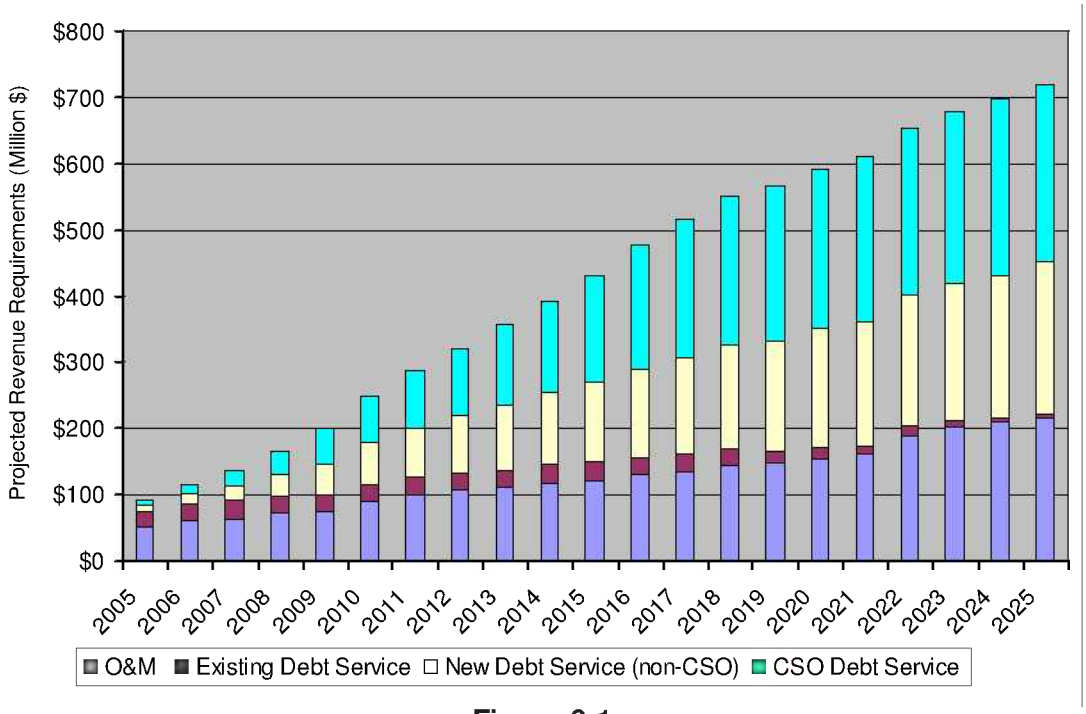


Figure 6-1
Projected Revenue Requirements

tions of the Sanitary Sewer Master Plan, the Large and Mid-Diameter Combined Sewer Master Plans, Basin Master Plan and other projected capital improvements and maintenance needs at the AWT plants and collection system. Since the costs published in the various master plans were developed at different times, all costs were converted to a common dollar base (2004 dollars). The total remaining capital need for the Wastewater Improvements CIP is estimated at $1.6885 billion in current dollars or $2.459 billion in future dollars (**Table 6-1**). Finally, the city is assumed to accelerate extension of sanitary sewers to replace the approximately 18,000 failing septic systems within the retail service area.

The total capital needed for the first 18,000 homes in the Septic Tank Elimination Program is estimated at $319 million in current dollars or $474 million in future dollars (**Table 6-1**).

6.3 Projected Revenue Requirements, Financing and Rate Impacts

Figure 6-1 displays the projected revenue requirements for the wastewater system over the forecast period.

For the period 2005 to 2015, the average annual increase in revenue requirements will exceed 18 percent. On average, through the end of 2025, the city's revenue requirements will increase by approximately 12 percent per year. As the figure shows, new debt service to ensure the long-term integrity of the system and LTCP compliance causes the greatest increases in revenue requirements. CSO debt service will increase from less than 5 percent of total revenue requirements in 2005 to nearly 30 percent in 2025. Similarly, debt service to fund ongoing improvements to the existing sanitary system is projected to increase from 25 percent of the existing revenue requirement to more than 50 percent.

6.3.1 Impact on Future Rates and Affordability

The city's current rate structure includes both a minimum charge per month and a volume-based charge. The volume-based charge is allocated among retail customers based on metered water consumption. (A small number of retail customers do not have centralized water service, and therefore pay a flat rate). Each wholesale contract has been negotiated on a case-by-case basis, over time; and has a different rate, rate structure methodology and process for adjusting those wholesale charges to reflect changes in the cost of service. Furthermore, the city does not control how retail rates are set inside the wholesale customer's service area. While the city has assumed that wholesale customers will pay a proportionate share of the increased costs, this assumption may prove to be optimistic.

The 2005 baseline city retail rate consisted of a monthly billing charge of $2.39 and a commodity rate of $1.33 per 1,000 gallons. There was also a minimum charge, such that no customer paid less than $6.40 per month. For the average residential customer using approximately 64,800 gallons per year, the annual bill in 2005 was approximately $115 per year.

Residential bills are projected to increase by an annual average exceeding 12 percent during the LTCP implementation period. The City-County Council approved a new rate structure on Oct. 31, 2005, that will raise rates approximately 29 percent annually in the years 2006-2008.

Under the U.S. EPA guidance, a key measure of affordability is the Residential Indicator: the ratio of the wastewater cost per household to median household income (MHI). The Residential Indicator is compared to EPA-defined criteria to determine whether costs impose a low, mid-range or high impact on residential users. **Figure 6-2** shows U.S. EPA's Residential Indicator criteria, which define a "low" impact as a cost per household less than 1.0 percent of MHI, a "mid-range" impact between 1.0 and 2.0 percent, and "high" impact as greater than 2.0 percent of MHI. For the forecast period, the residential indicator for Indianapolis is projected over time in **Figure 6-3**.

Figure 6-3 presents the data for three "classes" of households. The first is the Consolidated City, which best represents the city's retail service area. As described earlier in Section 5.0, the consolidation of city and county governments in Marion County left four "excluded cities" that retained some local control. Marion County also contains an independent conservancy district (Ben Davis). Lawrence, Beech Grove and the Ben Davis Conservancy District have wholesale contracts with the City of Indianapolis for sewage treatment services. Southport does not own its collection or treatment systems. Its residents are simply billed as retail customers of the Indianapolis sewer system. The fourth excluded city, Speedway, operates its own sewage collection system and wastewater treatment plant. Several smaller communities outside Marion County also receive wholesale sewage treatment services from the City of Indianapolis. **Figure 6-4** provides a map of Marion County, showing the excluded cities, Ben Davis Conservancy District, township boundaries and out-of-county wholesale customers. U.S. Census data for the Consolidated City includes all of Marion County except the excluded cities of Lawrence, Beech Grove, Southport and Speedway.

Figure 6-3 also shows residential indicators for the median household in Center Township and for a household at or below the poverty level. The Residential Indicator and financial impact on these low-income segments of the service area are significantly greater than they are for the consolidated city service area as a whole.

For the median Consolidated City household, the residential indicator will increase from below 0.5 percent in 2005 to nearly 1.0 percent by 2010 and over 1.5 percent by 2018. This median household will bear a sewer bill exceeding 1 percent of income for 13 years of the forecast period. For Center Township, the city's most populous township, the residential indicator will grow from approximately 0.5 percent in 2005 to approximately 1.30 percent by 2010 and over 2.5 percent (high impact) by 2018. For poverty-level households, the situation is more severe. The residential indicator will rise from nearly 1 percent in 2005 to over 4 percent in 2018.

Based on these projections and using the U.S. EPA guidance, the city anticipates that the residential burden will reach the high end of the medium burden range for the service area's median household in or about 2018. That burden level is projected to persist through the end of the forecast period (2025) and beyond. For the other classes of the city's residential base (Center Township and poverty level households), the burden is projected to be well within the high burden category beginning in approximately 2014 for Center Township and 2010 for poverty-level households. That burden will remain throughout the forecast period and a significant period after December 2025.

The city believes that these projections are reasonable. However, they assume that the share of billable flow allocated to residential customers will remain flat and that wholesale customers will pay a proportionate share of the cost increases. The projections also assume that the share of revenues generated from industrial and commercial customers remains stable, despite a history of declines in base flow over time. Finally, these projections are subject to actual construction costs, which may vary from the city's current projections.

6.3.2 Impacts of Future Competition and Inflation of Capital Costs

Program affordability may be negatively impacted if inflation of the capital costs increases dramatically during this 20-year timeframe. Based on currently available plans, the regional construction market will face significant competition given the large amount of public and private construction anticipated to occur. The city believes this will result in significant price increases for technical services, construction workers, materials and supplies in excess of that in the national construction market. The anticipated level of construction is summarized in **Figure 6-5**. Significant projects include:

- Indianapolis Airport Expansion
- Interstate 465 rehabilitation/reconstruction
- Interstate 69 construction
- New sports stadium/convention center expansion
- Market Square Arena site residential/commercial development
- Indianapolis Rapid Transit investments

Financial Impact	Cost per Household
Low (3)	Less than 1.0 percent of MHI
Mid-Range (2)	1.0 - 2.0 percent of MHI
High (1)	Greater than 2.0 percent of MHI

Note: Low impact equates to strong financial capability; high impact equates to weak financial capability.

Figure 6-2
Residential Indicator Criteria - U.S. EPA Guidance

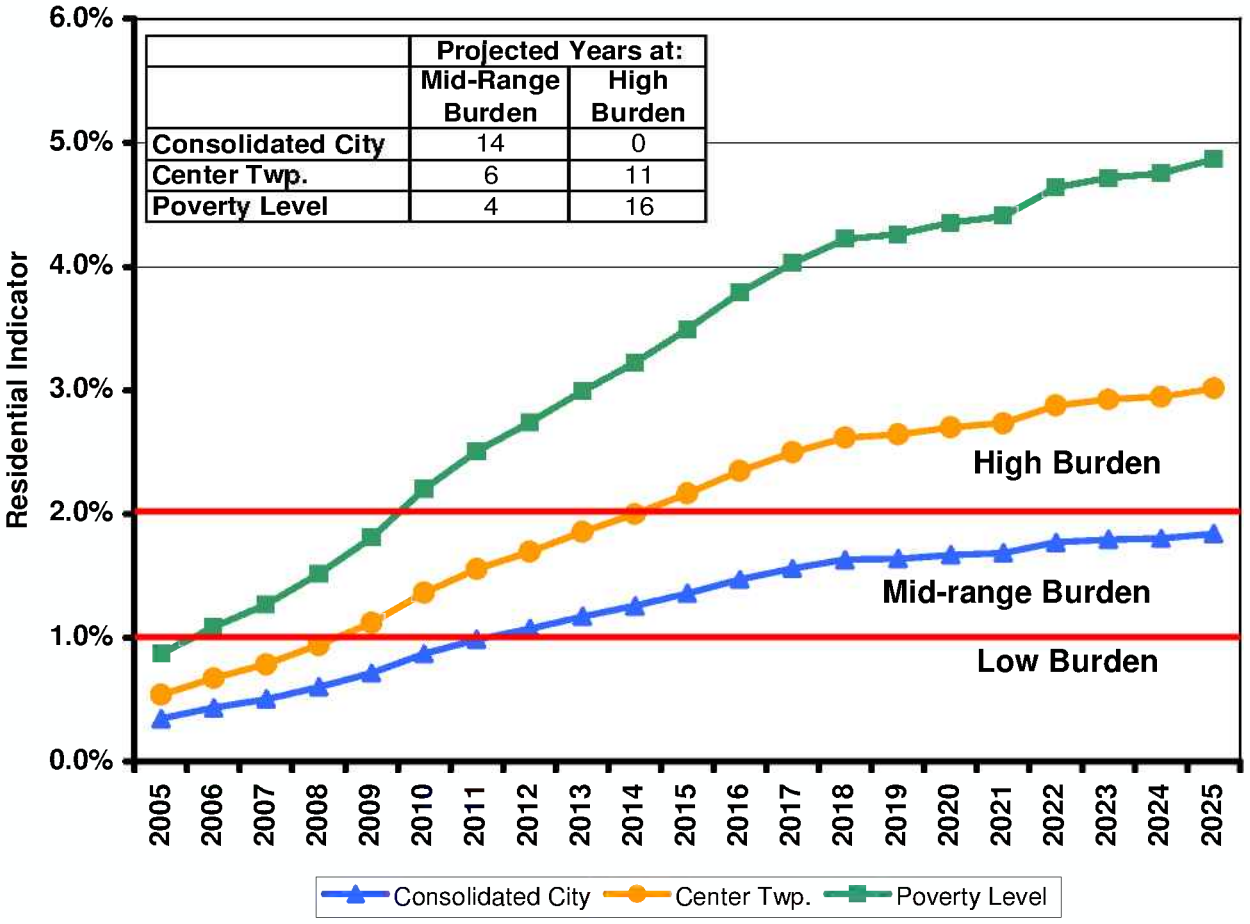


Figure 6-3
Residential Indicator, 2005-2025
Recommended Plan, 20-Year Implementation

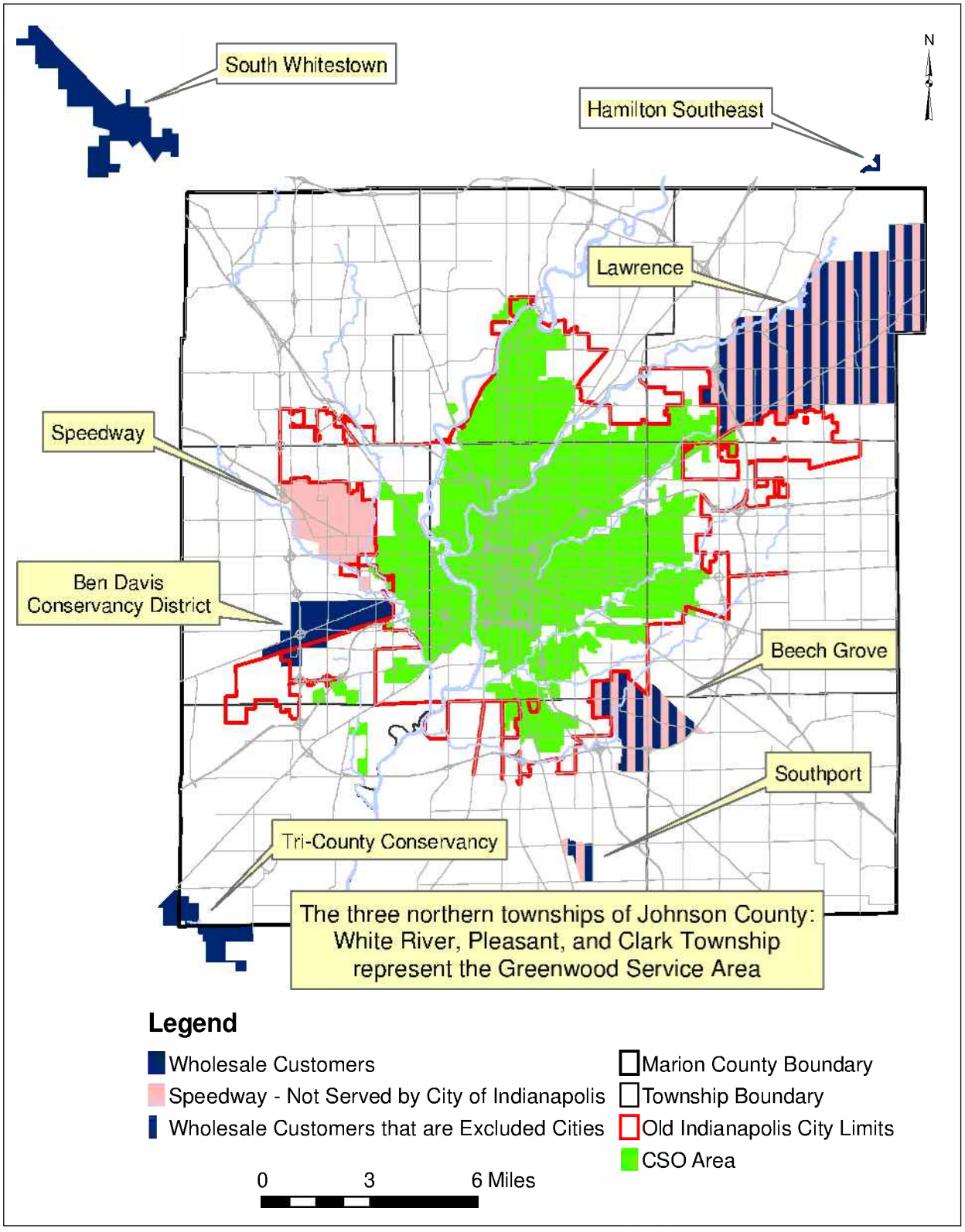
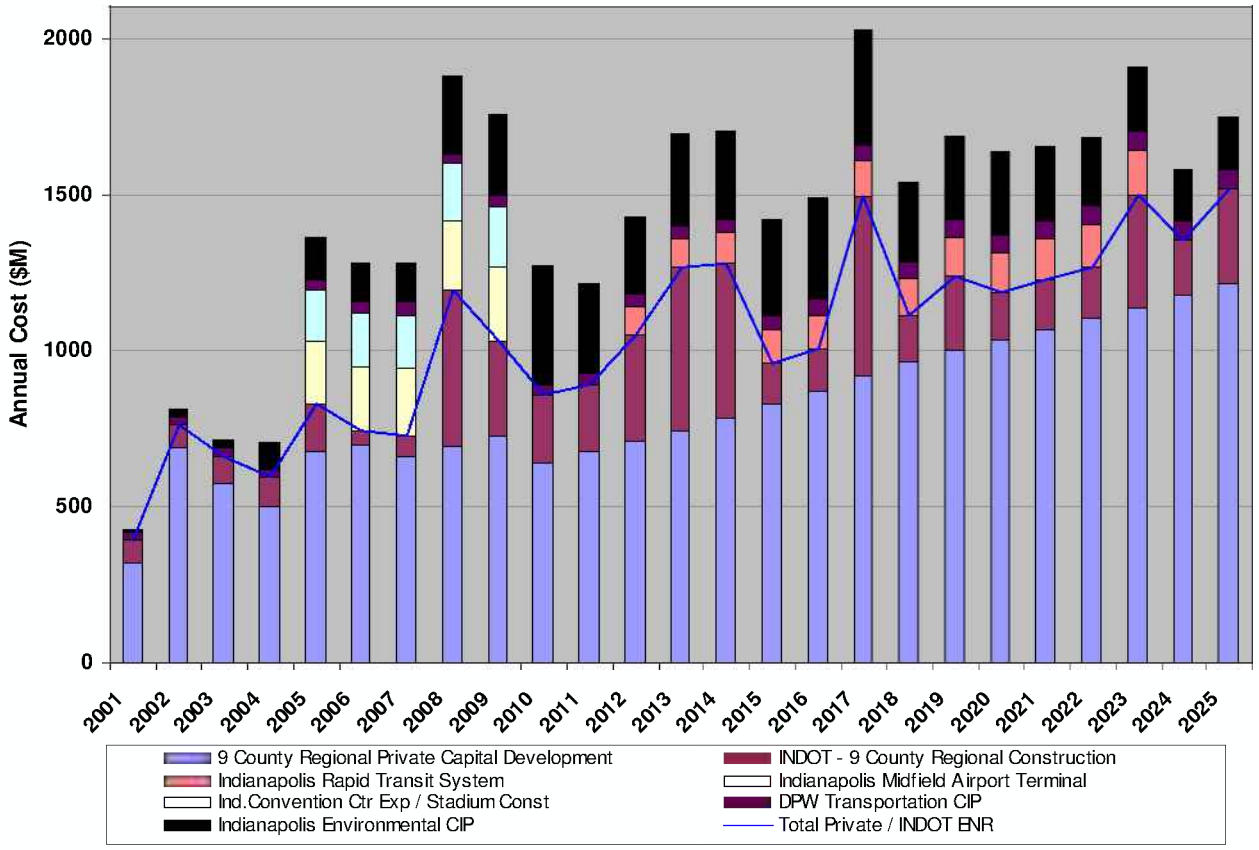


Figure 6-4
Wholesale Customers



Notes:
Costs shown on this chart are expressed in terms of estimated Engineering News Record Construction Cost Index (ENRCCI) over the 20-year project period.

Figure 6-5
Indianapolis Regional Major Capital Investment Programs / Projects 2001 - 2025
(20-year ENR Indexed)

These projects are in addition to standard infrastructure expenditures in the sectors of roads and bridges, transit and water. The volume of work generated by these projects, along with the city's CSO, sanitary, and transportation programs, will stretch local construction firms to the limits of their equipment and manpower resources. As seen in **Figure 6-5**, construction spending is projected to increase from the historical average of approximately $650 million per year in 2001-04 to more than $1.5 billion per year – nearly tripling on an annual basis.

In addition, the city is concerned that the large number of CSO programs underway at the same time in the Midwest will stretch the specialized construction resources associated with these types of programs. The concern is especially true for tunneling-related activities. **Table 6-2** shows eight Midwestern cities that have estimated CSO control programs totaling approximately $10.6 billion. This is in addition to

Table 6-2
Midwest Cities' CSO Control Programs:
Estimated Costs

City	Estimated CSO Control Program ($Billion)
Cincinnati	$1.50
Toledo	$0.80
Detroit	$1.40
Cleveland	$1.60
Akron	$0.40
Columbus, Ohio	$1.50
Youngstown	$0.40
Pittsburgh	$3.00

the City of Indianapolis's CSO program, and excludes the 103 other CSO plans being implemented by smaller Indiana communities.

Given this high concentration of similar programs in the region, the city expects considerable regional competition for engineering and construction resources. Construction resources can be the most critical component for achieving required implementation schedules.

Given the large amount of anticipated construction and the concentration of CSO-related programs, as well as similar impacts in other areas of the country, the city believes that its capital costs will increase faster than the historic national ENR index. Therefore, these projections assume that capital costs will increase at a rate two percentage points higher than the projected national ENR index during the period 2008 to 2018. In addition, the city anticipates upward pressure on its labor costs for operating and maintaining the sewer system and has assumed that these costs will increase at a rate two percentage points higher than the consumer price index during the same time period.

6.3.3 Financing Assumptions

The projections of burden and the residential indicator are extremely sensitive to assumptions regarding debt. The city has assumed that it will finance its program with a combination of state revolving fund loans and city-issued revenue bonds. The city is assuming that this debt will carry a weighted average interest rate of 6.0 percent with 20-year debt. This assumption is extremely sensitive to:

- The proportion of debt actually placed with the SRF
- Actual market rates over the forecast period

The city's projections assume that the city will fund 10 percent of its CIP through the SRF at an average interest rate of approximately 4.75 percent. This would amount to roughly $25 million per year in SRF loan funding, which is consistent with information provided to the city by representatives of the Indiana SRF program. If the city obtains less than the 10 percent that is assumed, actual rates will increase from current estimates.

The city is also assuming that over the 20-year implementation period, market interest rates do not increase significantly from current levels, and that its general obligation bond rating will not drop below AAA. The weighted average rate of 6.0 percent provides a cushion of approximately 100 to 125 basis points above current market rates. The city acknowledges that in the short term this interest rate assumption is conservative. However, current rates are at historically low levels. Given recent Federal Reserve Board actions, it is clear that rates will be moving up, not down. If the weighted average rates were to increase to 7.0 percent from the current assumption of 6.0 percent, the average cost per household could increase by approximately $60 per year.

6.3.4 Grant Availability

Although Indianapolis will pursue available grant programs, the city's financial analysis does not rely on significant grants to fund CSO controls. The amount of grant funding that may become available is expected to be relatively minor in comparison to the projected capital expenditures for the program. The city encourages the State of Indiana to issue substantial grants for CSO abatement projects, as has been the practice in other states. We also call on Congress to halt the federal disinvestment in grants and loans for municipal wastewater projects.

6.3.5 Income Growth

The city has assumed that incomes in the service area will continue to grow at their historical rate relative to inflation. The city believes that this is an aggressive assumption given changing demographics and other factors impacting income. These are discussed in more detail in the next section.

6.4 U.S. EPA Financial Capability Analysis

U.S. EPA Guidance documents set forth an approach for evaluating financial capability. This section presents the results of that assessment, including replicas of the worksheet/forms contained in the U.S. EPA Guidance. It is important to understand that since the CSO program will most likely be funded by revenue bonds and not general obligation bonds, most of these indicators do not reflect the financial capability of issuing revenue bonds.

The assessment is performed in two phases. Phase 1 determines the "Residential Indicator," described earlier, and Phase 2 develops the "Permittee Financial Capability Indicators," which include six indicators in the sub-categories of Debt Indicators, Socioeconomic Indicators, and Financial Management Indicators.

The U.S. EPA guidance also encourages a community to include additional factors or alternative assessment methods in assessing its financial capability and negotiating the CSO program implementation schedule. Therefore, the city has provided some supplemental information below related to population, employment and property tax reassessments.

As noted earlier, the city's retail service area is essentially the same as the Indianapolis Consolidated City boundaries

Table 6-3
Cost Per Household
U.S. EPA Guidance Worksheet 1

Row	Item	Unit	Peak
	Residential share of total wastewater treatment and CSO costs		
107	Total Revenue Requirement in Peak Year	($)	$ 718,370,000
	Current Revenue Requirement	($)	$65,586,000
	Total Increase	%	995.31%
	2005 Monthly bill	($)	$ 9.57
	2005 Annual bill	($)	$ 114.84
109	Projected Annual Cost per Household ("CPH")	($)	$ 1,258

shown on **Figure 6-4**. All data, unless specifically noted, is for the Indianapolis Consolidated City.

6.4.1 Phase One: The Residential Indicator

The city's methodology and projections described in Sections 6.1 through 6.3 set forth the calculations for the residential indicator.

6.4.1.1 Cost Per Household

Cost per household is summarized in **Table 6-3**.

As described in Section 6.1, the city's projection of the cost per household is a rates-based methodology. That is, the city projects total revenue requirements throughout the forecast period, estimates future rates and then estimates the cost per household based on per-dwelling unit annual water consumption of 65,000 gallons (this estimate is derived from the city's billing records). The determining factors are the revenue requirements and total billable flow. The city is assuming that the volume of billable flow remains relatively constant and that the average consumption per household remains at 65,000 gallons per year.

Table 6-4 calculates the Consolidated City's Residential Indicator: cost per household as a percentage of median household income. As a result of this process, the city has determined that the selected plan (Plan 1-storage/conveyance) at 95/97 percent capture would create a medium burden on residents in the Consolidated City, according to U.S. EPA's definitions.

6.4.1.2 Sub-Area Consideration

The Consolidated City is the city's retail service area, where it has direct control over the rates charged for wastewater service. Like most urbanized areas in the United States, the city has experienced a loss of population, income and employment to surrounding communities.

Table 6-5 shows that Center Township has the largest proportion of households at or below poverty level in the service area. Based on historical trends, the city anticipates that this concentration will continue.

Table 6-5 also shows that 9 percent of households in Indiana live at or below the poverty level, compared to 12 percent in Indianapolis and 24 percent in Center Township. The national percentage is 12.4 percent.

U.S. Census data show that the Indianapolis Consolidated City population grew 6 percent and the number of households grew 9 percent between 1990 and 2000. During this same period, the Center Township population declined about 9 percent and households declined 6 percent, while some other townships showed vigorous growth. However, Center Township continues to be the most populous township, with 159,527 people and 21 percent of the city's households. During this same time period, the Indiana population grew 9 percent and the national population grew 12 percent, indicating that the Consolidated City is lagging behind the state as well as the nation in growth.

Center Township residents, on average, have lower incomes and will experience more economic hardship associated with the CSO Program. The median household income in Center Township in 1999 (latest Census) was $26,435, compared to $40,154 for Indianapolis consolidated city, as shown in **Table 6-5**. The cost per household divided by the lower MHI yields a higher peak year Residential Indicator for Center Township: 2.92 percent vs. 1.78 percent for Indianapolis as a whole. This places residents in Center Township in the high burden category.

Table 6-4
Residential Indicator
U.S. EPA Guidance Worksheet 2

Row	Item	Unit	Indianapolis Value
	Median household income ("MHI")		
	Census year MHI		
	Census year		2000
201	MHI	($)	$ 40,154
	MHI adjustment		
	Adjustment Factor for 2004	(unit)	1.115
	Adjusted MHI 2004		$ 44,772
	Analysis year		2025
202	Annual Adjustment factor 2004 to 2025	(unit)	2.20
203	Adjusted MHI	($)	$ 70,705
204	Annual cost per household (line 109)	($)	$ 1,258
205	Residential indicator		
	CPH as a percentage of adjusted MHI	(%)	1.78%
	Financial capability score		2

Table 6-5
Median Household Income and the Poverty Level

	Households: Median Household Income in 1999	Population Above Poverty Level	Population at or Below Poverty Level	Total Population Counted	Percent of Population at or Below Poverty Level
Center	$ 26,435	120,671	38,856	159,527	24%
Decatur	$ 45,690	22,970	1,451	24,421	6%
Franklin	$ 58,482	30,885	1,120	32,005	3%
Lawrence	$ 49,246	101,085	9,860	110,945	9%
Perry	$ 42,378	84,660	6,247	90,907	7%
Pike	$ 47,250	65,593	4,942	70,535	7%
Warren	$ 39,672	84,208	8,240	92,448	9%
Washington	$ 47,079	118,722	10,241	128,963	8%
Wayne	$ 37,554	115,679	14,870	130,549	11%
Indianapolis City	$ 40,154	681,833	91,163	772,996	12%
State of Indiana	$ 41,567	5,334,811	559,484	5,894,295	9%

6.4.2 Phase Two: Permittee Financial Indicators

In the Phase 2 assessment, financial capability is determined by factors assessing a community's financial health and ability rather than by the residential financial burden estimated in Phase 1. The Phase 2 assessment computes six benchmarks, two in each of the following subcategories:

- Debt Indicators,
- Socioeconomic Indicators, and
- Financial Management Indicators.

Figure 6-6 shows U.S. EPA Financial Capability Benchmarks used to evaluate the six indicators. The benchmarks are shown in the left-hand column. A value of "3", "2", or "1" is assigned to a benchmark whose value assessments are "strong," "mid-range," or "weak," respectively.

6.4.2.1 Debt Indicators

The two Debt Indicators are Bond Rating and the Overall Net Debt as a percent of full market property value in the city's service area.

6.4.2.1.1 Bond Rating

This indicator is intended to address a community's general capacity to undertake debt. In January 2005, Standard & Poor's and Moody's Investors Service both rated the city's general obligation credit to be AAA: Negative Outlook. The agencies were concerned about the city's current operating deficit and the growing unfunded pension liability.

Overall the outstanding debt of the city is rated to be sound, and this indicator is considered strong by U.S. EPA criteria, as shown in **Table 6-6**. Standard & Poor's rated the city's revenue bonds AA in December 2004. The city's Sanitary District has outstanding General Obligation and revenue bonds and SRF loans. The 2003 revenue bonds were rated by Fitch Ratings and Standard & Poor's and received a AAA rating based on bond insurance. The SRF loans are rated AA by Standard & Poor's and, in some cases, also by Fitch.

6.4.2.1.2 Net Debt

Net debt is the amount of tax-backed bond debt for all taxing units, including the City of Indianapolis, Marion County, townships, libraries, and schools, that is not supported by revenue from user fees.

Information from the January 19, 2005 research report by Moody's Investors Service was used to develop **Table 6-7**. According to Moody's, the net direct debt as of January 2005 for the City of Indianapolis was $867,475,000. The overlapping debt of the other taxing units attributable to the residents and businesses in the city was $1,439,320,000. Moody's used the assessed value of property in the consolidated city from the 2004 Comprehensive Annual Financial Report statistical section. Because the percent ratio of

Indicator	Strong (3)	Mid-Range (2)	Weak (1)
Bond Rating	AAA-A (S&P) or Aaa-A (MIS)	BBB-A (S&P) or Baa-A (MIS)	BB-D (S&P) or Ba-C (MIS)
Net Debt/Property Value	Below 2%	2% - 5%	Above 5%
Unemployment Rate	>1% below National Ave.	±1% of National Ave.	>1% above National Ave.
Median Household Income	>25% above adj. Nat'l MHI	±25% of adj. Nat'l MHI	>25% below adj. Nat'l MHI
Property Tax/Property Value	Below 2%	2% - 4%	Above 4%
Prop. Tax Collection Rate	Above 98%	94% - 98%	Below 94%

Figure 6-6
Permittee Financial Capability Indicator Criteria
U.S. EPA Guidance

Table 6-6
Bond Rating
U.S. EPA Guidance Worksheet 3

Row	Item	Value
	Most recent general obligation	
	bond rating	
	Date	2005
	Rating agency	Standard & Poor's / Moody's
301	Rating	AAA / Aaa
	Most recent revenue bonds	
	Date	2004
	Rating agency:	S&P
	Bond insurance	no
302	Rating	AA
	Financial capability score	3

Table 6-7
Overall Net Debt as a Percent of Full Market Property Value
U.S. EPA Guidance Worksheet 4

Row	Item	Unit	Value
401	Direct net debt	($)	$ 867,475,000
	(tax-supported debt)		
402	Debt of overlapping entities	($)	$ 1,439,320,000
	(Proportionate share of multijurisdictional debt)		
403	Overall net debt	($)	$ 2,306,795,000
404	Market value of property (Consolidated City)	($)	$39,047,432,000
405	Overall net debt as a percent of full market property value	($)	5.91%
	Financial capability score		1

All numbers are based on data from Moody's Investor Services and appear in Moody's January 19, 2005 report.

net debt to property value is in excess of 5 percent, this indicator is considered weak by U.S. EPA criteria, as shown in **Table 6-7**.

6.4.2.2 Socioeconomic Indicators

The two Socioeconomic Indicators are Unemployment Rate and Household Income.

6.4.2.2.1 Unemployment Rate

The Unemployment Rate indicator is shown in **Table 6-8**. The Indianapolis monthly unemployment rate for 2004 was 5.63 percent, according to the U.S. Department of Labor, Bureau of Labor Statistics. The national unemployment rate was 5.50 percent and the State of Indiana's was 5.1 percent.

Because local unemployment is between one percentage point more than or less than the national unemployment rate benchmark, this indicator is considered mid-range, according to U.S. EPA criteria.

Table 6-9 shows employment increases and decreases in Indianapolis for various industries between 1990 and 2000. **Figure 6-7** shows the loss of employment from some key Indianapolis employers during the past four years due to closures and downsizing. The transportation decreases are predominantly related to the airline cutbacks.

6.4.2.2.2 Household Income

The Household Income indicator is related to the Residential Indicator in that both consider MHI. While the Residential Indicator compares MHI with the cost per household, here the Household Income indicator compares MHI with national MHI as a benchmark measurement of relative wealth or poverty as of the date of the General Census. Both MHI calculations are adjusted to 2025 numbers.

The MHI shown in **Table 6-10** is the same value used in **Table 6-4** for the Residential Indicator. National MHI is adjusted by the same factor, also as shown in **Table 6-10**.

Because local MHI is more than 75 percent of national MHI and less than 25 percent greater than national MHI, this indicator is judged to be mid-range and assigned a value of "2" according to the U.S. EPA benchmark criteria.

6.4.2.3 Financial Management Indicators

The two Financial Management indicators are Property Tax Revenues and Tax Collection Efficiency. Property tax revenues are collected by multiple taxing jurisdictions for residents within the consolidated city, including the City of Indianapolis, Marion County, the libraries, Marion County Health and Hospital Corporation, the townships, and the school districts.

6.4.2.3.1 Property Tax Revenues as Percent of Full Market Value

In the city's service area, property tax revenues collected in the 2004 fiscal period were $1,135.5 million. Property value shown in **Table 6-11** is about $36.8 billion. This information was obtained from the Marion County Auditor's Office, based on the Certified Assessed Valuations provided by the Indiana Department of Local Government Finance.

The calculated property tax revenue indicator for the city's service area is between 2 and 4 percent, suggesting a mid-range local financial capability under the U.S. EPA criteria.

In December 1998, the Indiana Supreme Court ruled that the state's method of property tax assessment was unconstitutional and required that the state implement a more market-based approach to valuation. The new rules for assessment

Table 6-8
Unemployment Rate
U.S. EPA Guidance Worksheet 5

Row	Item	Unit	Value
501	Unemployment rate of permittee	(%)	5.63%
	Source: Indianapolis Consolidated City, Bureau of Labor Statistics		
	Benchmark:		
503	Average national unemployment rate	(%)	5.50%
	Comparison of permittee with benchmark	(%)	(0.13%)
	Financial capability score		2

Table 6-9
Employed Persons by Industry for Indianapolis

Industry	1990	2000	Percent Increase/ Decrease in Jobs
Construction	19,754	24,719	20%
Manufacturing; nondurable goods	59,100	53,730	-10%
Wholesale trade	18,854	17,465	-8%
Retail trade	65,800	47,514	-38%
Transportation	18,678	22,753	18%
Communications and other public utilities	10,759	13,601	21%
Finance; insurance; and real estate	32,830	34,173	4%
Professional; scientific; management; administrative; and waste management services	19,976	37,813	47%
Professional and related services; educational services	24,408	24,873	2%
Professional and related services; health services	36,585	48,619	25%
Entertainment and recreation services, food service	16,926	34,014	50%
Other professional and related services	26,344	20,096	-31%
Public administration	18,431	16,899	-9%
Total	**368,445**	**396,269**	**7%**

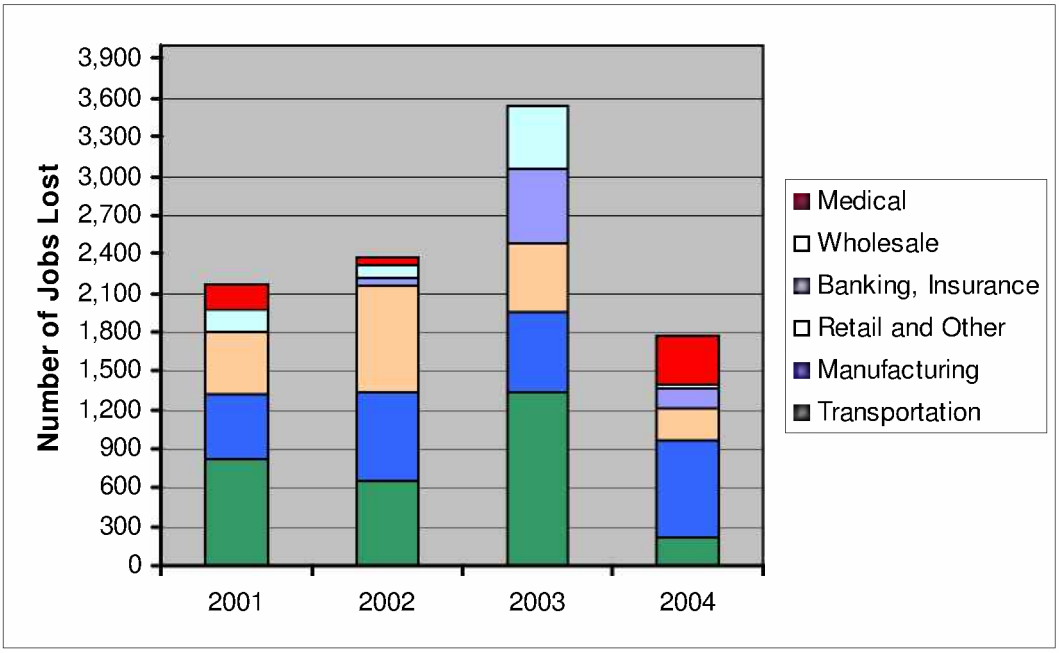


Figure 6-7
Jobs Lost 2001-2004

Table 6-10
Median Household Income
U.S. EPA Guidance Worksheet 6

Row	Item	Unit	Value
601	MHI of permittee (line 203)	($)	$ 70,705
	Benchmark:		
602	Census year national MHI	($)	$ 41,994
603	MHI adjustment factor to 2025	(unit)	176%
604	Adjusted national MHI	($)	$ 73,909
	Compare permittee with benchmark		-4.34%
	Financial capability score		2

Table 6-11
Property Tax Revenues as Percent of Full Market Property Value
U.S. EPA Guidance Worksheet 7

Row	Item	Unit	Value
701	Full market value of real property (Certified Assessed Value, Payable 2004)	($)	$ 36,808,011,015
702	Property tax revenue (paid in 2004)	($)	$ 1,135,502,840
703	Property tax revenue as a percentage of full market property value	(%)	3.08%
	Financial capability score		2

were implemented in 2003, resulting in a substantial shift in tax burden from business to residential taxpayers.

In 2002, the Indiana General Assembly adopted a significant tax reform package, including provisions to phase out certain business personal property taxes, place caps on certain local tax levies, and institute property tax relief measures for homeowners to mitigate the impact of the new assessment methodology. As a result of the combined impact of reassessment, appeals and tax reform, the city has seen a real decline in both assessed value and property tax revenue.

6.4.2.3.2 Tax Collection Efficiency

The final U.S. EPA Financial Guidance Phase 2 indicator is the rate of property tax collection. The 2004 property tax collection rate presented in **Table 6-12** represents the current taxes collected divided by property taxes levied for the Consolidated City. These amounts were provided by the Marion County Auditor's Office.

In the city's service area, tax collection efficiency is 102.79 percent. Because this figure is above 98 percent, it is indicative of a strong financial capability and receives a score of "3." However, the 102.79 percent efficiency rate includes collections for delinquent taxes. Without delinquencies, the collection rate in 2004 was 97.17 percent, which would result in a mid-range score of "2."

6.4.2.4 Summary of Phase 2 Indicators

The values and scores of the six Phase 2 Evaluation indicators are compared in **Table 6-13**. Overall, the unweighted average score for the Phase 2 Evaluation is 2.167.

6.4.3 Summary of Financial Capability Indicators

The Phase 1 Residential Indicator has a value of 1.84 percent of adjusted MHI and the Phase 2 Permittee Financial Capability Indicators have an unweighted average of 2.167, as shown in **Table 6-14**. These two converge on the Financial Capacity Matrix (**Figure 6-8**) and indicate a medium burden for the service area. However, due to the lower MHI in Center Township, residents in this area face a high burden.

Table 6-12
Property Tax Revenue Collection Rate
U.S. EPA Guidance Worksheet 8

	Item	Unit	Value
801	Property tax revenue collected (Consolidated City, 2004)	($s)	$ 1,135,502,840
802	Property taxes levied (Consolidated City, 2004)	($s)	$ 1,104,723,892
803	Property tax revenue collection rate (includes delinquent taxes)	(%)	102.79%
	Financial capability score		3

Table 6-13
Summary of Financial Capability Indicators
U.S. EPA Guidance Worksheet 9

Row	Item	Value	Score
901	Bond rating	AAA / Aaa	3
902	Net debt percent of property value	5.91%	1
903	Unemployment rate compared with national average	(0.13%)	2
904	Median household income compared with national average	-4.34%	2
905	Property tax revenue percent of property value	3.08%	2
906	Property tax revenue collection rate	102.79%	3
907	Permittee indicator score		2.17

Table 6-14
Financial Capability Matrix Score
U.S. EPA Guidance Worksheet 10

Row	Item	Value	Score
1001	Residential indicator score	1.78%	mid-range
1002	Permittee financial capability indicators score	2.17	mid-range
1003	Financial capability matrix category	medium burden	

Permittee Financial Capability Indicators Score (Socioeconomic, Debt & Financial Indicators)	Residential Indicator (Cost Per Household as a percentage of MHI)		
	Low Burden (below 1.0%)	Mid-Range (between 1.0 and 2.0%)	High (greater than 2.0%)
Weak (below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (above 2.5)	Low Burden	Low Burden	Medium Burden

Service Area-wide indicates a medium burden.

Center Township indicates a high burden.

Figure 6-8
Summary of Financial Capability Indicators: U.S. EPA Guidance

6.5 Summary

Implementing the long-term control plan will place a financial and economic burden on the City of Indianapolis. During the next 20 years, the city's wastewater revenue requirements will increase by approximately 12 percent per year, on average. This will significantly impact industrial, commercial and residential sewer rates. The impact on disadvantaged residents in Center Township and those living below the poverty level also must be considered. Based upon U.S. EPA guidance, the residential burden for the retail service area will reach the medium burden category. In Center Township and for people living below poverty, the burden will fall into the high burden category.

Following U.S. EPA's guidance document, the city is facing a medium to high burden, which is an important factor in the plan's implementation schedule of 20 years. A more aggressive schedule is impracticable for constructability reasons and would further increase the financial burden on residential customers.

Based upon this analysis, the city has selected a level of control for the Plan 1 systemwide alternative and developed a 20-year implementation schedule. The selected plan's individual components, projected costs and benefits, and implementation schedule are further described in Section 7.

Case Study #4: Anderson, Indiana CSO LTCP
Attachment 4-1
Anderson 2010 FCA

Section 7 Financial Capability Assessment

7.1 Introduction

The Indiana Department of Environmental Management (IDEM) and the United States Environmental Protection Agency (EPA) recognize that meeting the requirements of the Clean Water Act and the state water quality standards will present major challenges for most Combined Sewer Overflow (CSO) communities. One of the most significant challenges is finding a way to finance CSO controls without placing an undue burden on citizens and industries. In many communities, including the City of Anderson ("City"), the requirements contained in the Long-Term Control Plan (LTCP) can represent the single most costly public works project ever undertaken or likely to be undertaken by the current generation. Although EPA has provided communities with grants for wastewater projects in the past, no dedicated grant programs for CSO control are currently available.

The regulators also realize that among the many factors affecting the financial evaluation, the implementation and scheduling of the CSO-related projects is directly tied to a community's ability to reasonably afford proposed remediation activities. Consequently, both agencies require a comprehensive affordability analysis within the LTCP to determine its effect on both the current and future fiscal well being of any CSO community.

Therefore, the following affordability analysis discussion will focus on numerous integrated financial and socioeconomic issues such as:

- Median household income
- Total annual wastewater and CSO costs per household as a percent of the median household income
- Fixed service costs in addition to wastewater and CSO costs that impact affordability
- Residential Indicator as a percent of the median household income
- Overall net debt of the City as a percent of full market property value
- Term of current total bond indebtedness

- The City's current bond rating
- The City's ability to assume more debt
- Property tax revenues as a percent of full market property value
- Property tax collection rate
- City unemployment rate.

7.2 Factors Determining What Residents Can Afford

Federal CSO guidance documents suggest that the financial capability assessment be developed in two phases. The first phase involves calculating a Residential Indicator, and the second phase involves analyzing the City's Financial Capability Indicator.

The Residential Indicator considers the cost per household expended on wastewater collection and treatment, expressed as a percentage of median household income (MHI). The Financial Capability Indicator assesses community-wide factors such as the City's debt burden, socioeconomic conditions, and financial operations. Once these two financial indicators are developed, they are entered into a financial capability matrix (developed by EPA) to assess the overall financial burden placed on individual households and the City by the wastewater/stormwater treatment and CSO compliance measures. These two values, the Residential Indicator and the Financial Capability Indicator, are merely indicators used to assist the communities and regulators in making decisions. These indicators are based on standard calculations developed by EPA to compare the financial impacts of the CSO program for different communities across the nation. The Residential Indicator's cost per household should not be confused with a monthly or annual sewer user fee. The cost per household does not take into account all factors that are incorporated into an actual sewer rate study, such as project scheduling, account balances, debt service coverage, and industrial vs. residential rates. For these reasons, the cost per household should be considered simply an indicator of the financial impact that the current and proposed wastewater and CSO controls will have on residential users.

The regulatory agencies also encourage the City to report any information that will have a financial impact on CSO compliance.

7.2.1 Phase 1: Calculation of the Residential Indicator

Developing the residential indicator requires determining the current and proposed wastewater treatment and CSO project costs on a per-household basis. Once the total costs are developed, the cost per household is calculated as a percent of median household income. In addition, in the case of the City, certain other service and utility costs that significantly impact the affordability for residents must be taken into account. These other factors, further discussed below, include, sixteen percent (16%) decrease in population since 2000 and a significant loss of large employers. This Residential Indicator is then used in an EPA matrix to determine whether the CSO control program will produce a high, medium, or low impact on the community's residential users (Table 7-1).

Table 7-1 EPA Residential Indicator Financial Impacts

Financial Impact	Residential Indicator (CPH as % MHI)
Low	Less than 1.0 Percent of MHI
Mid-Range	1.0 - 2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI

In the case of the City, the calculation of the Residential Indicator, based upon estimated project scenarios revealed that the estimate of various ranges of project costs resulted in a residential indicator score that was greater than the EPA "high" level guidance of two percent (2%) of MHI. This provides a conclusion that the estimated ranges of project cost were not affordable for the residents of the City. We therefore analyzed the range of projects that could be provided through a cost per household equal to no more than 2% of MHI for the City of Anderson.

7.2.1.1 Residential Indicator Calculation

The residential indicator represents the annual wastewater and CSO control costs per household as a percent of adjusted median household income. It is typically calculated as an amount of projected cost per household (CPH) as a percentage of the average adjusted MHI. In the case of the City of Anderson, because the residential indicator calculated under the normal methodology resulted in an analysis that showed the projected project costs to be unaffordable, the City determined to calculate the project costs that could result from a residential indicator of 1% to 2%, which is the "Mid–Range" in the EPA guidance.

EPA guidelines suggest that the financial impact on a city is low if the CSO and wastewater treatment costs per household fall below one percent (1%) of median household income. Impacts are in the mid-range if costs fall between 1% and 2% of MHI. Costs are considered high when they exceed 2% of the adjusted MHI. While 1-2% of MHI may appear to be a relatively small number, the impacts may be quite large. For example, the average family only saves about 3% of disposable household income each year. Therefore, 2% of household income represents two-thirds of family savings that could otherwise be used for new homes, college educations, or a secure retirement. These levels can hardly be considered insignificant.

The City and the project team analyzed the amount of capital investment dollars that would trigger the 2% residential indicator for the City. These calculations show that City residents would reach the 2% threshold at approximately $161 million in capital costs (Table 7-2).

Table 7-2 Calculation of Cost Per Household Estimate and Residential Indicator

ANDERSON MUNICIPAL SEWAGE WORKS
Anderson, Indiana

Calculation of the Cost Per Household Estimate and Residential Indicator

Line No.	Current Wastewater Costs - Excluding Revenue Funded Capital Projects	Sensitivity Analysis Financial Impact Baseline - Low	2%
100	Annual Operation and Maintenance Expenses (1)	$ 9,270,929	$ 9,270,929
101	Annual Revenue Bond Debt Service (2)	1,961,596	1,961,596
	Annual Sanitary District Bond Service	743,861	743,861
	Annual Energy Audit Lease Payment	59,630	59,630
	HELP Program Lease Payment	14,344	14,344
102	Total Current Wastewater Costs	12,050,360	12,050,360
	Projected CSO Costs (Current Dollars)		
103	Estimated Annual Operation and Maintenance Expenses (3)	-	2,039,720
104	Annual Debt Service on CSO Projects to be Funded (4)	-	12,913,121
105	Total Projected CSO Costs (Current Dollars)	-	14,952,841
106	Total Current and Projected Wastewater and CSO Annual Costs	$ 12,050,360	$ 27,003,201
	Residential Factor Calculation		
	Total Annual Residential Wastewater Flow (Gallons) (5)	1,349,442,864	1,349,442,864
	Divided by: Total Annual Wastewater Flow (Gallons) (5)	2,049,409,296	2,049,409,296
	Residential Factor	0.6585	0.6585
107	Residential Share of Wastewater and CSO Annual Costs	$ 7,935,162	$ 17,781,608
108	Total Number of Households in Service Area (6)	22,246	22,246
109	Annual Wastewater Cost Per Household (CPH)	$ 356.70	$ 799.32
	Divide by: Twelve	12	12
	Total Monthly "Cost" Per Residential User	$ 29.73	$ 66.61
	Calculation of Residential Indicator		
	Adjusted Median Household Income (MHI) of the City of Anderson Service Area	$ 39,937	$ 39,937
205	Residential Indicator (CPH as a Percent of Adjusted MHI)	0.89%	2.00%
	Financial Impact	Low	High
	CSO Projects to be Funded		$ 160,926,000
	Present Worth of Operation and Maintenance Expenses	To be provided by Greely & Hansen	
	Total Present Value of CSO Plan		$ 160,926,000

IDEM specifies that a calculation similar to the EPA Residential Indicator be performed to derive the benchmark calculation. The State refers to this benchmark as the Municipal Affordability Screener, which is calculated as follows:

MAS = *[Annualized Project Cost per Household / Annualized Median Household Income] x 100%*

Solving for a MAS of 2% and using the MHI of the City's Service Area of $39,937, results in annual "high" level affordable monthly costs of $66.61.

7.2.1.2 Cost Per Household

Under EPA guidance, developing the cost per household (CPH) begins by adding current annual wastewater treatment (WWT) costs to the projected annual costs for proposed wastewater and CSO controls. In addition, the City has incorporated other fixed service and utility costs affecting City residents. Once the total annual costs are determined, the residential portion was calculated based on the percentage of flow attributed to the residential customers or other appropriate allocation factors.

Current WWT Costs: EPA defines current WWT costs as the current annual wastewater operating and maintenance expenses (excluding depreciation) plus current annual debt service. Expenses for funded depreciation, capital replacement funds, or other type of capital reserve funds are not to be included in the current WWT costs since they represent a type of savings account rather than an actual operation and maintenance expense. The annual debt service for the Sanitary District is also included because the projects funded by the Sanitary District's bond issue were for improvements to the Anderson Municipal Sewage Works and Stormwater Utility. In Table 7-2, column 1, line 102, the City's annual operation and maintenance (O & M) expenses (excluding depreciation) are shown.

Projected Additional WWT and CSO Costs: The projected total WWT and CSO costs for various levels of CSO control were developed in Section 4.0 of this report. As shown earlier, the City

developed its level of project by estimating the supportable amount of project costs as shown on Table 7-2. For purposes of this analysis, we have shown an estimated project cost of $161 million in capital project costs.

Line 104 column 2 on Table 7-2 calculates the annualized debt service costs for a $161 million capital project, financed over 20 years at five percent (5%) interest. Recently, the City has been able to issue debt in the four percent interest range, however, statistics show that the typical interest rate range over time averages to five percent. For the purposes of this analysis a rate of five percent has been used and, therefore, annualized debt service would be calculated as follows:

Annual Debt Service Costs (line 104)

$$= \text{Total CIP Cost} \times \text{Annualization Factor}$$

$$= \$1.0\ B \times \frac{\text{Interest Rate}}{(1 + \text{Interest Rate})^{\text{Years}} - 1} + \text{Int. Rate}$$

$$= \$1.0\ B \times \frac{.05}{(1+.05)^{20} - 1} + .05$$

$$= \mathbf{\$12,913,121}$$

Based on engineering and operation experience, an estimate of the annual operation and maintenance (O & M) costs were developed and entered on Line 103 of Table 7-2

Residential Share of Total WWT and CSO Costs: EPA guidance suggests computing the residential share of total costs by multiplying the percent of total wastewater flow attributable to residential users by the total costs:

Residential Share of Costs (line 107)

$$= \text{Total Costs} \times \frac{\text{Residential Wastewater Flow}}{\text{Total Wastewater Flow}}$$

The project team calculated the percentage of residential flow to total flow based upon consumption data collected from December 2006 through November 2007. Based upon this data, the calculation determined that the Annual Residential Wastewater Flow percentage was 65.85%. In order to calculate the residential portion of the costs, the team used the following formula:

Residential Share of Costs (line 107)

= (*Annual Residential Wastewater Flow / Total Annual Wastewater Flow) x (Current WWT O & M + Estimated CSO O & M + Projected CSO Debt Service)*

= *(1,349,442,864 M / 2,049,409,296 M) x ($12,050,360+$2,039,720+ $12,913,121)*

= **$17,781,608**

Total Annual WWT and CSO Cost per Household (CPH): The cost per household is calculated by dividing the Residential Share of Costs by the total number of households served by the system. For this reason, Line 109 column 2 of Table 7-2 is calculated as follows:

Annual Cost per Household (line 109)

= *Residential Share of Cost / Households Served*

= *$17,781,608/22,246*

= **$799.32**

The annual cost per household can be converted to a monthly CPH by simply dividing by 12:

Monthly CPH = $799.32 / 12 months = **$66.61**

In addition to WWT and CSO CPH, additional pressures exist on the residents of the City that create an impact on the affordability of the overall CSO project. Recent shortages in electricity and gas have caused intense pressures on local residents who cannot meet their utility bill obligations. Anderson Municipal Light and Power has seen recent summer spikes in spot market electricity costs which are directly passed through to the consumer. The Anderson

Utility Office reports that they have recently had to readjust their budget and guidelines due to the increased number of cases and size of transfer payments necessary through the Energy Assistance Program due to increased gas bills and fuel oil bills for winter heating. From calendar year 2006 to 2007, the amount of revenue received by the City from energy assistance increased by 32%. The increase in revenue continued from 2007 to 2008 by an additional 6%. The current economic situation will likely cause this to increase again from 2008 to 2009.

7.2.1.3 Median Household Income

The second step in developing the Residential Indicator is determining an adjusted median household income (MHI) for the sewer service area. Guidance documents suggest two methods for calculating the Median Household Income: averaging and weighting.

Averaging Method: This method uses the most recent MHI and inflates it to the current year according to the Consumer Price Index. The sewer service area for the City of Anderson includes the communities of Anderson, Chesterfield, Edgewood and Daleville. The MHI for all households in the City's sewer service area, based on information supplied by the U.S. Bureau of Census, was $33,739 in 2000. Using Consumer Price Index increases of approximately 3 percent per year, the adjusted 2007 MHI for the service area would be approximately $39,937. (See Table 7-3.)

Table 7-3 2007 Median Household Income for Anderson

	United States	City of Anderson	Line No.
Census Year 2000 MHI (1)	$ 41,994	$ 33,739	201
MHI Adjustment Factor	1.2101	1.1837	202
Adjusted MHI	$ 50,817	$ 39,937	203

(1) 2000 Census MHI is based on 1999 Income

The EPA guidelines also suggest comparing the City's MHI with the United States MHI. The United States MHI in 2000 was $41,994. When updated to 2007 values, the national MHI would be approximately $50,817. Table 7-3 shows the adjusted Anderson MHI compared to the national MHI for 2007.

7.2.2 Phase 2 – Calculation of Financial Capability Indicators

The second phase of the financial capability assessment involves calculating a Financial Capability Indicator for the City of Anderson. The indicator includes six factors that assess debt, socioeconomic, and financial management conditions in the community. The six factors are:

- Bond rating
- Total net debt as a percentage of full market property, and real estate value
- Unemployment rates
- Median household income
- Property tax revenues as a percentage of full market property value
- Property tax collection rate

For each measure, the City was given a score of three (strong), two (mid-range), or one (weak), according to EPA-suggested standards. Table 7-4 presents the six factors and the criteria that determine whether a community is strong, mid-range, or weak in each category.

Table 7-4 Financial Capability Indicator Benchmarks

Indicator	Strong (1)	Mid-Range (2)	Weak (1)
Bond Rating	AAA_A (S&P) or Aaa-A (Moody's)	BBB (S&P) or Baa (Moody's)	BB-D (S&P) or BaC (Moody's)
Overall Net Debt as a % of Full Property Value	Below 2%	2% - 5%	Above 5%
Unemployment Rate	More than 1% Point Below National Average	Plus/minus 1% Point of National Average	More than 1% Point Above National Average
Median Household Income (MHI)	More than 25% Above Adjusted National Average	25% of Adjusted National Average	More than 25% Above Adjusted National Average
Property Tax Revenues as a % of Full Markety Property Value	Below 2%	2% - 4%	Above 4%
Property Tax Collection Rate	Above 98%	94% - 98%	Below 94%

The Matrix was provided in the EPA Combined Sewer Overflows - Guidance for Financial Capability Assessment and Schedule Development

An overall indicator is then derived by scoring each indicator for each category, and then dividing the sum by six to develop a single value. The resulting Financial Capability Indicator is then used to determine the level of financial burden on the City as a whole. The following section analyzes each of the six factors for the City of Anderson.

Bond Rating: According to Crowe Horwath LLP ("Crowe"), the City's financial advisor for the City has recently been rated by several bond-rating agencies. Standard & Poors (S&P) gave Anderson a "BBB+" rating and Moody's Investor Services ("Moody's") an "A3" rating for sewage revenue bonds in 2007. S&P downgraded the Sewage Works bonds ratings in November 2005 and affirmed the BBB+ rating in May 2007. Due to this recent downgrade and the split in ratings between Moody's and S&P, Anderson will receive a mid-range score for this indicator.

Total Net Debt as a Percentage of Full Market Property and Real Estate Value: Table 7-5 presents the direct and overlapping debt as a percent of the full market value of property in the

City. This indicator is often referred to as the "property tax burden" since it indicates the funding capacity available to support debt based on the wealth of the community. The City receives a weak score for this factor since the calculated percentage is 9.43%.

Unemployment Rates: According to EPA guidelines, the seasonally adjusted unemployment rate for the municipality should be compared to the adjusted rate for the U.S. A variance of greater than 1 percent from the national rate indicates a weak financial capability. The City maintained an unemployment rate of 5.5 percent for 2006, compared to a seasonally adjusted national unemployment rate of 4.3 percent. This gives the City a weak score for unemployment (See Table 7-5).

Median Household Income: Median household income was discussed earlier in calculations of the Residential Indicator. EPA guidelines require a comparison of the community's MHI to the adjusted national MHI. The City of Anderson's average median household income is $39,937 Because the City of Anderson's MHI is within + 25 percent the national MHI of $50,817, Anderson receives a mid-range score for this factor (See Table 7-5).

Property Tax Revenues as a Percentage of Full Market Property Value: The assessed valuation of property in Anderson is approximately equal to the full market value. Therefore, the total real estate and property tax levy for all tax districts is approximately 2.9 percent of full market value. The financial capability assessment makes no provision for measuring a local tax burden other than the personal property and real estate taxes. The City receives a mid-range rating for this factor (See Table 7-5).

Property Tax Collection Rate: Personal property and real estate tax collections are reported to be approximately 94.95 percent in 2006, as presented on Table 7-5. This collection rate is classified as mid-range by the EPA property tax collection rating criteria.

7.2.2.1 Summary of Permittee Financial Capability Indicator

Table 7-5, Summary of Financial Capability Indicators, summarizes the financial indicators for the City of Anderson. Therefore, the City of Anderson received a financial capability rating of 1.67. The City falls in the mid-range category for the financial capability indicator.

Table 7-5 Financial Capability Indicators

ANDERSON MUNICIPAL SEWAGE WORKS
Anderson, Indiana

Financial Capability Indicators

		Value	Weak, Mid-Range or Strong	Score
Bond Rating		Moody's "A3", S&P "BBB+"	Mid-Range	2
Overall Net Debt as a Percent of Full Market Property Value				
Direct Net Debt as of December 1, 2006	$	1,530,000		
Add: Debt of Overlapping Entities as of December 1, 2006		151,743,670		
Overall Net Debt as of December 1, 2006	$	153,273,670		
Divided by: Estimated Market Property Value (True Tax Value) Payable Year 2006	$	1,625,046,142		
Overall Net Debt as a Percent of Full Market Property Value Payable Year 2006		9.43%	Weak	1
Average Unemployment Rates for 2006				
City of Anderson Average Unemployment Rates for 2006		5.5%		
Less: National Average Unemployment Rates for 2006		4.3%		
Difference of Anderson to the National Average Unemployment Rates for 2006		1.2%	Weak	1
Median Household Income (MHI)				
City of Anderson Adjusted MHI from 2000 Census	$	39,937		
National Adjusted MHI from 2000 Census	$	50,817		
Service Area MHI Comparison to National MHI		-21.41%	Mid-Range	2
Property Tax Revenue as a Percent of Full Market Property Value				
Payable Year 2006 Property Tax Levied - All Tax Districts	$	47,124,798		
Divided by: Estimated Market Property Value (True Tax Value) Payable Year 2006	$	1,625,046,142		
Property Tax Levy as a Percent of Full Market Property Value Payable Year 2006		2.90%	Mid-Range	2
Property Tax Revenue Collection Rate - City of Anderson				
Payable Year 2006 Property Tax Revenue	$	24,126,905		
Payable Year 2006 Property Tax Levied	$	25,410,976		
Property Tax Revenue Collection Rate		94.95%	Mid-Range	2
Financial Capability Indicators Matrix Total				10
Financial Capability Indicators Matrix Average			Mid-Range	1.67

7.3 Financial Capability Assessment Summary

Under EPA guidelines, the results of the residential indicator and permittee financial capability indicator analyses are combined in a Financial Capability Matrix to evaluate the financial burden that CSO controls may impose on a permittee. The matrix is used by permittees and EPA and state authorities to establish "reasonable and workable CSO control implementation schedules." The Financial Capability Matrix is presented on Table 7-6. It demonstrates that spending $161 million in CSO control costs would impose a financial burden on the City that is on the border between the medium and high ranges. Any increase in costs, which are anticipated as the project progresses, would put the financial burden squarely in the high range. IDEM draft guidance suggests that further analysis is needed for communities facing a medium burden to determine the extent of the social and economic impacts of CSO controls. Additional analysis of financial conditions in Anderson is provided in the following text.

Table 7-6 Financial Capability Matrix

Permittee Financial Capability Indicators Score	Residential Indicator (Cost per Household as a percentage of MHI)		
	Low (below 1.0 %)	Mid-Range (between 1.0 and 2.0 %)	High (greater than 2.0 %)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

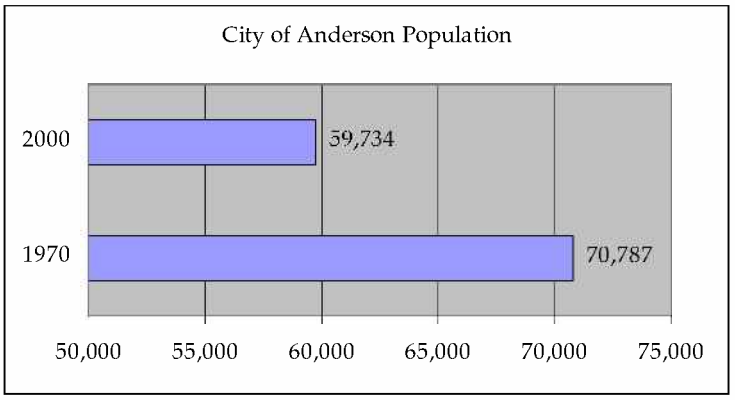
7.4 Anderson Demographics

The State and Federal CSO guidance documents recognize the need to consider a community's demographics when assessing its citizens' ability to afford improvements to wastewater treatment plants and sewers. The following demographic analysis includes discussions of the City of Anderson to accurately portray the socioeconomic, demographic, and employment conditions within the sewer service area.

7.4.1 Population of Anderson

U. S. Census data show that the City of Anderson's population decreased sixteen percent (16%) between 1970 and 2000, from 70,787 persons to 59,734. The estimated population for 2006 based upon U.S. Census statistics is 57,496 (Table 7-7).

Table 7-7 Anderson Population per U.S. Census



7.4.2 Employment Trends

Future income growth in the City and the surrounding communities depends upon prospective economic trends, driven in large part by employment. The affordability of CSO compliance is tied to such economic trends. If the economy is robust because of increased employment, median household income levels could rise, and the City would be able to afford higher compliance costs. If employment falls in a weak economy, residential households will bear a greater financial burden.

In the past few years, the City has lost many large employers. The City has recently attracted Nestle to the area. The large investment by Nestle is anticipated to add jobs to the community. While such investments indicate a recovering economy for the City, it is important at this time that the City is competitive with other communities in order to attract such investment. Undue burden in the form of utility rate increases may impact the City's ability to attract additional investments and therefore additional jobs.

7.5 Implementation Schedule

Both the EPA and IDEM have allowed ratepayers and permittees who are highly burdened by CSO compliance costs 15 to 20 years to fully address and complete capital projects. In cases where a high burden on the community is proven, permittees have been allowed a 20-year compliance schedule. The City believes that more than $161 million (including capital and O & M) will be spent to meet CSO control goals. As a result, the community burden from the Financial Capability Matrix would be pushed into the high range. In order to control the burden on the residential sewer users, the City of Anderson is proposing a 20-year implementation schedule for CSO controls.

The City realizes that the final CSO control schedule must be negotiated among the City, IDEM, and EPA. These negotiations will be based on the specific circumstances of the City's environmental and financial situation, plus the specific nature of any engineering and construction requirements that have been outlined in this LTCP. It is vital to develop an LTCP schedule that considers the overall increased financial burden on Anderson.

7.6 Funding

Funding of the CSO-related projects could be obtained through a number of different avenues. Not all projects need to utilize the same avenue of funding. The funding options available to the City could include the following:

Bonds: Bonds are promissory notes that could be issued, or sold, by the City to raise the funds to pay for the CSO project. This type funding is typically used for projects requiring large amounts of capital. Bonds typically have fixed payment schedules of 20 years, with the payments of interest and principal being made semi-annually. Interest rates of bonds are affected by the City's indebtedness and perceived ability to repay the bond. Several forms of bonds are available such as revenue bonds, general obligation bonds, moral obligation bonds, double-barreled bonds, and bonds available through state bond banks. Each bond type has specific advantages and disadvantages to the community.

Loans: Loans are another means of funding CSO-related programs. Loan interest rates vary according to each loan program. Loan programs vary in type, with some loan programs available primarily to small to mid-sized communities. Loan availability is based, in part, on the ability of a community to repay the funds it borrows. Depending on the specific municipality, loans are available from the state revolving fund (SRF) program, rural utility service, CoBank, and other commercial lending institutions. Each source of loans has different requirements, benefits, and limitations.

Grants: Traditionally, EPA grants were used for wastewater project funding. However, this funding source is very limited and the program has been replaced with a reliance on SRF loans and other funding options. Most current grant programs are designed to provide assistance for small and economically disadvantaged communities. While grants do not have to be repaid, they are not a reliable source of project funding, their requirements are extremely lengthy and complex, and they typically add both conditions and cost to projects. While the City plans to pursue both state and federal grant sources, grants are not likely to play a major role in funding the CSO program, given the project cost.

7.6.1 Grant and Loan Availability

As previously discussed, grant programs have been reduced significantly over the years and those programs currently still in place are very restrictive. Although the City is reviewing the availability of grant programs, at this time the City is not placing significant reliance on grants to

fund CSO controls. The amount of grant funding available is relatively minor in comparison to the anticipated capital expenditures for the program.

Ideally, the City of Anderson would prefer to use SRF loans to finance most CSO program projects. The SRF program would make funds available to the City at relatively low interest rates. However, there are no guarantees by the State of Indiana that SRF monies (or amounts in excess of $161 million) will be available for the City to finance the entire proposed program. Therefore, this financial capability assessment has been based on the assumption that the City will finance the project under the current bond rate.

Additionally, the City's Sewage Works currently has an "A3" and "BBB+" bond rating. The bond rate is based on the current outstanding debt, the economic condition of the City, and ability of the City to repay the debt. If the City incurs significant amounts of additional debt, the debt rating of the City and/or Sewage Works could be reduced, which could increase the interest rates paid for the bonds. A preliminary sensitivity analysis on the project indicates significant financial impacts as higher interest rates are incurred. This net effect would negatively impact sewer users in addition to potentially increasing interest costs to all other non-related projects that the City might fund through bonding programs.

7.6.2 Other Viable Funding Mechanisms

Few other viable funding mechanisms are available to fund wastewater projects. Some communities use a portion of property taxes to supplement user fee funding of capital improvements. However, the use of property taxes in this application does not place the burden of repayment equitably on the sewer system users. As an example, a single-family residence having a higher value, and consequently paying a higher amount of property tax, would not necessarily create a larger burden on the sewer system than a smaller single-family residence. In addition, property taxes would impose costs on property owners who are not connected to the sewer system, such as residences on septic systems. Therefore, the use of property taxes to fund wastewater system improvements does not provide a direct link between services and costs as does a system based on water usage and type of discharge.

7.6.3 Projected Residential, Commercial, and Industrial User Fee Impacts

The actual impact of the CSO controls on sewer user fees will depend on many factors. To cover anticipated design, engineering and construction costs during the first five years of the project, the City implemented a rate increase. The funds generated by this increase will help fund initial treatment plant upgrades as well as design and engineering work for CSO controls recommended in this LTCP. Beyond the initial five-year period, the impact on sewer user fees is difficult to predict. Actual user fees will depend on the final plan approved by IDEM and EPA, sources of funding, the interest rate and time allowed to repay any loans, and potential changes in technology that might reduce costs over time.

Crowe, the City's rate consultant, has analyzed potential impacts on residential sewer user rates based upon a 20-year implementation schedule using a variety of assumptions. This analysis estimates that residential sewer user fees would rise from their current average of $30.09 per 700 cubic feet to $121.01 per 700 cubic feet by 2029.

Because of rate increases, the largest industrial dischargers may evaluate the installation of on-site treatment or recycling facilities, which would both reduce wastewater flow in the sewer system and also reduce the projected cash flow to the City for the CSO project. If industrial rates are not comparable to other cities, some industries may re-evaluate expansion or new business startups in the City's service area. Loss of existing industrial revenue and lack of new growth could lower projected revenues, causing the project to be scaled back or causing rates to rise more than expected for the remaining ratepayers.

7.7 Summary

Using EPA and IDEM guidelines, the project team has analyzed the City's financial capability to bear the costs of proposed CSO controls. This included developing the EPA-defined cost per household as an indicator of the project's burden on citizens. In general, EPA and IDEM guidelines suggest that CSO control costs place a medium burden on a community if the cost per household is between 1% and 2% percent of the median household income (MHI). Controls are considered a high burden if the cost per household exceeds 2% of MHI.

Based on an estimated $161 million project cost, the City would face a financial burden on the border between the medium and high ranges. With anticipated capital cost increases, however, including O&M costs, the true burden is expected to push into the high range. In order to control the burden on the residential sewer users, the City is proposing a 20-year implementation schedule for CSO controls.

The City realizes that the final CSO control schedule must be negotiated among the City, IDEM, and EPA. These negotiations will be based on the specific circumstances of the City's environmental and financial situation, plus any engineering and construction constraints related to scheduling such a complex wastewater project. It is vital to develop an LTCP schedule that considers the overall increased financial burden on City of Anderson residents.

The actual impact of the CSO controls on sewer user fees will depend on many factors, including 1) the final plan approved by IDEM and EPA, 2) sources of funding (whether grants or loans), 3) the interest rate and time allowed to repay any loans, and 4) potential changes in technology that might reduce costs over time. The City also must carefully consider the relative impacts of sewer rate increases on residential, commercial and industrial users in developing a fair and equitable rate schedule.

Case Study #4: Anderson, Indiana CSO LTCP
Attachment 4-2
Newspaper Article

The Herald Bulletin
BECAUSE LIFE CHANGES DAILY
The Herald Bulletin e-Edition

Chesterfield wants sewer plant in wake of rate hike

By Brandi Watters, Herald Bulletin Staff Writer

May 18, 2009 11:41 pm

— CHESTERFIELD — Town Council members took a step toward building a wastewater treatment plant by approving the order for a preliminary engineering report, or PER, with Commonwealth Engineering Monday night.

Richard Lautz of Commonwealth told the board that a recent feasibility study showed that the town would save more money if it built its own wastewater treatment plant rather than continuing its contract with Anderson.

Chesterfield currently sends its wastewater to Anderson for treatment and Anderson has raised sewer rates. Last month, Anderson changed its rates, bringing rates up in increments over the next three years.

By 2011, Chesterfield residents will be expected to pay over $8.22 per 1,000 gallons under Anderson's new rate plan, according to Lautz.

Chesterfield residents currently pay $1.11 per 1,000 gallons.

Lautz was unable to give a specific rate estimate for residents if the plant was built, but said it was expected to be significantly cheaper than if the town continued its contract with Anderson.

The preliminary engineering report approved Monday will allow Commonwealth Engineers to complete an environmental impact study and gather data regarding the need for the sewer system as required by the state revolving loan fund, which will provide a loan for the construction of the plant.

Lautz estimated that the cost of a plant that treats up to 500,000 gallons of wastewater per day would be roughly $5.3 million, including all administrative and land acquisition costs.

Mark and Max Abrell of the Delaware County Regional Waste District attended the meeting to discuss the possibility of Daleville joining forces with Chesterfield in the operation of the plant.

Daleville will also be affected by Anderson's rate hike and the sewer lines are maintained by the Delaware County waste district.

Mark Abrell said joining forces "makes the most sense unless Anderson decides that it has made a mistake on the rates."

"It's definitely clear that it's cheaper," Lautz said.

If Chesterfield decides to go ahead with the project, with or without the cooperation of Delaware County, it will still be another two years before the town has its own plant, Lautz said.

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United States Environmental Protection Agency
Office of Water
Office of Wastewater Management (4204)
February 1997
EPA 832-B-97-004

EPA

Combined Sewer Overflows—Guidance for Financial Capability Assessment and Schedule Development

Final

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I. INTRODUCTION

Background

Combined sewer systems (CSSs) are wastewater collection systems designed to carry sanitary sewage (consisting of domestic, commercial and industrial wastewater) and storm water (surface drainage from rainfall or snow melt) in a single pipe to a treatment facility. CSSs serve about 43 million people in approximately 1,100 communities nationwide. Most of these communities are located in the Northeast and Great Lakes regions. During dry weather, CSSs convey domestic, commercial, and industrial wastewater. In periods of rainfall or snow melt, total wastewater flows can exceed the capacity of the CSS and/or treatment facilities. When this occurs, the CSS is designed to overflow directly to surface water bodies, such as lakes, rivers, estuaries, or coastal waters. These overflows - called combined sewer overflows (CSOs) - can be a major source of water pollution in communities served by CSSs.

Because CSOs contain untreated domestic, commercial, and industrial wastes, as well as surface runoff, many types of contaminants can be present. Contaminants may include pathogens, oxygen-demanding pollutants, suspended solids, nutrients, toxics, and floatable matter. Because of these contaminants and the volume of the flows, CSOs can cause a variety of adverse impacts on the physical characteristics of surface water, impair the viability of aquatic habitats, and pose a potential threat to drinking water supplies. CSOs have been shown to be a major contributor to use impairment and aesthetic degradation of many receiving waters and have contributed to shellfish harvesting restrictions, beach closures, and even occasional fish kills.

History of the CSO Control Policy

Historically, the control of CSOs has proven to be extremely complex. This complexity stems partly from the difficulty in quantifying combined sewer overflow (CSO) impacts on receiving water quality and the site specific variability in the volume, frequency, and characteristics of CSOs. In addition, the financial considerations for communities with CSOs can be significant. The U.S. Environmental Protection Agency (EPA) estimates the CSO abatement costs for the 1,100 communities served by CSSs to be approximately $41.2 billion.

To address these challenges, EPA's Office of Water issued a National Combined Sewer Overflow Control Strategy on August 10, 1989 (54 *Federal Register* 37370). This Strategy reaffirmed that CSOs are point source discharges subject to National Pollutant Discharge Elimination System (NPDES) permit requirements and Clean Water Act (CWA) requirements.

The CSO Strategy recommended that all CSOs be identified and categorized according to their status of compliance with these requirements. It also set forth three objectives:

- Ensure that if CSOs occur, they are only as a result of wet weather
- Bring all wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA
- Minimize the impacts of CSOs on water quality, aquatic biota, and human health.

In addition, the CSO Strategy charged all States with developing state-wide permitting strategies designed to reduce, eliminate, or control CSOs.

Although the CSO Strategy was successful in focusing increased attention on CSOs, it fell short in resolving many fundamental issues. In mid-1991, EPA initiated a process to accelerate implementation of the Strategy. The process included negotiations with representatives of the regulated community, State regulatory agencies, and environmental groups. These negotiations were conducted through the Office of Water Management Advisory Group. The initiative resulted in the development of a CSO Control Policy, which was published in the *Federal Register* on April 19, 1994 (59 *Federal Register* 18688). The intent of the CSO Control Policy is to:

- Provide guidance to permittees with CSOs, NPDES permitting and enforcement authorities, and State water quality standards (WQS) authorities
- Ensure coordination among the appropriate parties in planning, selecting, designing, and implementing CSO management practices and controls to meet the requirements of the CWA
- Ensure public involvement during the decision-making process.

The CSO Control Policy contains provisions for developing appropriate, site-specific NPDES permit requirements for all CSSs that overflow due to wet weather events. It also announces an enforcement initiative that requires the immediate elimination of overflows that occur during dry weather and ensures that the remaining CWA requirements are complied with as soon as possible.

Key Elements of the CSO Control Policy

The CSO Control Policy contains four key principles to ensure that CSO controls are cost-effective and meet the requirements of the CWA:

- Provide clear levels of control that would be presumed to meet appropriate health and environmental objectives

- Provide sufficient flexibility to municipalities, especially those that are financially disadvantaged, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements

- Allow a phased approach for implementation of CSO controls considering a community's financial capability

- Review and revise, as appropriate, WQS and their implementation procedures when developing long-term CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In addition, the CSO Control Policy clearly defines expectations for permittees, State WQS authorities, and NPDES permitting and enforcement authorities. These expectations include the following:

- Permittees should immediately implement the nine minimum controls (NMC), which are technology-based actions or measures designed to reduce CSOs and their effects on receiving water quality, as soon as possible but no later than January 1, 1997. More information on the NMC can be found in the EPA document *Combined Sewer Overflows Guidance for Nine Minimum Controls* (EPA 832-B-95-003)

- Permittees should give priority to environmentally sensitive areas

- Permittees should develop long-term control plans (LTCPs) for controlling CSOs. A permittee may use one of two approaches: 1) demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or 2) implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach")

- WQS authorities should review and revise, as appropriate, State WQS during the CSO long-term planning process

- NPDES permitting authorities should consider the financial capability of permittees

when reviewing CSO control plans.

Table 1 illustrates the roles and responsibilities of permittees, NPDES permitting and enforcement authorities, and state WQS authorities.

In addition to these key elements and expectations, the CSO Control Policy also addresses important issues such as ongoing or completed CSO control projects, public participation, small communities and watershed planning.

ROLES AND RESPONSIBILITIES
Table 1

Permittee	NPDES Permitting Authority	NPDES Enforcement Authority	State WQS Authorities
• Evaluate and implement NMC • Submit documentation of NMC implementation by January 1, 1997 • Develop LTCP and submit for review to NPDES permitting authority • Support the review of WQS in CSO-impacted receiving water bodies • Comply with permit conditions based on narrative WQS • Implement selected CSO controls from LTCP • Perform post-construction compliance monitoring • Reassess overflows to sensitive areas • Coordinate all activities with NPDES permitting authority, State WQS authority, and State watershed personnel	• Reassess/revise CSO permitting strategy • Incorporate into Phase I permits CSO-related conditions (e.g., NMC implementation and documentation and LTCP development) • Review documentation of NMC implementation • Coordinate review of LTCP components throughout the LTCP development process and accept/approve permittee's LTCP • Coordinate the review and revision of WQS as appropriate • Incorporation into Phase II permits CSO-related conditions (e.g., continued NMC implementation and LTCP implementation) • Incorporate implementation schedule into an appropriate enforceable mechanism • Review implementation activity reports (e.g., compliance schedule progress reports)	• Ensure that CSO requirements and schedules for compliance are incorporated into appropriate enforceable mechanisms • Monitor compliance with Jan 1, 1997, deadline for NMC implementation and documentation • Take appropriate enforcement action against dry weather overflows • Monitor compliance with Phase I, Phase II, and post-Phase II permits and take enforcement action as appropriate	• Review WQS in CSO-impacted receiving water bodies • Coordinate review with LTCP development • Revise WQS as appropriate Development of site-specific criteria Modification of designated use to - Partial use reflecting specific situations - Define use more explicitly Temporary variance from WQS

Guidance to Support Implementation of the CSO Control Policy

To help permittees and NPDES permitting and WQS authorities implement the provisions of the CSO Control Policy, EPA has developed the following documents:

- *Combined Sewer Overflows—Guidance for Long-Term Control Plan* (EPA 832-B-95-002)
- *Combined Sewer Overflows—Guidance for Nine Minimum Controls* (EPA 832-B-95-003)
- *Combined Sewer Overflows—Guidance for Screening and Ranking* (EPA 832-B-95-004)
- *Combined Sewer Overflows—Guidance for Monitoring and Modeling* (EPA 832-B-97-001)
- *Combined Sewer Overflows—Guidance for Financial Capability Assessment and Schedule Development* (EPA 832-B-97-004)
- *Combined Sewer Overflows—Guidance for Funding Options* (EPA 832-B-95-007)
- *Combined Sewer Overflows—Guidance for Permit Writers* (EPA 832-B-95-008)

Goal of this Guidance

The CSO Policy recognizes the need to address the relative importance of environmental and financial issues when developing an implementation schedule for CSO controls to be contained in the LTCP and the NPDES permit or other enforceable mechanism. According to the CSO Policy, an implementation schedule "may be phased based on the relative importance of adverse impacts upon WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability."

This guidance has two goals. The first goal is to provide a planning tool for evaluating the financial resources a permittee has available to implement CSO controls. This assessment will involve the use of the following financial capability indicators listed in the CSO Policy:

- Total annual wastewater and CSO control cost per household as a percent of median household income
- Bond ratings
- Overall net debt as percent of full market property value

- Unemployment rate
- Median household income
- Property tax revenue collection rate
- Property tax revenues as a percent of full market property value

It must be emphasized that the financial indicators found in this guidance might not present the most complete picture of a permittee's financial capability to fund the CSO controls. However, the financial indicators do provide a common basis for financial burden discussions between the permittee and EPA and state NPDES authorities. Since flexibility is an important aspect of the CSO Policy, permittees are encouraged to submit any additional documentation that would create a more accurate and complete picture of their financial capability.

Although this guidance focuses on the role of financial capability for development of an implementation schedule for CSO controls, the financial capability analysis process can be useful for the identification and evaluation of long-term control alternatives in the LTCP.

The second goal is to assist the permittee, EPA and state NPDES authorities in cooperatively developing CSO control implementation schedules. This will involve an evaluation of the following environmental and financial considerations listed in the CSO Policy:

- Eliminating overflows to sensitive areas
- Use impairment
- Financial capability
- Grant and loan availability
- Previous and current sewer user fees and rate structures
- Other viable funding mechanisms and sources of financing

This guidance does not recommend specific schedules for implementation of the CSO controls based on financial capability or other considerations identified in the CSO Policy. It does, however, provide general boundaries to aid all parties in negotiating reasonable and effective schedules for implementation of the CSO controls.

It is important to recognize that scheduling flexibility is not the only form of relief available to permittees. The CWA and EPA regulations provide mechanisms for the review and revision of WQS. The CSO Policy also encourages the "review and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs." During the process of developing the

LTCP, the permittee should consult with NPDES and WQS authorities to share information on the water quality impacts of CSOs, the attainability of WQS, and the appropriate water quality-based requirements of the permit. It may be appropriate to conduct a use attainability analysis and revisit existing designated uses in order to ensure that the LTCP selected will be sufficient to attain WQS. EPA's "Interim Economic Guidance for Water Quality Standards-Workbook"(EPA-823-B-95-002) provides an approach for assessing whether a water pollution project will impose "substantial and widespread social and economic impacts," as defined in EPA regulations.

Organization of Guidance

Section II summarizes a two phase approach for assessing a permittee's financial capability to implement CSO controls. Section III describes the first phase which calculates the financial impact of wastewater and CSO controls on individual households. Section IV describes the second phase used to calculate a permittee's debt, socioeconomic and financial conditions. The results of the first and second phases are combined to give an overall assessment of a permittee's financial capability to be used in CSO schedule development. Although financial capability is only one factor in schedule development, a major portion of this guidance is devoted to financial capability assessment because of the complexity of the process and its importance. Section V describes the schedule development process for implementing CSO controls, and details how environmental and financial considerations influence schedule development.

Audience

This guidance is designed for use by permittees, EPA and state NPDES authorities, and other personnel with CSO planning and permitting responsibilities. It is written in a format that allows individuals with limited municipal financial assessment experience to conduct CSO financial capability assessments and negotiate reasonable CSO implementation schedules. Individuals with experience in establishing schedules for enforcement orders and reviewing financial capability assessments under the Water Quality Standards, Construction Grants and State Revolving Fund (SRF) programs will be able to quickly and efficiently conduct the assessment detailed in this guidebook.

II. CSO FINANCIAL CAPABILITY ASSESSMENT APPROACH

This section describes a process for evaluating parameters that measure a permittee's financial capability to implement CSO controls. The process reflects the experience of EPA in the Water Quality Standards (WQS) program, Construction Grants program, State Revolving Fund (SRF) program and the water enforcement program. Experience with these programs provides the foundation upon which EPA has built the CSO financial capability assessment approach.

In the WQS program, economic factors are considered in the process of modifying WQS. State WQS authorities conduct economic analysis of the impacts that will result from treatment levels beyond the technology-based requirements of the Clean Water Act. EPA's "Interim Economic Guidance for Water Quality Standards" (EPA 823-B-95-002) provides an approach for assessing substantial and widespread social and economic impacts of specific water pollution control projects. The process to identify "substantial" impacts is similar to the process used in this guidance to analyze financial capability and its implications for scheduling CSO controls.

Under the Construction Grants Program, financial capability assessments were conducted by municipalities and reviewed by EPA to demonstrate that municipalities had the ability to pay for the capital investments and the costs for operation and maintenance of the wastewater facilities. The assessments measured the financial conditions of the municipality and the financial burden the proposed projects imposed on households. Some of the financial indicators used in the demonstrations were similar to those used in this guidance. The demonstration procedure is described in EPA's "Financial Capability Guidebook" (1984).

As part of SRF program implementation, states devised financial capability assessment procedures for loan applicants. Often the procedures include a review of the same financial indicators described in this document.

The Agency's water enforcement program conducts detailed evaluations of a permittee's current financial conditions to assess the amount of penalty that can be borne by the permittee for violations of the CWA. The evaluations frequently include financial indicators used in this guidance.

The CSO financial capability assessment process also reflects the approach taken by bond rating agencies and other investment industry firms to assess a municipality's or wastewater utility's overall financial condition and credit capacity. The bond rating agencies generally use the same types of financial information when they evaluate specific bond issues. Rating agencies evaluate this information to determine the overall financial health of an issuer and identify any factors that could make it difficult for the permittee to repay its bonds. The approach developed for the CSO financial capability assessment incorporates the principles used by the rating agencies.

The Two-Phase Approach

The guidance presents a two-phase approach to assessing a permittee's financial capability. The first phase identifies the combined impact of wastewater and CSO control costs on individual households. The second phase examines the debt, socioeconomic, and financial conditions of a permittee. The results of the two-phase analysis are combined in a Financial Capability Matrix. Permittees and the WQS and NPDES authorities can use this matrix to assess the financial burden of the CSO control costs and establish reasonable schedules to implement the CSO controls.

Phase one determines a Residential Indicator. This indicator is the permittee's average cost per household (CPH) for wastewater treatment (WWT) and CSO controls as a percentage of the local median household income (MHI). It reflects the residential share of current and planned WWT and CSO controls needed to meet the requirements of the CWA. A value range for this indicator characterizes whether the costs impose a "low," "mid-range" or "high" financial impact on residential users.

The second phase develops the Permittee Financial Capability Indicators. Six indicators are used to evaluate the debt, socioeconomic, and financial conditions that affect a permittee's financial capability to implement the CSO controls. These indicators serve as the basis for a second phase analysis that will characterize the permittee's financial capability as "weak," "mid-range" or "strong."

A Financial Capability Matrix combines the Residential Indicator (first phase) and Permittee Financial Capability Indicators (second phase) to give an overall assessment of the permittee's financial capability. This assessment can be used to help establish an appropriate CSO control implementation schedule.

Since flexibility is an important component of the CSO Policy, WQS authorities, NPDES authorities, EPA personnel, and permittees should communicate throughout the CSO control planning process to coordinate the development of an effective LTCP. This guidance document provides all CSO participants with a structured yet flexible approach for evaluating the financial burden CSO controls place on permittees. It also recognizes the importance of this financial burden when establishing a CSO control implementation schedule. The financial capability information developed in this guidance provides a basis for the permittee and the NPDES authorities to negotiate the implementation schedule for the CSO controls. However, when a permittee believes that there are unique circumstances that would affect the conclusion of this guidance, the permittee may submit documentation of its unique financial conditions to the appropriate EPA or State NPDES authorities for consideration.

Financial Benchmarks and Information Sources

The information used to develop the indicators needed for the financial assessment is drawn from several different sources. In general, this information should be available through a combination of local, state, and Federal sources. Project cost information is available in the LTCP. Socioeconomic information, such as median household income, is available from census data. Detailed financial information is available from a community's annual financial statements. Financial statements may be obtained directly from a community or, in most states, from the state auditor's office which maintains a central file of audited reports. When the permittee's service area involves more than one jurisdiction, it will be necessary to examine data for each jurisdiction to develop the necessary data.

III. PHASE ONE: THE RESIDENTIAL INDICATOR

The Residential Indicator measures the financial impact of the current and proposed WWT and CSO controls on residential users. Development of this indicator starts with the determination of the current and proposed WWT and CSO control costs per household (CPH). Second, the service area's CPH estimate and the median household income (MHI) are used to calculate the Residential Indicator. Finally, the Residential Indicator is compared to established financial impact ranges to determine whether CSO controls will produce a possible high, mid-range or low financial impact on the permittee's residential users. Worksheets are provided to aid in developing the Residential Indicator.

Developing CPH Estimate

The first step in developing the CPH is to determine the permittee's total WWT and CSO costs by adding together the current costs for existing wastewater treatment operations and the projected costs for any proposed WWT and CSO controls. The next step is to calculate the residential share of the total WWT and CSO costs. The final step is to calculate the CPH by dividing the residential share of total WWT and CSO costs by the number of households in the permittee's total wastewater service area.

Current WWT costs are defined as current annual wastewater operating and maintenance expenses (excluding depreciation) plus current annual debt service (principal and interest). This fairly represents cash expenses for current wastewater treatment operations. (Expenses for funded depreciation, capital replacement funds, or other types of capital reserve funds are not included in current WWT costs, because they represent a type of savings account rather than an actual operation and maintenance expense.)

Estimates of projected costs are made for any proposed WWT projects and the CSO controls. Any concerns about including specific proposed WWT projects or CSO controls in the projected costs, or the length of the planning period, should be discussed with the appropriate NPDES permitting and enforcement authorities. These costs are adjusted to current dollars (i.e., deflated). These include projected operation and maintenance expenses plus projected debt service costs for any proposed WWT and the CSO controls. The residential or household costs exclude the portion of expenses attributable to commercial, governmental and industrial wastewater discharges. The information and calculations used to develop the CPH and the Residential Indicator are presented in Worksheets 1 and 2 and their instructions.

Worksheet 1 Instructions

Enter the requested data on lines 100 through 109. The operation and maintenance costs on lines 100 and 103 should include all significant cost categories, such as labor, chemicals, utilities, administration, and equipment replacement. Do not include depreciation on line 100 or line 103. Adjust the projected annual WWT and CSO costs to current dollars using the average annual national Consumer Price Index (CPI) inflation rate for the past five years available from the Bureau of Labor Statistics. The CPI is used as a simple and reliable method of indexing projected WWT costs and household income. For example, if the most recent five year average CPI is 4 percent, and the projected annual O& M and debt service costs will begin in 2 years, adjust the projected costs with the following formula:

$$Adjusted\ Projected\ Costs\ (Current\ Dollars) = Projected\ Costs \times Adjustment\ Factor$$

The adjustment factor can be calculated using the following formula or the present value factor from the table on page 55:

$$Adjustment\ Factor = \frac{1}{(1+CPI)^{years}} = \frac{1}{(1+.04)^2} = .925$$

The annualized debt service cost information for the projected WWT facilities and projected CSO controls (Line 104) can be calculated using an annualization factor obtained from the table on page 56, which reflects the local borrowing interest rate and borrowing term of the permittee. For example, if the adjusted projected debt costs (current dollars) are $25,000,000 and typical borrowing terms include an interest rate of eight percent over 20 years, then costs can be annualized with the following calculation:

$$Annual\ Debt\ Service\ Costs = Adjusted\ Debt\ Costs \times Annualization\ Factor$$

$$Annual\ Debt\ Service\ Cost = \$25,000,000 \times .1019 = \$2,547,500$$

The annualization factor can be calculated using the following formula:

$$Annualization\ Factor = \frac{Interest\ Rate}{(1+Interest\ Rate)^{years} - 1} + Interest\ Rate = \frac{.08}{(1+.08)^{20} - 1} + .08 = .1019$$

The annualized debt service cost for the projected WWT facilities and projected CSO controls is entered on line 104. Add the current and projected wastewater treatment and projected CSO control costs to estimate the total WWT and CSO costs (line 102 + line 105).

Calculate the residential share of the total cost (line 106) and enter on line 107. The residential share of total costs (line 107) is computed by multiplying the percent of total wastewater flow including infiltration and inflow attributable to residential users by the total costs (line 106). For example, for a permittee with the following characteristics:

Total Costs:	$12,000,000
Residential Flow:	10.5 Million Gallons per Day
Total Flow:	13.1 Million Gallons per Day

The residential share of the total cost is:

$$\textit{Residential Share of Costs} = \textit{Total Costs} \times \frac{\textit{Residential Wastewater Flow}}{\textit{Total Wastewater Flow}}$$

$$\textit{Residential Share of Costs} = \$12{,}000{,}000 \times \frac{10.5\ \textit{Million Gallons Per Day}}{13.1\ \textit{Million Gallons Per Day}}$$

$$\$9{,}600{,}000$$

Calculate the CPH (line 109) by dividing total residential share costs (line 107) by the total number of households (line 108) in the permittee's total wastewater service area.

Data Sources

The permittee's latest financial reports should be available to develop the current wastewater treatment costs. In order to comply with accounting requirements, most permittees develop a combined statement of revenues, expenses, and changes in fund balance. These reports should be available directly from the permittee, or, in some states, from central records kept by the state auditor or other state offices. (Many states conduct audits and generate financial reports - i.e., balance sheet, statement of revenues, expenses, and changes in fund balance, and statement of cash flows, for each permittee.) Projected costs and households in the wastewater service area should be available through planning documents. The Bureau of Labor Statistics frequently has data on the number of households in the service area.

The Consumer Price Index rate (CPI) should be the average rate for the previous five years. The CPI is available through the Bureau of Labor Statistics.

COST PER HOUSEHOLD
Worksheet 1

		Line Number
Current WWT Costs		
• Annual Operations and Maintenance Expenses (Excluding Depreciation)	_____	100
• Annual Debt Service (Principal and Interest)	_____	101
Subtotal (Line 100 + Line 101)	_____	102
Projected WWT and CSO Costs (Current Dollars)		
• Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	_____	103
• Annual Debt Service (Principal and Interest)	_____	104
Subtotal (Line 103 + Line 104)	_____	105
Total Current and Projected WWT and CSO Costs (Line 102 + Line 105)	_____	106
Residential Share of Total WWT and CSO Costs	_____	107
Total number of Households in Service Area	_____	108
Cost Per Household (Line 107 ÷ Line 108)	_____	109

Developing the MHI Estimate

The second step in developing the Residential Indicator is to determine the adjusted median household income (MHI) for the permittee's entire wastewater service area. Information and calculations used to develop the adjusted MHI value are presented in Worksheet 2 and its instructions.

Worksheet 2 Instructions

Enter the requested information on Worksheet 2, lines 201 through 203. MHI from the latest census year should be adjusted to current year dollars with the average CPI inflation rate from the latest census year to the current year using the following formula.

$$Adjusted\ MHI = MHI \times Adjustment\ Factor$$

The MHI adjustment factor can be calculated using the following formula or the inflation adjustment factor from the table on page 58:

$$MHI\ Adjustment\ Factor = (1+CPI)^{Current\ Year-Census\ Year}$$

For example, if a permittee's MHI was $30,000 in the 1990 census year, the average annual CPI since 1990 was 4 percent and the current year is 1992, the following calculation would be made to adjust the MHI to current dollars:

$$Adjustment\ Factor = (1+.04)^{1992-1990} = 1.0816$$

$$Adjusted\ MHI = \$30,000 \times 1.0816 = \$32,448$$

On Worksheet 2, calculate the adjusted MHI by entering the latest census MHI value on line 201. Then enter the MHI Adjustment Factor on line 202. Finally, multiply the MHI (line 201) by the Adjustment Factor (line 202) and enter the Adjusted MHI on line 203.

RESIDENTIAL INDICATOR
Worksheet 2

Median Household Income (MHI)		Line Number
• Census Year MHI	_____	201
• MHI Adjustment Factor	_____	202
• Adjusted MHI (Line 201 x Line 202)	_____	203
Annual WWT and CSO Control Cost Per Household (CPH) (Line 109)	_____	204
Residential Indicator:		
Annual Wastewater and CSO Control Costs per Household as a percent of Adjusted Median Household Income (CPH as % MHI) (Line 204 ÷ Line 203 x 100)	_____	205

If the permittee's service area includes more than one jurisdiction, it may be necessary to develop a weighted MHI for the entire service area. The Bureau of Census's designated MHI areas generally encompass most permittees' service areas. For this reason, the calculation of a weighted MHI usually will not be necessary to reasonably represent the permittee's MHI. When a weighted MHI must be acquired, a weight would be assigned to each jurisdiction to reflect its share of the total households.

The following example illustrates how to develop a weighted MHI value before adjusting it to current year dollars. If a permittee is a regional authority that serves three local jurisdictions, the weighted average MHI would be calculated as follows:

Jurisdiction	MHI	Number of Households (HH)
A	$30,000	100,000
B	$45,000	25,000
C	$25,000	50,000
		175,000

$$\text{Weighted MHI} \quad MHI_A\left(\frac{HH_A}{\text{Total HH}}\right) + MHI_B\left(\frac{HH_B}{\text{Total HH}}\right) + MHI_C\left(\frac{HH_C}{\text{Total HH}}\right)$$

$$\$30{,}000\left(\frac{100{,}000}{175{,}000}\right) + \$45{,}000\left(\frac{25{,}000}{175{,}000}\right) + \$25{,}000\left(\frac{50{,}000}{175{,}000}\right)$$

$$\$17{,}143 + \$6{,}429 + \$7{,}143$$

$$\$30{,}715$$

Data Sources

Median household income is available for most communities from the latest census. In the few cases where a local jurisdiction's MHI is not available, the surrounding county's MHI may be sufficient. Each state has a state data center that serves as a local source of census data for public use. This center may be contacted to obtain the information available from the Bureau of Census for use during this assessment (see Appendix B).

Developing the Residential Indicator

Worksheet 2 Instructions

To calculate the Residential Indicator (line 205 of Worksheet 2), divide the annual WWT and CSO control cost per household (line 109 transferred to line 204) by the Adjusted MHI (line 203) and multiply by 100.

Analyzing the Residential Indicator

The Residential Indicator will be used in the Financial Capability Matrix in Section IV to help permittees, and EPA and state NPDES authorities determine reasonable and workable long-term CSO control schedules. (The Residential Indicator does not provide special recognition for low income groups since their influence is automatically reflected in the median household income component of the indicators.)

To assess the financial impact CSO controls may have on the permittee's residential users, the Residential Indicator is compared to the financial impact ranges that reflect EPA's previous experience with water pollution control programs. These ranges are as follows:

Financial Impact	Residential Indicator (CPH as % MHI)
Low	Less than 1.0 Percent of MHI
Mid-Range	1.0 - 2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI

When the Residential Indicator is less than 1.0 percent, between 1.0 and 2.0 percent, and greater than 2.0 percent, the financial impact on residential users to implement the CSO controls will be characterized as "low," "mid-range," and "high," respectively. Unless there are significant weaknesses in a permittee's financial and socioeconomic conditions, second phase reviews for permittees that have a low residential indicator score (less than 1.0) are unlikely to result in longer implementation schedules. Permittees with low residential indicators may wish to forego the second phase analysis and proceed with the normal engineering and construction implementation schedule developed as part of the CSO planning process.

In situations where a permittee believes that there are unique circumstances that would affect the conclusion of the first phase, the permittee may submit documentation of its unique financial conditions to the appropriate state NPDES and EPA authorities for consideration.

IV. PHASE TWO: PERMITTEE FINANCIAL CAPABILITY INDICATORS

In the second phase, selected indicators are assessed to evaluate the financial capability of the permittee. These indicators will examine the permittee's debt burden, socioeconomic conditions, and financial operations. The second-phase review examines three general categories of financial capability indicators for the permittee:

- Debt Indicators - Assess current debt burden of the permittee or the communities within the permittee's service area and their ability to issue additional debt to finance the CSO controls. The indicators selected for this purpose are:
  - Bond Ratings (General Obligation and/or Revenue Bond Fund)
  - Overall Net Debt as a Percent of Full Market Property Value
- Socioeconomic Indicators - Assess the general economic well-being of residential users in the permittee's service area. The indicators selected for this purpose are:
  - Unemployment Rate
  - Median Household Income
- Financial Management Indicators - Evaluate the permittee's overall ability to manage financial operations. The indicators selected for this purpose are:
  - Property Tax Revenue Collection Rate
  - Property Tax Revenues as a Percent of Full Market Property Value

Even though the financial capability analysis reflects current conditions, pending changes in the service area should be considered in development of the second phase indicators. For example, if the current unemployment rate is high, but there is a new plant opening that will stimulate economic growth, the unemployment indicators for the service area would need to be modified to reflect the projected impact of the new plant. The permittee should submit documentation of such conditions to the appropriate EPA and state NPDES authorities for consideration. When the permittee is a sanitary district, sewer authority or similar entity, the second phase indicators related to property values and tax revenues may not be applicable. In those circumstances, the permittee may simply use the remaining indicators or submit other related documentation that will help assess its financial capability to implement the CSO controls.

DEBT INDICATORS

The debt indicators described below were selected to assess the current debt burden conditions and the ability to issue new debt. These indicators are the bond rating and overall net debt as a percent of full market property value. When these indicators are not available for the permittee, other financial data which illustrates debt burden and debt issuing capacity may be used to assess the permittee's financial capability in this area.

Bond Rating

The information needed to evaluate the bond ratings is presented in Worksheet 3. Recent bond ratings for the permittee and service area communities summarize a bond rating agency's assessment of a permittee's or community's credit capacity. General obligation (G.O.) bonds are bonds issued by a local government and repaid with taxes (usually property taxes). They are the primary long-term debt funding mechanism in use by local governments. General obligation bond ratings reflect financial and socioeconomic conditions experienced by the community as a whole.

"Revenue bond" ratings, by comparison, reflect the financial conditions and management capability of the wastewater utility. They are repaid with revenues generated from user fees. Revenue bonds are sometimes referred to as water or sewer bonds. In some cases these bonds may have been issued by the state on behalf of local communities. (Additional information on bonds is contained in EPA's Combined Sewer Overflows—Guidance For Funding Options (EPA 832-B-95-007).

Bond ratings normally incorporate an analysis of many financial capability indicators. These analyses evaluate the long term trends and current conditions for the indicators. The ultimate bond ratings reflect a general assessment of the current financial conditions. However, if security enhancements like bond insurance have been used for a revenue bond issue, the bond rating may be higher than justified by the local conditions.

Many small and medium-sized communities and permittees have not used debt financing for projects and, as a result, have no bond rating. The absence of bond rating does not indicate strong or weak financial health. When a bond rating is not available, this indicator may be excluded from the financial analysis.

Worksheet 3 Instructions

Enter the most recent bond ratings on Worksheet 3, lines 301 and 302. Note that ratings are requested for general obligation bonds and revenue bonds. When there are several different bond ratings, enter the most recent bond rating on Line 303 as the summary bond rating.

Data Sources

Municipal bond reports from rating agencies (e.g., Moody's Bond Record, Standard & Poor's Corporation) provide recent ratings.

Benchmarks

Moody's Investor Services

"Baa" is the minimum investment grade rating. See *Moody's on Municipals - an Introduction to Issuing Debt* for a description of bond ratings.

Moody's Investor Services' Ratings

- Weak: Ba, B, Caa, Ca, C
- Mid-Range: Baa
- Strong: Aaa, AA, A

Standard & Poor's

"BBB" is the minimum investment grade rating. See Standard & Poor's *Municipal Finance Criteria* for a description of bond ratings.

Standard and Poor's Ratings

- Weak: BB, B, CCC, CC, C, D
- Mid-Range: BBB
- Strong: AAA, AA, A

BOND RATING
Worksheet 3

		Line Number
• Most Recent General Obligation Bond Rating	_____	
Date:	_____	
Rating Agency:	_____	
Rating:	_____	301
• Most Recent Revenue (Water/Sewer or Sewer) Bond		
Date:	_____	
Rating Agency:	_____	
Bond Insurance (Yes/No)	_____	
Rating:	_____	302
Summary Bond Rating:	_____	303

Overall Net Debt as a Percent of Full Market Property Value

Description

Overall net debt is debt repaid by property taxes in the permittee's service area. It excludes debt which is repaid by special user fees (e.g., revenue debt). This indicator provides a measure of the debt burden on residents within the permittee's service area and measures the ability of local governmental jurisdictions to issue additional debt. It includes the debt issued directly by the local jurisdiction and debt of overlapping entities, such as school districts. This indicator compares the level of debt owed by the service area population with the full market value of real property used to support that debt and serves as a measure of financial wealth in the permittee's service area. Information needed to develop overall net debt as a percent of full market value is identified on Worksheet 4.

Worksheet 4 Instructions

Enter requested data on Worksheet 4, lines 401 - 405.

Line 401 - Direct Net Debt - Enter the amount of each jurisdiction's general obligation debt outstanding that is supported by the property in the permittee's service area. General obligation bonds are secured by the "full faith and credit" of the community and are payable from general tax revenues. This debt amount excludes general obligation bonds that are payable from some dedicated user fees or specific revenue source other than the general tax revenues. These general obligation bonds are called "double-barreled bonds."

Line 402 - Debt of Overlapping Entities - Calculate the permittee's service area's share of any debt from overlapping entities using the process illustrated below.

1. Identify in Column A below each overlapping entity that has incurred debt that must be partially supported by the permittee's service area. (Check the State assessor's office for this information).
2. Identify the total amount of tax-supported outstanding debt for each overlapping entity in Column B. Money in a sinking fund is not included in the outstanding debt since it represents periodic deposits into an account to ensure the availability of sufficient monies to make timely debt service payments.
3. Identify the percentage of each overlapping entity's outstanding debt charged to persons or property in the permittee's service area in Column C. The percentage is based on the estimated full market value of real property of the respective jurisdictions.

4. Multiply the total outstanding debt of each overlapping entity by the percentage identified for the permittee's service area (Column B x C).
5. Add the figures in Column D to arrive at total overlapping debt for permittee's service area.

(A) Overlapping Entities	(B) Outstanding Debt (less Sinking Fund)	(C) Percent Chargeable to Permittee's Service Area	(D) Outstanding Debt Attributable to Permittee's Service Area
County	$10,500,000	25%	$2,625,000
School District	16,800,000	95%	15,960,000
Total Overlapping Debt			$18,585,000

Line 403 - Overall Net Debt - Add lines 401 and 402.

Line 404 - Market Value of Property - The property value should reflect the full market value of property within the permittee's service area. It is possible that the tax assessed property value will not reflect full market value. This occurs when the tax assessment ratio is less than one. In such cases the full market value of property is computed by dividing the total tax assessment value by the assessment ratio (the assessment ratio represents the percentage of the full market value that is taxed at the established tax rate). For example, if the assessed value is $1,000,000 and the assessment ratio is 50 percent then the full market value of real property is $1,000,000/.50= $2,000,000.

Line 405 - Overall Net Debt as a Percent of Full Market Property Value - Divide line 403 by line 404 and multiply by 100.

Data Sources

Debt information is available from the financial statements of each community. In most cases the most recent financial statements are on file with the state (e.g., State Auditor's Office). Overlapping debt may or may not be provided in a community's financial statements. The property assessment data should be readily available through the community or the State's assessor office. The boundary of most permittees' service areas generally conforms to one or more community boundaries. Therefore, prorating community data to reflect specific service area boundaries is not normally necessary for evaluating the general financial capability of the permittee.

Benchmarks

- Weak: Above 5%
- Mid-range: 2-5%
- Strong: Below 2%

OVERALL NET DEBT AS A PERCENT OF FULL MARKET PROPERTY VALUE
Worksheet 4

		Line Number
• Direct Net Debt (G.O. Bonds Excluding Double-Barreled Bonds)	_____	401
• Debt of Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	_____	402
• Overall Net Debt (Lines 401+402)	_____	403
• Market Value of Property	_____	404
• Overall Net Debt as a Percent of Full Market Property Value (Line 403 divided by Line 404 x 100)	_____	405

SOCIOECONOMIC INDICATORS

The socioeconomic indicators are used to assess the general economic well-being of residential users in the permittee's service area. The indicators used to assess economic conditions are unemployment rate and median household income. When the permittee has additional socioeconomic data, it may want to submit the data to the appropriate EPA and state NPDES authorities to facilitate a better understanding of the permittee's unique economic conditions. Several examples of this type of socioeconomic data could be poverty rate, population growth, and employment projections.

Unemployment Rate

Unemployment information is entered on Worksheet 5. The unemployment rate is defined as the percent of a permittee's service area residents on the unemployment rolls.

Worksheet 5 Instructions

Unemployment values are entered on lines 501 - 503 on Worksheet 5. If the unemployment rate for a permittee's service area is not available, the unemployment rate for the county in which the service area is located may be used as a substitute. On line 503, enter the average national unemployment rate.

Data Sources

The Bureau of Labor Statistics (BLS) maintains current unemployment rate figures for municipalities and counties over 25,000 population. National and state unemployment data are also available for comparison purposes. This information can be obtained from the BLS by request at (202) 606-6392.

Benchmarks

Compare the permittee's unemployment values with the national average values. National averages are readily available through the Bureau of Labor Statistics.

- Weak: More than 1 percentage point above the National Average
- Mid-range: ± 1 percentage point of the National Average
- Strong: More than 1 percentage point below National Average

For example, if the national average unemployment rate is 6 percent, an unemployment rate greater than 7 percent would be considered weak, while an unemployment rate less than 5 percent would be considered strong.

UNEMPLOYMENT RATE
Worksheet 5

		Line Number
• Unemployment Rate - Permittee	_____	501
Source:	_____	
• Unemployment Rate - County (use if permittee's rate is unavailable)	_____	502
• Source:	_____	
Benchmark:		
• Average National Unemployment Rate:	_____	503
• Source:	_____	

Median Household Income

Median household income (MHI) is defined as the median amount of total income dollars received per household during a calendar year in a given area. It serves as an overall indicator of community earning capacity. Worksheet 6 is used to present information for this indicator.

Worksheet 6 Instructions

Median household income was discussed during the first phase assessment and is presented on Worksheet 2. On line 601 of Worksheet 6, enter the adjusted MHI from Worksheet 2 (line 203). Use the MHI adjustment factor from Worksheet 2 (line 202) to calculate the adjusted national MHI from the latest census, national MHI value (line 602) and enter the value on Line 604.

Data Sources

Median household income is available through state data centers. Refer to Worksheet 2 for MHI of the permittee's service area. Refer to Appendix B for the address and telephone number of the state's data center to acquire the latest census national MHI value.

Benchmarks

Compare the permittee's MHI to the adjusted national MHI:

- Weak: More than 25% below Adjusted National MHI
- Mid-Range: ± 25% of the Adjusted National MHI
- Strong: More than 25% above Adjusted National MHI

MEDIAN HOUSEHOLD INCOME
Worksheet 6

		Line Number
• Median Household Income - Permittee (Line 203)	_____	601
• Source:	_____	
Benchmark:		
• Census Year National MHI	_____	602
• MHI Adjustment Factor (line 202)	_____	603
• Adjusted National MHI: (line 602 x line 603)	_____	604
• Source:	_____	

FINANCIAL MANAGEMENT INDICATORS

The financial management indicators used to evaluate a permittee's financial management ability are property tax revenue as a percent of full market value of real property and property tax revenue collection rate.

Property Tax Revenues as a Percent of Full Market Property Value

This indicator can be referred to as the "property tax burden" since it indicates the funding capacity available to support debt based on the wealth of the community. It also reflects the effectiveness of management in providing community services.

Worksheet 7 Instructions

Property tax burden is computed on Worksheet 7. The full market value of real property was calculated in Worksheet 4, line 404. Enter the full market value on line 701. Enter the most recent year's property tax revenue on line 702. General fund revenues are primarily property tax receipts.

Data Sources

The property assessment data should be readily available through the community or the State's assessor office (see Worksheet 4, Line 404). Property tax revenues are available in communities' annual financial statements. Occasionally, the assessment and tax revenue data of communities partially serviced by the permittee may have to be prorated to provide a clearer picture of the permittee's property tax burden.

Benchmarks

- Weak: Above 4%
- Mid-range: 2%-4%
- Strong: Below 2%.

PROPERTY TAX REVENUES AS A PERCENT OF FULL MARKET PROPERTY VALUE

Worksheet 7

		Line Number
• Full Market Value of Real Property (Line 404)	_____	701
• Property Tax Revenues	_____	702
• Property Tax Revenue as a Percent of Full Market Property Value (702 ÷ 701 x 100)	_____	703

Property Tax Revenue Collection Rate

The property tax revenue collection rate is an indicator of the efficiency of the tax collection system and the acceptability of tax levels to residents.

Worksheet 8 Instructions

The property tax revenue collection rate is calculated on Worksheet 8. The property tax revenues collected was listed in Worksheet 7, Line 702. Enter this value on line 801. Enter the property taxes levied on line 802. Divide the property tax revenue collected by the property taxes levied and multiply by 100 to present the collection rate as a percentage on line 803.

Data Sources

Property taxes levied can be computed by multiplying the assessed value of real property by the property tax rate, both of which are available from a community's financial statements or the state assessor's office (see Worksheet 4, Line 404). Property tax revenues are available in communities' annual financial statements. Occasionally, the assessment and tax revenue data of communities partially serviced by the permittee may have to be prorated to provide a clearer picture of the permittee's property tax revenue collection rate.

Benchmarks

- Weak: Below 94%
- Mid-range: 94-98%
- Strong: Above 98%.

PROPERTY TAX REVENUE COLLECTION RATE
Worksheet 8

		Line Number
• Property Tax Revenue Collected (Line 702)	_____	801
• Property Taxes Levied	_____	802
• Property Tax Revenue Collection Rate (line 801 ÷ line 802 x 100)	_____	803

Analyzing Permittee Financial Capability Indicators

This section describes how the indicators in the second phase may be used to generate an overall score of a permittee's financial capability. The indicators are compared to national benchmarks to form an overall assessment of the permittee's financial capability and its effect on implemention schedules in the long-term CSO control plan.

In situations where a permittee believes that there are unique circumstances that would affect the conclusion of the second phase, the permittee may submit documentation of its unique financial conditions to the appropriate EPA and state NPDES authorities for consideration. The purpose of additional information is to clarify unique circumstances which are not fairly represented by the overall scores of the selected indicators. An example could be where a state or community imposes restrictions on property taxes.

Worksheet 9 Instructions

The indicators generated from the worksheets are compared to the state, national or industry benchmarks presented in Table 2. Information compiled from Worksheets 3 through 8 is summarized in Column A on Worksheet 9. Score each of these values using the rating standards in Table 2 and the following score benchmarks and enter the appropriate number in Column B. The score definitions are:

Benchmarks	Score
• Weak	1
• Mid-Range	2
• Strong	3

To calculate an average score for the indicators, total the values in Column B and divide by the number of entries. Enter the average score on Line 907.

If it is not possible to develop one or more of the six indicators, the permittee should explain why the indicator is inappropriate or unavailable. Since the point of the analysis is to measure the overall financial burden of the CSO controls, the debt and socioeconomic indicators are generally better measures of this burden than the financial management indicators. Consequently, if one of the debt or socioeconomic indicators is not available, the two financial management indicators should be averaged and used as a single indicator to average with the available debt and socioeconomic indicators. This averaging is necessary so that undue weight is not given to the financial management indicators.

PERMITTEE FINANCIAL CAPABILITY INDICATOR BENCHMARKS

Table 2

Indicator	Strong	Mid-Range	Weak
Bond Rating	AAA-A (S&P) or Aaa-A (Moody's)	BBB (S&P) Baa (Moody's)	BB-D (S&P) Ba-C (Moody's)
Overall Net Debt as a Percent of Full Market Property Value	Below 2%	2% - 5%	Above 5%
Unemployment Rate	More than 1 Percentage Point Below the National Average	± 1 Percentage Point of National Average	More than 1 Percentage Point Above the National Average
Median Household Income	More than 25% Above Adjusted National MHI	±25% of Adjusted National MHI	More than 25% Below Adjusted National MHI
Property Tax Revenues as a Percent of Full Market Property Value	Below 2%	2% - 4%	Above 4%
Property Tax Collection Rate	Above 98%	94% - 98%	Below 94%

SUMMARY OF PERMITTEE FINANCIAL CAPABILITY INDICATORS
Worksheet 9

Indicator	Column A: Actual Value	Column B: Score	Line Number
Bond Rating (Line 303)	_____	_____	901
Overall Net Debt as a Percent of Full Market Property Value (line 405)	_____	_____	902
Unemployment Rate (Line 501)	_____	_____	903
Median Household Income (Line 601)	_____	_____	904
Property Tax Revenues as a Percent of Full Market Property Value (Line 703)	_____	_____	905
Property Tax Revenue Collection Rate (Line 803)	_____	_____	906
Permittee Indicators Score (Sum of Column B ÷ Number of Entries)		_____	907

The Financial Capability Matrix

The results of the Residential Indicator and the Permittee Financial Capability Indicators analyses are combined in the Financial Capability Matrix to evaluate the level of financial burden the CSO controls may impose on a permittee. This matrix can be used by permittees, EPA and state NPDES authorities to establish reasonable and workable CSO control implementation schedules.

Worksheet 10 Instructions

First, enter the value of the Residential Indicator (Cost Per Household as a % of MHI) from Line 205 (Worksheet 2) on Line 1001 of Worksheet 10. Enter the Permittee Financial Capability Indicators score from Line 907 (Worksheet 9) on Line 1002. With this information, find the financial burden category for the permittee in the Financial Impact Matrix (Table 3). Enter the category on line 1003.

For example, if the Residential Indicator from Line 1001 is 1.3% and the Permittee Financial Capability Indicators score from Line 1002 is 2.1, the Financial Capability Matrix would indicate that implementation of the CSO control would be "Medium Burden" for the permittee.

The result from the Financial Capability Matrix is used to develop a CSO implementation schedule as described in Section V: CSO Schedule Development.

FINANCIAL CAPABILITY MATRIX SCORE
Worksheet 10

		Line Number
• Residential Indicator Score (Line 205)	_____	1001
• Permittee Financial Capability Indicators Score (Line 907)	_____	1002
• Financial Capability Matrix Category (see matrix next page)	_____	1003

FINANCIAL CAPABILITY MATRIX
Table 3

Permittee Financial Capability Indicators Score (Socioeconomic, Debt and Financial Indicators)	**Residential Indicator** (Cost Per Household as a % of MHI)		
	Low (Below 1.0 %)	Mid-Range (Between 1.0 and 2.0%)	High (Above 2.0 %)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

V. CSO SCHEDULE DEVELOPMENT

The CSO Policy recognizes that the causes and impacts of CSOs are site-specific water pollution control problems. Identification of CSO controls involves evaluation of significant technical, environmental, and financial issues. Therefore, the CSO Policy provides an opportunity for flexible, phased implementation of CSO controls to achieve compliance with the technology-based and water quality based requirements of the Clean Water Act.

Under the CSO Policy, permittees with combined sewer systems are expected to implement the nine minimum CSO controls as expeditiously as possible but no later than January 1, 1997. The nine minimum controls are technology-based controls that can reduce the magnitude, duration, and frequency of CSOs and their effects on receiving waters (See guidance: *Combined Sewer Overflows—Guidance for Nine Minimum Controls* (EPA, 832-B-95-003)). These minimum controls are not intended to require significant engineering activities or major construction.

Permittees with combined sewer systems are also expected to develop long-term control plans (LTCPs) that include provisions for public participation, monitoring of CSOs and their impacts, evaluation and selection of control alternatives, and implementation schedules for long-term controls. A permittee is expected to develop its LTCP as soon as practicable, but generally within two years after a requirement to develop an LTCP has been specified in its NPDES permit or other enforceable mechanism. The development and implementation of an LTCP will be coordinated with implementation of the nine minimum controls. Development of the LTCP involves negotiations with the EPA and state NPDES authorities and if appropriate, state WQS authorities. Among other components the LTCP contains fixed-date implementation and financing schedules to design and construct the needed CSO controls.

The CSO Policy recognizes the need to address the relative importance of environmental and financial issues when developing an implementation schedule for CSO controls to be contained in the LTCP and the NPDES permit or other enforceable mechanism. According to the CSO Policy, an implementation schedule "may be phased based on the relative importance of adverse impacts on WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability." The CSO Policy identifies the following environmental and financial considerations that may affect the phasing of an implementation schedule for CSO controls:

- Eliminating overflows to sensitive areas
- Use impairment
- Financial capability
- Grant and loan availability
- Previous and current sewer user fees and rate structures

- Other viable funding mechanisms and sources of financing.

These factors, may warrant phasing the CSO control implementation schedules in a manner other than would be prescribed by logical engineering sequencing and normal construction practices. This section illustrates how these considerations may affect scheduling and provides some general scheduling boundaries to aid all parties in negotiating the final implementation schedule for CSO controls.

Scheduling is first considered during the permittee's development of an LTCP. The LTCP should assess CSO control alternatives including estimated design and construction time requirements for various components of the CSO controls. In general, CSO controls should be implemented as expeditiously as possible.

The permittee should first develop a tentative implementation schedule based on logical engineering sequencing and normal construction practices. The permittee should complete a critical path analysis to identify the shortest implementation schedule that will achieve the control objectives identified in the LTCP (See guidance: *Combined Sewer Overflows-Guidance for Long-term Control Plan (EPA 832-13-95-002)).* As a result of negotiations with state NPDES and EPA authorities, it may be appropriate to modify the tentative design and construction schedule based on the environmental and financial considerations listed above.

In general, the final negotiated schedule for CSO controls would reflect two types of modifications to the engineering and construction schedule. First, where CSOs discharge to sensitive or significantly use-impaired water bodies, the final schedule would provide for expedited implementation of the controls for these discharges. Second, the schedules may be phased or extended to reflect the significance of various financial considerations, particularly financial capability. The number of years to implement the CSO controls would be negotiated between the permittee, EPA and state NPDES authorities.

The following discussion provides more information on environmental and financial considerations that affect implementation schedules for CSO controls..

ENVIRONMENTAL CONSIDERATIONS

Discharges to Sensitive Areas

The CSO Control Policy states that a permittee's LTCP should give the highest priority to "sensitive areas." Sensitive areas are identified by the NPDES permitting authorities. They include the following:

- Outstanding National Resource Waters
- National Marine Sanctuaries
- Waters with threatened or endangered species and their habitat
- Waters with primary contact recreation
- Public drinking water intakes or their designated protection areas
- Shellfish beds.

For discharges to sensitive areas, the CSO Control Policy provides the following approaches:

- Prohibit new or significantly increased overflows
- Eliminate or relocate overflows
- Where elimination or relocation is not feasible, provide treatment to meet WQS and regularly reassess the feasibility of prohibition, elimination, or relocation.

During the planning process the permittee should characterize existing CSO conditions and identify receiving waters that are sensitive areas. The LTCP should give priority to sensitive areas and any implementation schedule should sequence projects to mitigate impacts on sensitive areas as early as possible. Giving high priority to sensitive areas might mean in some cases that discharges to non-sensitive areas would be addressed later in the implementation schedule than would be the case under a normal engineering and construction schedule.

Use Impairment

Long-term control plans should also give priority to receiving waters that experience recurring adverse impacts from CSOs on aquatic life, human health or aesthetics. Such waters may be the subject of public or media concern.

As a result of public participation and discussion with the permitting authority, the permittee should develop an implementation schedule that gives high priority to waters with impaired uses

and addresses them as soon as possible. As was the case for sensitive areas, giving high priority to certain use-impaired waters might mean that discharges to other waters would be addressed later in the implementation schedule than would be the case under a normal engineering and construction schedule.

The EPA document *Combined Sewer Overflows –Guidance for Screening and Ranking (EPA-832-B-95-004)* can provide assistance in identifying which CSO discharge points are likely to have the greatest adverse impact on water quality, aquatic life, or human health.

PRIMARY FINANCIAL CONSIDERATIONS

Financial Capability

The CSO Control Policy recognizes that financial capability is a significant factor in schedule development. A permittee's financial capability is assessed according to where the permittee falls on the Financial Capability Matrix calculated in worksheet 10. The matrix characterizes the financial burden on the permittee to implement CSO controls as either "Low Burden," "Medium Burden," or "High Burden."

To aid permittees, and EPA and state NPDES authorities during the negotiations necessary to establish implementation schedules for CSO controls, general time periods are presented in Table 4 that correspond with the permittee's Financial Capability Matrix Score summarized in Worksheet 10. The general implementation schedule time boundaries provide a basis for developing consistent and reasonably uniform implementation schedules across the nation in situations where permittee's CSO controls impose similar financial burdens. The time boundaries are not intended to replace the negotiations and deliberations necessary to balance all of the environmental and financial considerations that influence the site specific nature of the controls and implementation schedules.

FINANCIAL CAPABILITY GENERAL SCHEDULING BOUNDARIES
Table 4

Financial Capability Matrix Category	Implementation Period
Low Burden	Normal Engineering/Construction
Medium Burden	Up to 10 years
High Burden	Up to 15 Years*
	*(Schedule up to 20 years based on negotiation with EPA and state NPDES authorities)

Generally, a permittee in the "Low Burden" category would be expected to implement CSO control projects based on a normal engineering and construction schedule. In all cases, discharge to sensitive areas and impaired waters would be addressed on a high priority basis.

For permittees in the "Medium Burden" category, an implementation schedule up to 10 years might be appropriate. A permittee in the "High Burden" category is likely to incur substantial financial impacts to implement CSO controls; in such cases, an implementation schedule up to 15 years might be appropriate. In unusually "High Burden" situations, an implementation schedule up to 20 years may be negotiated with state NPDES and EPA authorities.

SECONDARY FINANCIAL CONSIDERATIONS

The three financial considerations--grant and loan availability, sewer user fees, and other viable funding mechanisms--are normally investigated early in the process of establishing CSO controls. They are described in more detail in the EPA document *Combined Sewer Overflows—Guidance for Funding Options* (EPA-832-B-95-007). They are typically addressed and resolved in the development of the financial schedule for the LTCP prior to design and construction. Therefore, these considerations normally do not have a significant impact on the length of time needed to implement CSO controls. An exception could occur in a case where a permittee's CSO controls can be constructed quickly but where the only available CSO funding source takes an inordinately long time to implement.

Grant and Loan Availability

During the long-term planning process, the permittee should develop a financing plan that identifies sources of capital funds. Generally, these will include some form of loan or grant. Typically, availability of grants and loans will not have a significant impact on the implementation schedule. In evaluating the effect of grant and loan availability on the permittee's schedule, the following funding sources would be considered:

- State wastewater treatment grant programs
- SRF Program
- State loan program (other than SRF program)
- Rural Utility Services Program (formerly: Rural Development Administration loan program)
- CoBank loan program
- Commercial loans
- Local revenue bonds
- Local general obligation bonds

Sewer User Fees

As part of the long-term planning process, the permittee should identify existing user fees and rate structures for wastewater treatment and then develop a new rate structure that includes recovery of the costs for CSO controls. Depending upon how CSO user fees are apportioned among residential, commercial, and industrial users, implementation of the LTCP may cause fees to increase significantly. In most cases, construction of the CSO controls occurs over an extended period allowing time for an orderly increase in the user fees. Thus, user fees typically are unlikely to have a significant impact on the implementation schedule. Combining increases in user fees with an ongoing public education program can help ease the effects of "rate shock" related to the higher user fees. The EPA document "Building Support for Increasing User Fees," (EPA 430/09-89-006) provides specific details on creating a public education program to successfully raise user fees.

Other Viable Funding Mechanisms and Sources of Funding

The permittee may have to consider alternate sources of funding if loans and grants are not available or if a need exists to reduce the financial impact of CSO controls on the users. In some cases, alternative funding mechanisms or financing sources may require additional time to set up. To evaluate the scheduling impacts of other viable funding mechanisms and sources of financing, the permittee's ability to accomplish the following actions would be assessed:

- Establish special assessment districts
- Increase user fees
- Impose/increase taxes (such as income taxes, sales taxes, or property taxes)
- Privatize wastewater treatment.

Most permittees would be expected to have several of these options available; therefore other viable funding mechanisms and sources of funding typically are not likely to have a significant impact on the implementation schedule.

SCHEDULING CONSIDERATIONS

Establishing an implementation schedule for the CSO controls is a negotiating process involving the permittee and EPA and state NPDES authorities. Normally, the time period for the CSO control implementation schedule is defined by the time required for normal engineering and construction practices. However, environmental and financial considerations can influence the time allowed to complete the CSO controls. The implementation schedule would always give high priority to addressing the environmental considerations involving discharges to sensitive areas and use-impaired water bodies. The CSO controls for these discharges would be constructed as expeditiously as possible. The implementation schedule can lengthen by phasing construction of the CSO controls when financial considerations create a financial burden. The primary financial

consideration which usually results in an extended implementation schedule with phased construction is the financial capability consideration.

Application of environmental and financial considerations to the development of implementation schedules for three hypothetical permittees is presented in Table 5.

Permittee number 1 required an eight year normal engineering/construction schedule to implement the CSO controls. Negotiations between the permittee and EPA and the state NPDES authorities resulted in agreement that four years would be allowed for the special circumstances of the permittee's low-burden financial capability category. Therefore, the eight-year engineering schedule took precedence over the financial consideration (therefore were no environmental considerations), and the schedule for implementation of CSO controls was eight years.

Permittee number 2 required three years to implement long-term controls under a normal engineering/construction schedule. Negotiations with the NPDES and WQS authorities concluded that four years would be necessary to obtain SRF loans. A four-year implementation schedule for CSO controls was established by the NPDES permitting authority to accommodate the most time consuming funding option.

Implementation of permittee number 3's CSO controls required a six-year normal engineering/construction schedule. However, the following environmental and financial considerations affected the final schedule:

- One of the permittee's CSO outfalls discharges to a bathing beach. Bathing beaches are defined as sensitive areas in the CSO Control Policy. Although a normal engineering/construction schedule would have eliminated this outfall in four years, it was determined that the schedule could be modified to eliminate this outfall in two years.

- The permittee's cost per household as percent of median household income is 2.2 percent, yielding a Residential Indicator of "Weak." The other socioeconomic, debt, and financial indicators yield a Permittee Indicators score of 1.7, or "Mid-Range." According to Table 3, these two indicators place the permittee in the "High-Burden" category for financial capability.

- User fees will have to increase significantly.

The unusual nature of permittee number 3's "high burden" financial capability category resulted in a sixteen-year schedule for this financial consideration after negotiations with the EPA and state NPDES authorities. Therefore, the permittee would receive a sixteen-year schedule to implement all CSO controls, with a special requirement that the CSO discharge to the bathing beaches be removed in the first two years of the schedule.

It is important to note that the final CSO control implementation schedule established for each permittee should be a time period that is negotiated between the permittee and EPA and state NPDES authorities based on the specific circumstances of each permittee's environmental and financial situation, plus the specific nature of any engineering and construction requirements.

SCHEDULING CONSIDERATION FOR HYPOTHETICAL PERMITTEES
Table 5

Scheduling Consideration	**Permittee #1**	**Permittee #2**	**Permittee #3**
Engineering/ Construction Schedule	8 years	3 years	6 years
Sensitive Areas	n/a	n/a	2 years to remove discharges from sensitive areas
Use Impairment	n/a	n/a	16 years
Financial Capability	4 years	0 years	0 years
Grant/Loan Availability	0 years	4 years	0 years
User fees/rate Structures	0 years	0 years	0 years
Other Funding Mechanisms	0 years	0 years	0 years
Schedule:	8 years	4 years	16 years (removal of discharge from sensitive area would occur within first 2 years)

The time periods presented in this guidance should be viewed as general boundaries to aid all parties in establishing reasonable and effective CSO control implementation schedules.

It is important to note that the final CSO control implementation schedule established for each permittee should be a time period that is negotiated between the permittee and EPA and state NPDES authorities based on the specific circumstances of each permittee's environmental and financial situation, plus the specific nature of any engineering and construction requirements. The time periods presented in this guidance should be viewed as general boundaries to aid all parties in establishing reasonable and effective CSO control implementation schedules.

ACRONYM LIST

CPH	Cost Per Household
CPI	Consumer Price Index
CSS	Combined Sewer System
CSO	Combined Sewer Overflow
CWA	Clean Water Act
EPA	Environmental Protection Agency
LTCP	Long Term Control Plan
MHI	Median Household Income
NMC	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
SRF	State Revolving Fund
WQS	Water Quality Standards
WWT	Wastewater Treatment

State Data Centers

Alabama
Center for Business and Economic Research
University of Alabama
Tuscaloosa, AL 35487
(205) 348-6191

Alaska
Research and Analysis
Department of Labor
Juneau, AK 99802
(907) 465-4500

Arizona
Arizona Department of Economic Security
Phoenix, AZ 85005
(602) 542-5984

Arkansas
University of Arkansas
Little Rock, AR 72204
(501) 569-8530

California
Department of Finance
Sacramento, CA 95814
(916) 322-4651

Colorado
Colorado Department of Local Affairs
Denver, CO 80203
(303) 866-2156

Connecticut
Connecticut Office of Policy and Management
Hartford, CT 06106
(203) 566-8285

Delaware
Delaware Development Office
Dover, DE 19903
(302) 739-4271

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Mayor's Office of Planning
Washington, D.C. 20004
(202) 727-6533

Florida
Executive Office of the Governor
Tallahassee, FL 32399
(904) 487-2114

Georgia
Office of Planning and Budget
Atlanta, GA 30334
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Guam
Guam Department of Commerce
Tamuning, Guam 96911
(671) 646-5841

Hawaii
State Department of Business and Economic Development
Honolulu, HI 96804
(808) 548-3082

Idaho
Idaho Department of Commerce
Boise, ID 83720
(208) 334-2470

Illinois
Illinois Bureau of the Budget
Springfield, IL 62706
(217) 782-1381

Indiana
Indiana State Data Center
Indiana State Library
Indianapolis, IN 46204
(317) 232-3733

Iowa
State Library of Iowa
Des Moines, IA 50319
(515) 281-4350

Kansas
State Library
Topeka, KS 66612
(913) 296-3296

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Urban Research Institute
University of Louisville
Louisville, KY 40292
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(612) 297-2360

Mississippi
Center for Population Studies
University of Mississippi
University, MS 38677
(601) 232-7288

Missouri
Missouri State Library
Jefferson City, MO 65102
(314) 751-3615

State Data Centers

Montana
Montana Department of Commerce
Helena, MT 59620
(406) 444-2896

Nebraska
Center for Applied Urban Research
University of Nebraska- Omaha
Omaha, NE 68182
(402) 595-2311

Nevada
Nevada State Library
Carson City, NV 89710
(702) 885-5160

New Hampshire
Office of State Planning
Concord, NH 03301
(603) 271-2155

New Jersey
New Jersey Department of Labor
Trenton, NJ 08625
(609) 984-2593

New Mexico
Economic Development and Tourism Department
Sante Fe, NM 87503
(505) 474-6005

New York
Department of Economic Development
Albany, NY 12245
(518) 474-6005

North Carolina
Office of State Budget and Management
Raleigh, NC 27603
(919) 733-7061

North Dakota
Department of Agricultural Economics
North Dakota State University
Fargo, ND 58105
(701) 237-8621

Ohio
Department of Development
Columbus, OH 43266
(614) 466-2115

Oklahoma
Department of Commerce
Oklahoma City, OK 73126
(405) 841-5184

Oregon Center for Population Research and Census
Portland State University
Portland, OR 97207
(717) 948-6336

Puerto Rico
Puerto Rico Planning Board
San Juan, PR 00940
(809) 723-6200

Rhode Island
Office of Municipal Affairs
Providence, RI 02908
(401) 277-6493

South Carolina
South Carolina Budget and Control Board
Columbia, SC 29201
(803) 734-3780

South Dakota
Business Research Bureau
University of South Dakota
Vermillion, SD 57069
(605) 677-5287

Tennessee
State Planning Office
Nashville, TN 37219
(615) 741-1676

Texas
Department of Commerce
Capital Station
Austin, Tx 78711
(512) 472-9667

Utah
Office of Planning and Budget
Salt Lake City, UT 84114
(801) 538-1036

Vermont
Office of Policy Research and Coordination
Montpelier, VT 05602
(802) 828-3326

Virgin Islands
Caribbean Research Institute
University of the Virgin Islands
Charlotte Amalie
St. Thomas, VI 00802
(809) 776-9200

Virginia
Virginia Employment Commission
Richmond, VA 23219
(804) 786-8308

Washington
Office of Financial Management
Olympia, WA 98504
(206) 586-2504

West Virginia
Office of Community and Industrial Development
Charleston, WV 25305
(304) 348-4010

Wisconsin
Demographic Service Center
Madison, WI 53707
(608) 266-1927

Wyoming
Department of Administration and Fiscal Control
Cheyenne, WY 82002
(307) 777-7504

Present Value Factors

Years	Interest Rate 1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797	0.783	0.769	0.756
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712	0.693	0.675	0.658
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636	0.613	0.592	0.572
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567	0.543	0.519	0.497
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507	0.480	0.456	0.432
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452	0.425	0.400	0.376
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404	0.376	0.351	0.327
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361	0.333	0.308	0.284
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322	0.295	0.270	0.247
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287	0.261	0.237	0.215
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257	0.231	0.208	0.187
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229	0.204	0.182	0.163
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205	0.181	0.160	0.141
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183	0.160	0.140	0.123
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163	0.141	0.123	0.107
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146	0.125	0.108	0.093
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130	0.111	0.095	0.081
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164	0.138	0.116	0.098	0.083	0.070
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104	0.087	0.073	0.061
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059	0.047	0.038	0.030
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.044	0.033	0.026	0.020	0.015

Annualization Factors

Year	Interest Rate 0.005	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05	0.055	0.06
1	1.0050	1.0100	1.0150	1.0200	1.0250	1.0300	1.0350	1.0400	1.0450	1.0500	1.0550	1.0600
2	0.5038	0.5075	0.5113	0.5150	0.5188	0.5226	0.5264	0.5302	0.5340	0.5378	0.5416	0.5454
3	0.3367	0.3400	0.3434	0.3468	0.3501	0.3535	0.3569	0.3603	0.3638	0.3672	0.3707	0.3741
4	0.2531	0.2563	0.2594	0.2626	0.2658	0.2690	0.2723	0.2755	0.2787	0.2820	0.2853	0.2886
5	0.2030	0.2060	0.2091	0.2122	0.2152	0.2184	0.2215	0.2246	0.2278	0.2310	0.2342	0.2374
6	0.1696	0.1725	0.1755	0.1785	0.1815	0.1846	0.1877	0.1908	0.1939	0.1970	0.2002	0.2034
7	0.1457	0.1486	0.1516	0.1545	0.1575	0.1605	0.1635	0.1666	0.1697	0.1728	0.1760	0.1791
8	0.1278	0.1307	0.1336	0.1365	0.1395	0.1425	0.1455	0.1485	0.1516	0.1547	0.1579	0.1610
9	0.1139	0.1167	0.1196	0.1225	0.1255	0.1284	0.1314	0.1345	0.1376	0.1407	0.1438	0.1470
10	0.1028	0.1056	0.1084	0.1113	0.1143	0.1172	0.1202	0.1233	0.1264	0.1295	0.1327	0.1359
11	0.0937	0.0965	0.0993	0.1022	0.1051	0.1081	0.1111	0.1141	0.1172	0.1204	0.1236	0.1268
12	0.0861	0.0888	0.0917	0.0946	0.0975	0.1005	0.1035	0.1066	0.1097	0.1128	0.1160	0.1193
13	0.0796	0.0824	0.0852	0.0881	0.0910	0.0940	0.0971	0.1001	0.1033	0.1065	0.1097	0.1130
14	0.0741	0.0769	0.0797	0.0826	0.0855	0.0885	0.0916	0.0947	0.0978	0.1010	0.1043	0.1076
15	0.0694	0.0721	0.0749	0.0778	0.0808	0.0838	0.0868	0.0899	0.0931	0.0963	0.0996	0.1030
16	0.0652	0.0679	0.0708	0.0737	0.0766	0.0796	0.0827	0.0858	0.0890	0.0923	0.0956	0.0990
17	0.0615	0.0643	0.0671	0.0700	0.0729	0.0760	0.0790	0.0822	0.0854	0.0887	0.0920	0.0954
18	0.0582	0.0610	0.0638	0.0667	0.0697	0.0727	0.0758	0.0790	0.0822	0.0855	0.0889	0.0924
19	0.0553	0.0581	0.0609	0.0638	0.0668	0.0698	0.0729	0.0761	0.0794	0.0827	0.0862	0.0896
20	0.0527	0.0554	0.0582	0.0612	0.0641	0.0672	0.0704	0.0736	0.0769	0.0802	0.0837	0.0872

Annualization Factors

Year	Interest Rate 0.065	0.07	0.075	0.08	0.085	0.09	0.095	0.1	0.105	0.11	0.115	0.12
1	1.0650	1.0700	1.0750	1.0800	1.0850	1.0900	1.0950	1.1000	1.1050	1.1100	1.1150	1.1200
2	0.5493	0.5531	0.5569	0.5608	0.5646	0.5685	0.5723	0.5762	0.5801	0.5839	0.5878	0.5917
3	0.3776	0.3811	0.3845	0.3880	0.3915	0.3951	0.3986	0.4021	0.4057	0.4092	0.4128	0.4163
4	0.2919	0.2952	0.2986	0.3019	0.3053	0.3087	0.3121	0.3155	0.3189	0.3223	0.3258	0.3292
5	0.2406	0.2439	0.2472	0.2505	0.2538	0.2571	0.2604	0.2638	0.2672	0.2706	0.2740	0.2774
6	0.2066	0.2098	0.2130	0.2163	0.2196	0.2229	0.2263	0.2296	0.2330	0.2364	0.2398	0.2432
7	0.1823	0.1856	0.1888	0.1921	0.1954	0.1987	0.2020	0.2054	0.2088	0.2122	0.2157	0.2191
8	0.1642	0.1675	0.1707	0.1740	0.1773	0.1807	0.1840	0.1874	0.1909	0.1943	0.1978	0.2013
9	0.1502	0.1535	0.1568	0.1601	0.1634	0.1668	0.1702	0.1736	0.1771	0.1806	0.1841	0.1877
10	0.1391	0.1424	0.1457	0.1490	0.1524	0.1558	0.1593	0.1627	0.1663	0.1698	0.1734	0.1770
11	0.1301	0.1334	0.1367	0.1401	0.1435	0.1469	0.1504	0.1540	0.1575	0.1611	0.1648	0.1684
12	0.1226	0.1259	0.1293	0.1327	0.1362	0.1397	0.1432	0.1468	0.1504	0.1540	0.1577	0.1614
13	0.1163	0.1197	0.1231	0.1265	0.1300	0.1336	0.1372	0.1408	0.1444	0.1482	0.1519	0.1557
14	0.1109	0.1143	0.1178	0.1213	0.1248	0.1284	0.1321	0.1357	0.1395	0.1432	0.1470	0.1509
15	0.1064	0.1098	0.1133	0.1168	0.1204	0.1241	0.1277	0.1315	0.1352	0.1391	0.1429	0.1468
16	0.1024	0.1059	0.1094	0.1130	0.1166	0.1203	0.1240	0.1278	0.1316	0.1355	0.1394	0.1434
17	0.0989	0.1024	0.1060	0.1096	0.1133	0.1170	0.1208	0.1247	0.1285	0.1325	0.1364	0.1405
18	0.0959	0.0994	0.1030	0.1067	0.1104	0.1142	0.1180	0.1219	0.1259	0.1298	0.1339	0.1379
19	0.0932	0.0968	0.1004	0.1041	0.1079	0.1117	0.1156	0.1195	0.1235	0.1276	0.1316	0.1358
20	0.0908	0.0944	0.0981	0.1019	0.1057	0.1095	0.1135	0.1175	0.1215	0.1256	0.1297	0.1339

Inflation Adjustment Factors

Years	Interest Rate 1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1	1.010	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.100	1.110	1.120	1.130	1.140	1.150
2	1.020	1.040	1.061	1.082	1.103	1.124	1.145	1.166	1.188	1.210	1.232	1.254	1.277	1.300	1.323
3	1.030	1.061	1.093	1.125	1.158	1.191	1.225	1.260	1.295	1.331	1.368	1.405	1.443	1.482	1.521
4	1.041	1.082	1.126	1.170	1.216	1.262	1.311	1.360	1.412	1.464	1.518	1.574	1.630	1.689	1.749
5	1.051	1.104	1.159	1.217	1.276	1.338	1.403	1.469	1.539	1.611	1.685	1.762	1.842	1.925	2.011
6	1.062	1.126	1.194	1.265	1.340	1.419	1.501	1.587	1.677	1.772	1.870	1.974	2.082	2.195	2.313
7	1.072	1.149	1.230	1.316	1.407	1.504	1.606	1.714	1.828	1.949	2.076	2.211	2.353	2.502	2.660
8	1.083	1.172	1.267	1.369	1.477	1.594	1.718	1.851	1.993	2.144	2.305	2.476	2.658	2.853	3.059
9	1.094	1.195	1.305	1.423	1.551	1.689	1.838	1.999	2.172	2.358	2.558	2.773	3.004	3.252	3.518
10	1.105	1.219	1.344	1.480	1.629	1.791	1.967	2.159	2.367	2.594	2.839	3.106	3.395	3.707	4.046
11	1.116	1.243	1.384	1.539	1.710	1.898	2.105	2.332	2.580	2.853	3.152	3.479	3.836	4.226	4.652
12	1.127	1.268	1.426	1.601	1.796	2.012	2.252	2.518	2.813	3.138	3.498	3.896	4.335	4.818	5.350
13	1.138	1.294	1.469	1.665	1.886	2.133	2.410	2.720	3.066	3.452	3.883	4.363	4.898	5.492	6.153
14	1.149	1.319	1.513	1.732	1.980	2.261	2.579	2.937	3.342	3.797	4.310	4.887	5.535	6.261	7.076
15	1.161	1.346	1.558	1.801	2.079	2.397	2.759	3.172	3.642	4.177	4.785	5.474	6.254	7.138	8.137
16	1.173	1.373	1.605	1.873	2.183	2.540	2.952	3.426	3.970	4.595	5.311	6.130	7.067	8.137	9.358
17	1.184	1.400	1.653	1.948	2.292	2.693	3.159	3.700	4.328	5.054	5.895	6.866	7.986	9.276	10.761
18	1.196	1.428	1.702	2.026	2.407	2.854	3.380	3.996	4.717	5.560	6.544	7.690	9.024	10.575	12.375
19	1.208	1.457	1.754	2.107	2.527	3.026	3.617	4.316	5.142	6.116	7.263	8.613	10.197	12.056	14.232
20	1.220	1.486	1.806	2.191	2.653	3.207	3.870	4.661	5.604	6.727	8.062	9.646	11.523	13.743	16.367
25	1.282	1.641	2.094	2.666	3.386	4.292	5.427	6.848	8.623	10.835	13.585	17.000	21.231	26.462	32.919
30	1.348	1.811	2.427	3.243	4.322	5.743	7.612	10.063	13.268	17.449	22.892	29.960	39.116	50.950	66.212

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 2 4 2014

MEMORANDUM

SUBJECT: Financial Capability Assessment Framework for Municipal Clean Water Act Requirements

FROM: Ken Kopocis
Deputy Assistant Administrator
Office of Water (OW)

Cynthia Giles
Assistant Administrator
Office of Enforcement and Compliance Assurance (OECA)

TO: Regional Administrators
Regional Water Division Directors
Regional Enforcement Division Directors

In May of 2012, we distributed the Integrated Municipal Stormwater and Wastewater Planning Approach Framework (Integrated Planning Framework). Since that time, we have made solid progress in promoting integrated approaches to meet Clean Water Act (CWA) obligations. Thanks to the hard work of regional and headquarters staff, and the active engagement of cities, many of our enforcement settlements now embody integrated planning principles in the structure and schedule for injunctive relief or explicitly include integrated planning as part of the settlement. We have also seen an increasing number of municipalities and local authorities moving towards developing integrated plans to support the development of their NPDES permits. We have been working with EPA Regions and States to assist in that process.

As the implementation of the Integrated Planning Framework has progressed and evolved, we have been actively engaged with stakeholders on ways to build on our efforts. Those discussions found a natural focus on issues related to the financial capability of permittees working toward our shared goals of clean water. One consistent theme that emerged was the benefit of more clearly articulating the flexibility available under the existing guidance. EPA continues to be guided by the 1997 "Combined Sewer Overflows – Guidance for Financial Capability Assessment

and Schedule Development" (FCA Guidance) that provides an aid for assessing financial capability as part of negotiating schedules for implementing CWA requirements for municipalities and local authorities. The FCA Guidance also encourages permittees "to submit any additional documentation that would create a more accurate and complete picture of their financial capability" that may "affect the conclusion" of the analysis described in the guidance.

As part of EPA's commitment to implementing CWA objectives in a sustainable manner, we have developed the attached "Financial Capability Assessment Framework" (FCA Framework). The FCA Framework has been greatly informed by the comments and experiences of a variety of stakeholders and financial experts. The FCA Framework identifies the key elements EPA uses in working with permittees to evaluate how their financial capability should influence schedules. In addition, the FCA Framework provides examples of additional information that may help some communities provide a "more accurate and complete picture" of their financial capability as is envisioned in the FCA guidance. We will be posting the FCA Framework to our website as an important next step in the pursuit of integrated planning approaches and in our ongoing work with municipalities and local authorities to achieve our shared goals of protecting our nation's waters. While this memorandum releases the FCA Framework, we know that we will continue to learn and refine our understanding of the issues surrounding financial capability assessments as we use it moving forward. We will continue to look for ways to improve the Framework as we gain new insights and additional information.

We look forward to continue working with the Regions on these important issues and encourage you to contact Deborah Nagle, Director, Water Permits Division (nagle.deborah@epa.gov) and Mark Pollins, Director, Water Enforcement Division (pollins.mark@epa.gov) with any questions you might have.

Attachment

cc: Regional Permit and Enforcement Liaisons

FINANCIAL CAPABILITY ASSESSMENT FRAMEWORK

November 24, 2014

Purpose

The Environmental Protection Agency (EPA) is committed to working with state and local government partners to assist local municipalities and local authorities to meet Clean Water Act (CWA) obligations in a manner that recognizes the unique financial challenges that local jurisdictions face. This financial capability assessment framework is intended to provide additional examples and greater clarity on the flexibilities built into existing guidance that local governments or authorities can use in assessing their financial capability, and the relationship between that assessment and consideration of schedules for permit and consent decree implementation. This framework builds on the progress already made in the May 2012 "Integrated Municipal Stormwater and Wastewater Planning Approach Framework," and the experience gained from talking with communities about their financial capability in actual, on the ground circumstances. Integrated Planning has been helping in identifying a permittee's relative priorities for projects based on the relative importance of adverse impacts on human health and water quality and the municipality's financial capability.

Background

Local governments and authorities want to provide clean water for their communities, and they play an essential role in providing wastewater and stormwater infrastructure and services for their citizens, businesses and institutions. These municipal functions have been an important part of implementing the CWA to protect public health and improve water quality in streams, lakes, bays, and other waters nationwide. However, significant water quality challenges remain. Public officials remain strong supporters of the CWA goals and objectives by directing the public investments that are necessary to comply with the Act and to provide clean water for their citizens. Many local governments face complex water quality issues that are heightened by the need to address population growth or decline, increases in impervious surfaces, source water supply needs, and aging infrastructure. In recent years, many local governments and authorities have increased investments in their wastewater and stormwater infrastructure through capital projects to rehabilitate existing systems, improve operation and maintenance, and address additional regulatory requirements. As programs are implemented to improve water quality and attain CWA objectives, many state and local government partners find themselves facing difficult economic challenges with limited resources and financial capability. We recognize these challenging conditions and are working with states and local governments to develop and implement new approaches that will achieve water quality goals at lower costs and in a manner that addresses the most pressing problems first.

Long-term approaches to meeting CWA objectives should be sustainable and within a local government or authority's financial capability. The financial capability of these entities and other relevant factors are important to consider when developing appropriate schedules for infrastructure projects in permits or enforcement actions to help protect human health and the environment. EPA's financial capability assessment guidance, "Combined Sewer Overflows:

Guidance for Financial Capability Assessment and Schedule Development" (FCA Guidance) (EPA 832-B-97-004) provides a reference point to aid all parties in negotiating reasonable and effective schedules for implementing CWA requirements, and the flexibility to take into account local considerations that may not be fully captured by the approach detailed in the guidance. As described in more detail in this Framework, the guidance provides for consideration of the impact on residential rate payers and the financial capability of the permittee using a suite of indicators, as well as allowing schedules to be responsive to circumstances unique to that community, while advancing the mutual goal to protect clean water. The FCA Guidance encourages permittees to provide any additional information that would be useful in understanding those unique or atypical circumstances and how they may affect CWA schedules, so that all relevant information presented by a community can be taken into account to ensure that a full understanding of financial capability guides the development of schedules.

Financial Capability Assessment

The following are key elements of EPA's approach to the evaluation of the financial capability of municipalities to inform implementation schedules, both in permits and enforcement actions. The elements are fully compatible with the FCA Guidance, integrated planning approaches, and the flexibility embodied in both.

1. **The 1997 FCA Guidance identifies a valuable assessment that provides a common basis for financial burden discussions between the permittee, EPA and state NPDES authorities. Permittees have the option of submitting additional information that would create a more accurate and complete picture of their financial conditions.** The financial capability assessment described in the 1997 FCA Guidance identifies information that provides a basis for a general comparison of financial conditions between communities across the country and provides a consistent assessment of basic financial indicators as part of the overall analysis. Additional information that the community provides on its unique financial circumstances will be considered so that schedules take local considerations into account. Where appropriate, this information can result in schedules that are different than the schedules suggested by the baseline analysis suggested in the 1997 FCA Guidance.

2. **Financial capability is on a continuum.** Although the FCA Guidance approach categorizes financial burden as "high, medium, or low," this does not mean that schedules will be rigidly set according to the break points between the categories. For example, two communities whose total residential share of costs are 1.1% and 1.9% of median household income (MHI) are both categorized in the FCA Guidance as having a "medium" burden for the Residential Indicator (RI). All other things being equal, the appropriate schedules for those communities are likely to be different. Similarly, all other things being equal, two communities whose residential share of costs are 1.9% and 2.1% of MHI would be more likely to have similar overall compliance timeframes, even though one community is ranked as having a "medium" burden and the other as having a "high" burden. Finally, additional information submitted by the community may affect the length of the schedule regardless of where the community is on the "high, medium, and low" continuum.

3. **EPA will consider all CWA costs presented in the analysis described in the FCA Guidance**. EPA originally published the FCA Guidance to assist in negotiating schedules for communities with combined sewer systems, as these typically represent the most expensive CWA compliance issues. The FCA Guidance has since been recognized as equally suitable for considering other municipal CWA obligations as well, such as those related to separate sanitary sewer systems. With the release of EPA's 2012 Integrated Planning Framework, the Agency clarified that the financial capability analysis could include costs of: stormwater and wastewater; ongoing asset management or system rehabilitation programs; existing, CWA related capital improvement programs; collection systems and treatment facilities; and other CWA obligations required by state or other regulators. Where the costs of multiple CWA obligations are included in an FCA, each of those costs should be enumerated separately, so as to provide an understanding of how each contributes to the overall analysis.

4. **When presented, Safe Drinking Water Act (SDWA) obligations will be considered, primarily as additional information about a permittee's financial capability.** EPA believes that the SDWA obligations of a community can be an important consideration in establishing schedules for implementing integrated plans. EPA recognizes that both clean water and drinking water costs are often covered through charges on a single rate base. One component of a financial capability assessment includes an evaluation of the residential indicator that is based on only CWA costs as this best reflects the intended use of the metric and allows for comparisons with other communities. Drinking water costs may be reflected in other components of a financial capability assessment. For example, the financial capability indicator includes consideration of bond rating of the entity that issues debt to fund the permittee's capital project, which can be impacted by both wastewater and drinking water obligations for a permittee that provides both services. If a community has incurred general obligation debt associated with the SDWA, these obligations would be considered in the indicator "overall net debt as a percent of full market property value." In addition, as discussed below, additional information, including information regarding drinking water obligations, may be submitted for consideration in analyzing financial capability. To the extent that drinking water costs are not fully addressed by these other components, communities are encouraged to provide additional information about these costs.

5. **Communities should demonstrate how the CWA work included as costs in the financial capability assessment will be implemented, including appropriate assurances that those expenditures will be made.**

The Financial Capability Assessment Guidance and Examples of Additional Information that are Relevant to a Consideration of Financial Capability

The specific approaches laid out in the FCA Guidance provide a good foundation for the assessment of financial capability. As stated in the guidance and outlined in this Framework, communities can build on that foundation to include additional relevant information. The FCA Guidance presents a two-phased approach to assessing overall financial capability. The first phase assesses the impact on residential customers, and the first step is to calculate the portion of

the annual costs that would be borne by residential households for both current and projected Clean Water Act related expenses. The residential share of the annual costs of CWA obligations is then compared to the MHI of the service area. MHI is calculated using current census data and may be adjusted based on the current Consumer Price Index. Finally, the CWA compliance costs per household are divided by the adjusted MHI to calculate the residential indicator (RI). The FCA Guidance then identifies various ranges of RI scores as "low, mid-range or high" levels of burden. In situations where there are unique circumstances that would affect the conclusion of the first phase of the assessment, additional information documenting unique financial conditions may be submitted.

The second phase of the financial capability analysis assesses the financial strength of the permittee. Six indicators are used to evaluate the debt, socioeconomic and financial conditions that affect a permittee's financial capability to implement CWA controls necessary for compliance with the Act. These include bond ratings, overall net debt as a percent of full market property value, unemployment rate, median household income, property tax revenue collection rate, and property taxes as a percent of full market property value. In the Guidance, EPA has established benchmarks for each of the six indicators showing whether the indicator reflects a "weak", "mid-range", or "strong" financial capability. These benchmarks are used to generate an overall score of a permittee's financial capability.

The residential indicator calculated in phase one and the permittee capability indicators analyzed in phase two are evaluated together in a Financial Capability Matrix to assess the level of financial burden. The level of burden is then used to inform discussions to establish an appropriate schedule for meeting CWA obligations in permits and enforcement actions. EPA uses these indicators, including the annualized costs as a percent of MHI, to help assess when costs are reaching levels that may represent a high burden on ratepayers and that longer compliance timeframes are likely to be appropriate to spread the cost over a longer period. EPA does not view or use the Financial Capability Matrix as a rigid metric that points to a given schedule length or threshold over which the costs are unaffordable.

Permittees have suggested and the FCA Guidance recognizes that the two step analysis may not provide a complete representation of financial capability. As noted above, other relevant financial or demographic information presented that illustrates the unique or atypical circumstances faced by a permittee will also be considered in evaluating financial capability. The presentation of additional information can be very valuable in analyzing financial capability, and the submission of this type of information has become fairly common practice. For example, in many consent decree negotiations, additional information has resulted in the establishment of schedules that differ from the ones suggested by the baseline analysis described in the FCA Guidance.

Some examples of information that may be relevant in negotiating schedules to be included in permits and consent decrees are given below. In order for such information to adequately illustrate that a permittee's situation is atypical, EPA encourages permittees to compare any additional information on their circumstances to national averages or to that of other permittees.

The examples given below are not intended to be a complete list, nor a list of factors that will be relevant in every community. Rather it provides an illustration of information that may prove useful in some instances.

Examples of Information Related to Residential Impacts:

1. Income distribution by quintile, geography or other breakdown, illustrating how income distribution in the service area differs from comparable data on the national level or for similar cities.

2. Where cities have adopted differential rates for low income customers, the income distribution that led to that rate structure.

3. Information about service area poverty rates and trends.

4. Projected, current and historical sewer, and stormwater fees as a percentage of household income, quintile, geography or other breakdown.

5. Information on sewer and water usage for various classes of ratepayers or by type of dwelling unit.

6. Information on the percent of households who own versus rent.

Examples of Information Related to Financial Strength:

1. Historical population trends or population projections.

2. Service area unemployment data and trends, or other labor market indicators, including unemployment on an absolute basis.

3. Rate or revenue models, including dynamic financial planning models showing the projections of impacts over the program period. All revenue sources tied to CWA obligations may be included as appropriate.

4. Rate determination studies used to develop and support recent rate increases.

5. Data and trends on late payments, disconnection notices, service terminations, uncollectable accounts, or revenue collection rates.

6. Historical increases in rates or other dedicated revenue streams.

7. State or local legal restrictions or limitations on property taxes, other revenue streams or debt levels.

8. Other costs or financial obligations, such as those that relate to drinking water or other infrastructure, that significantly affect a permittee's ability to raise revenue.

9. Circumstances that may affect a permittee's bond rating. For instance, incurring debt beyond certain thresholds may negatively impact the permittee's bond rating, thus reducing the ability to raise capital.

10. Financial plans that show the implications of incurring additional debt for a permittee's ability to secure financing, including projections of metrics such as debt ratios, debt service coverage, debt per customer, days of cash on hand, days

of working capital and other metrics used by rating agencies. Such data should be benchmarked to metrics such as rating agency medians and relative to similar entities. This will be especially relevant where the permittee does not have a bond rating.

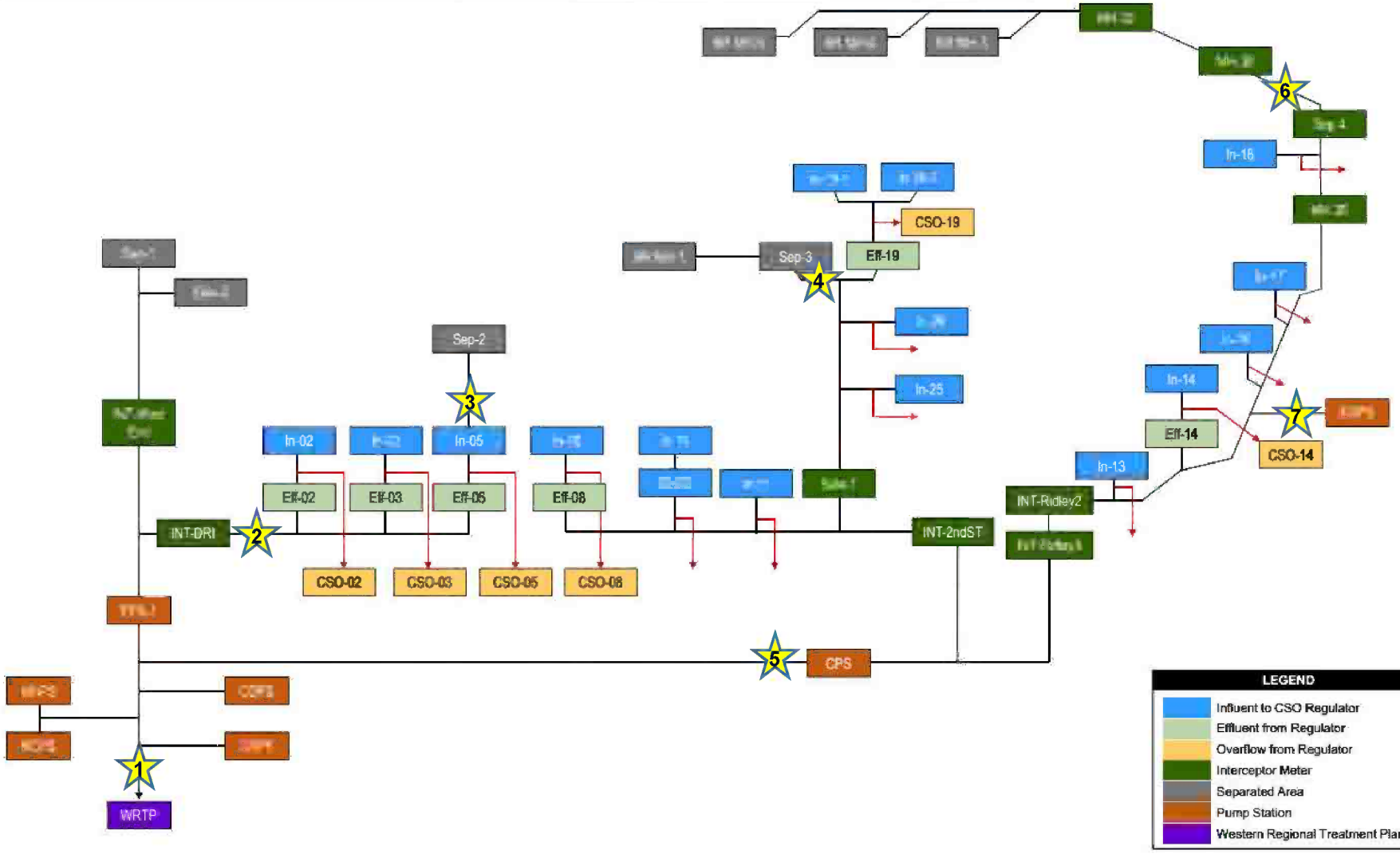
11. Extraordinary stressors such as those from natural disasters, municipal bankruptcies, unusual capital market conditions, or other situations which impact a permittee's ability to raise revenue or acquire needed financing. When such stressors occur, they may also provide support for making changes to existing schedules.

Basis for Allocating CSO LTCP Costs to Municipalities, Authorities, & Industries
Total Annual Excess Wet Weather Volume and
Percent of Total Annual Excess Wet Weather Volume

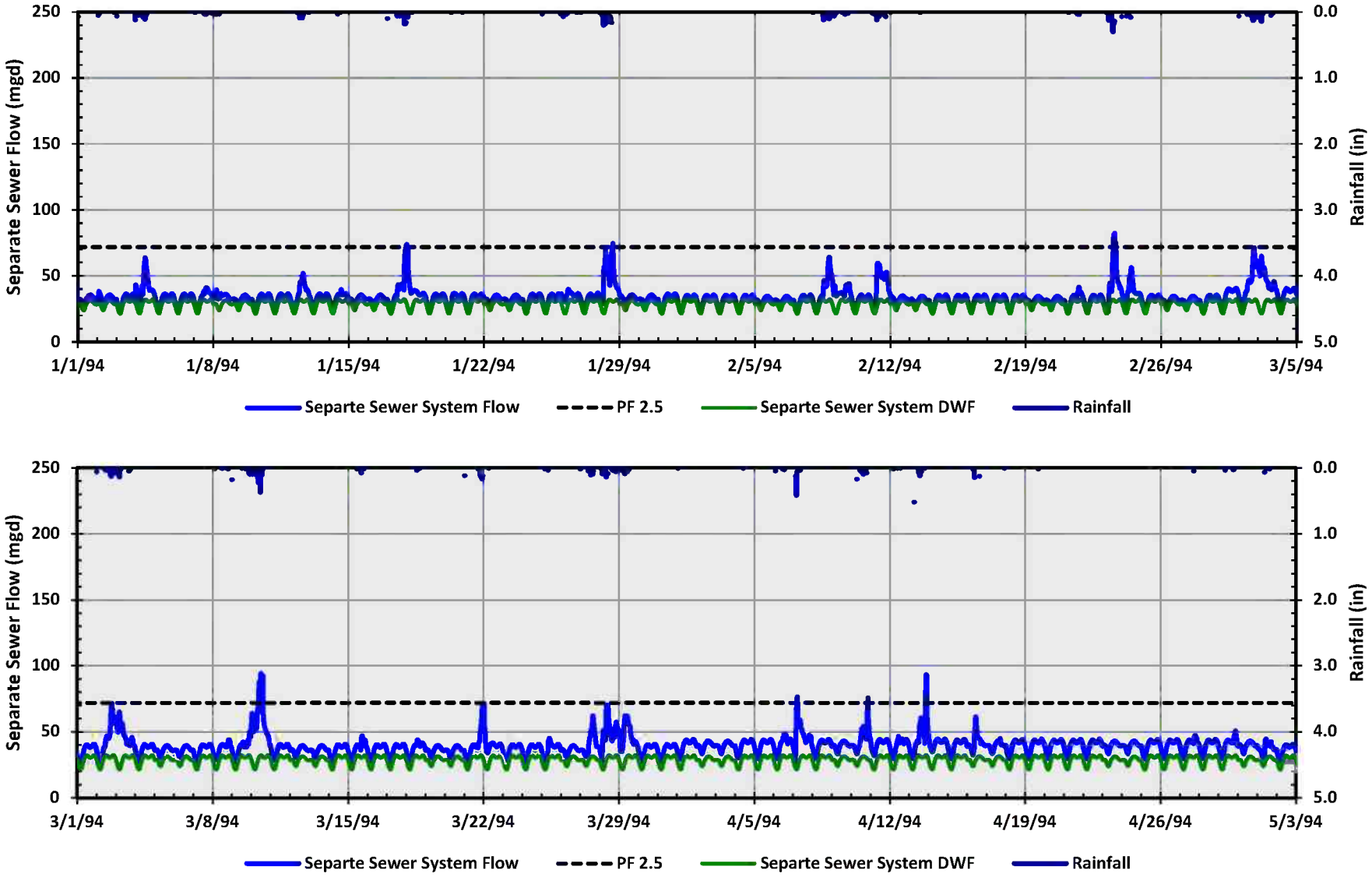
	A	B	C = A +B	D = A / C	E = B / C
Year	Annual CSO Volume (MG)	Excess Wet Weather Volume from Separate Sewer System (MG)	Total Excess Wet Weather Volume (MG)	Annual CSO Volume (%)	Excess Wet Weather Volume from Separate Sewer System (%)
1994	327	34	361	90.7%	9.3%
1995	201	18	219	91.8%	8.2%
1996	371	49	420	88.4%	11.6%
Average	300	33	333	90.0%	10.0%

Basis for Allocating CSO LTCP Costs to Municipalities, Authorities, & Industries
Separate Sewer System Flows to Western Regional Treatment Plant
Model Locations to Calculate Separate Sewer System Flow

Separate Sewer System Flow = 1 – 2 + 3 – 5 + 4 + 6 + 7



Basis for Allocating CSO LTCP Costs to Municipalities, Authorities, & Industries
Separate Sewer System Flows to Western Regional Treatment Plant
Calibrated Model Results for CSO LTCP Climate Period



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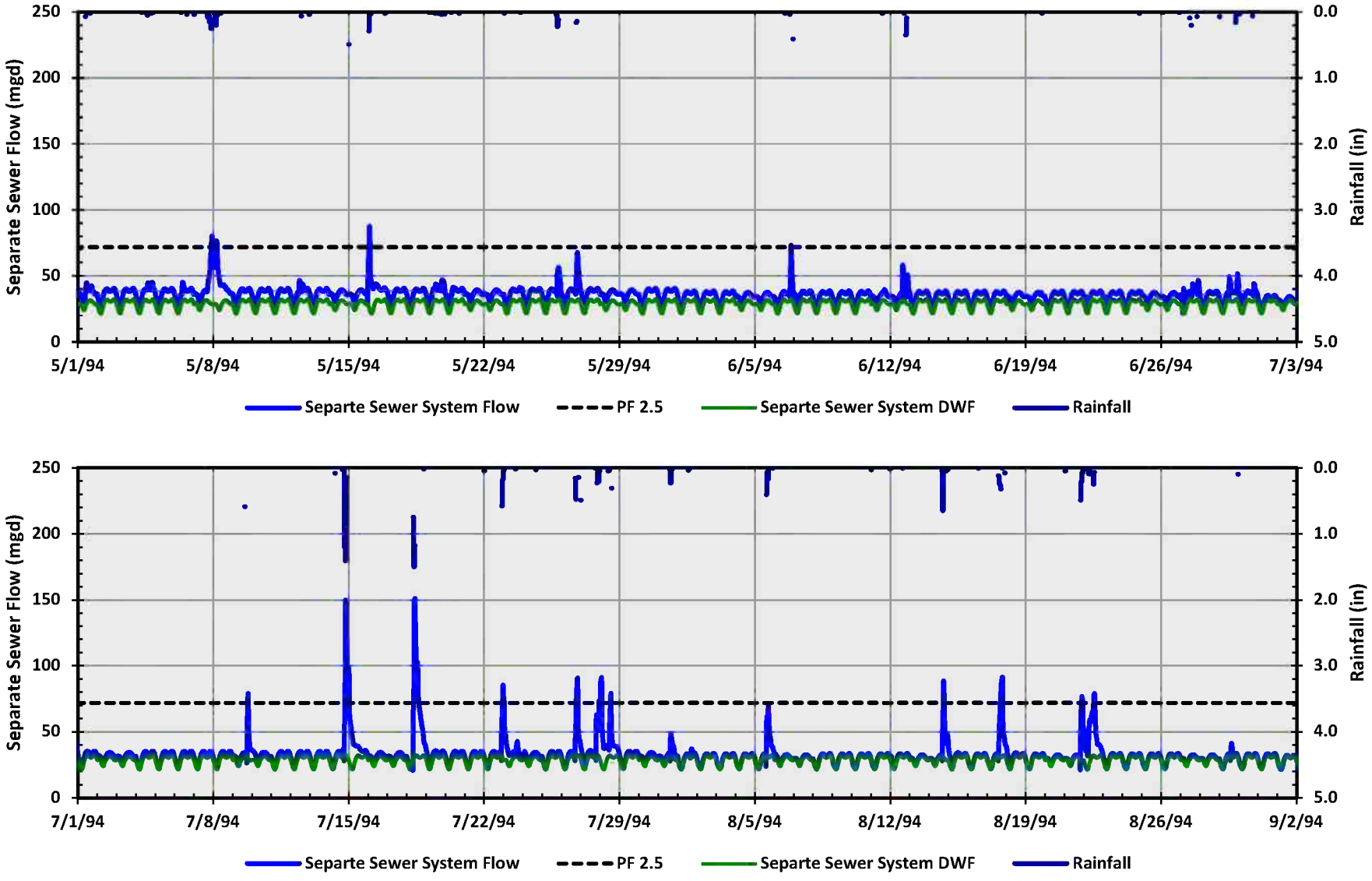

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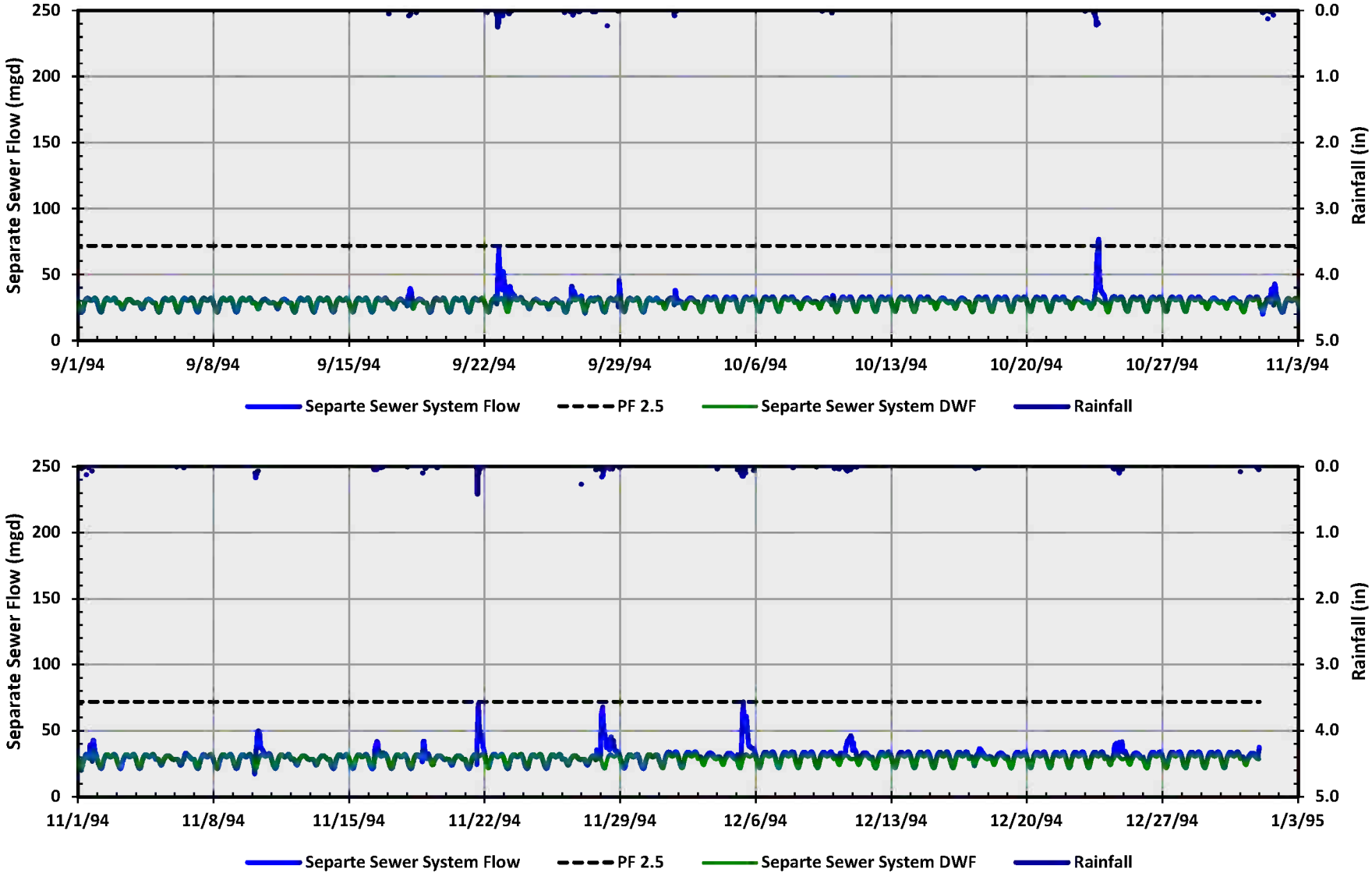

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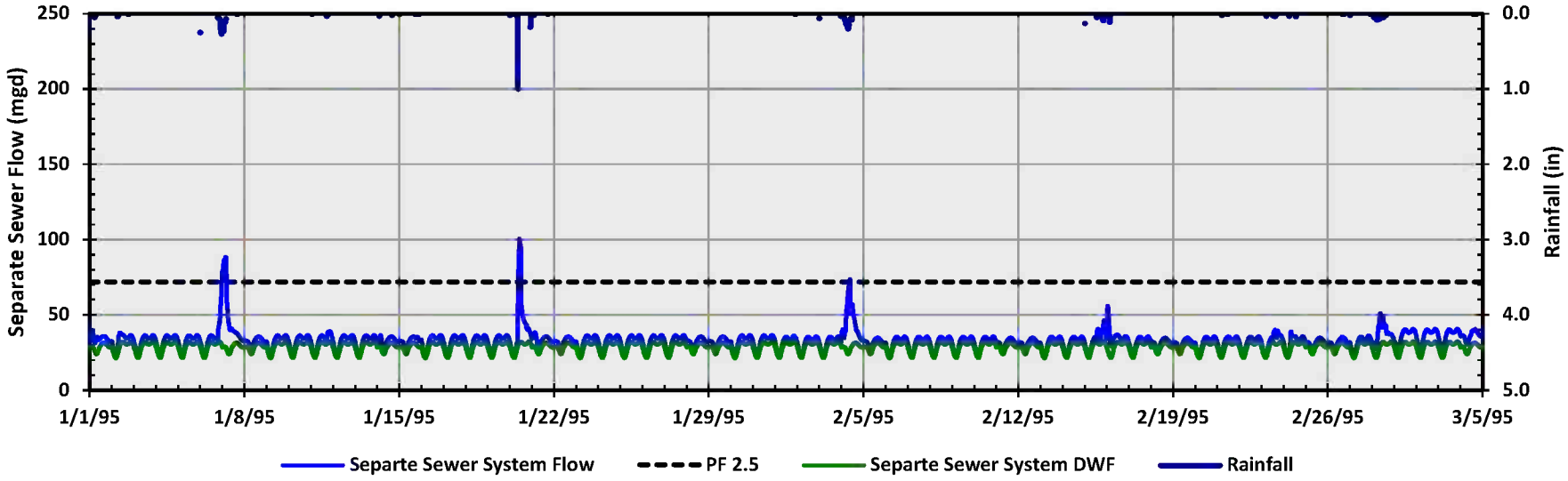

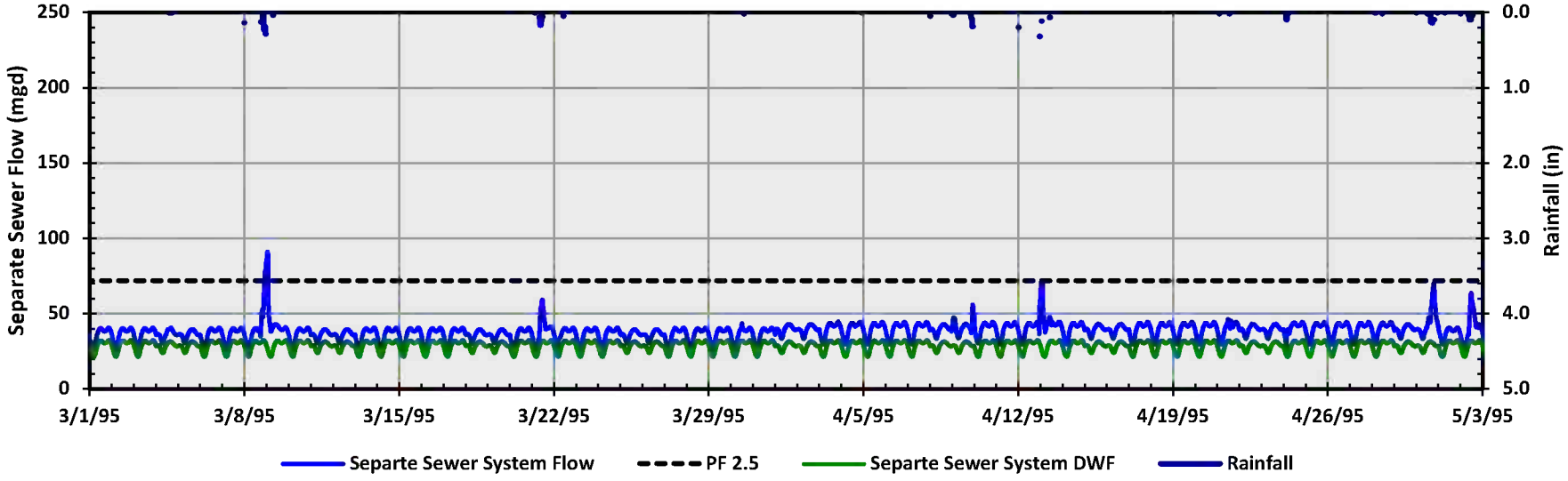

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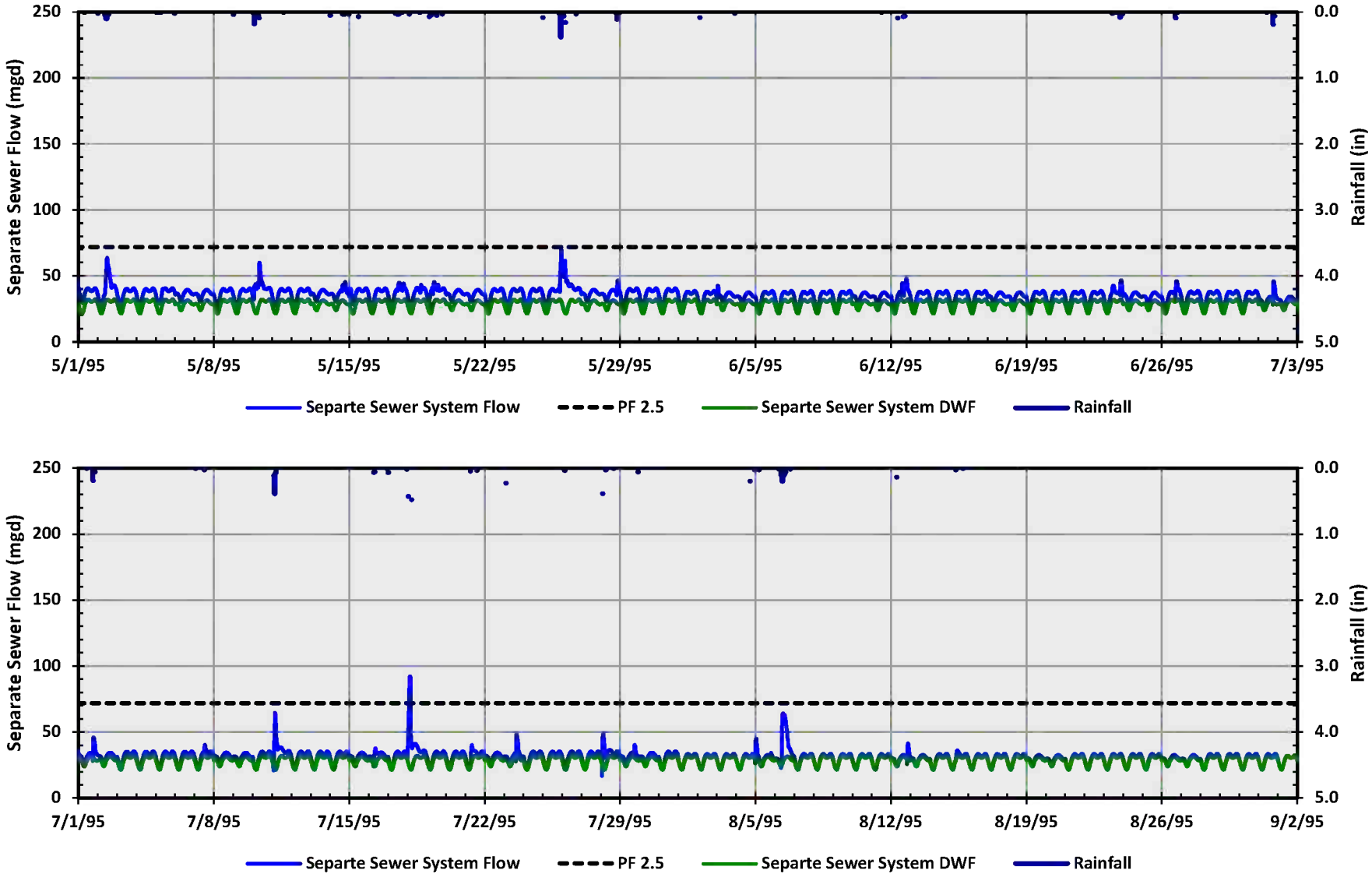

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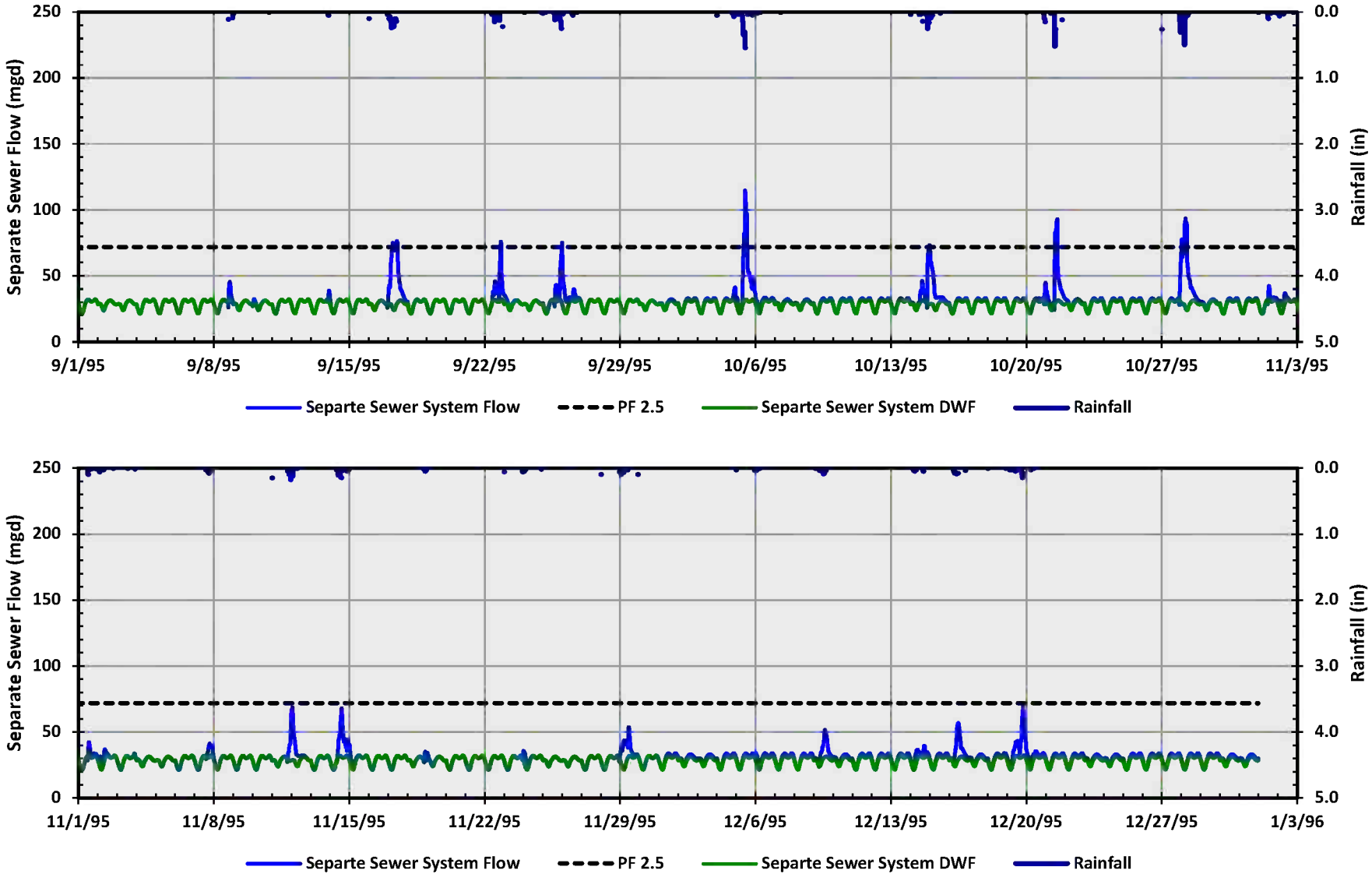

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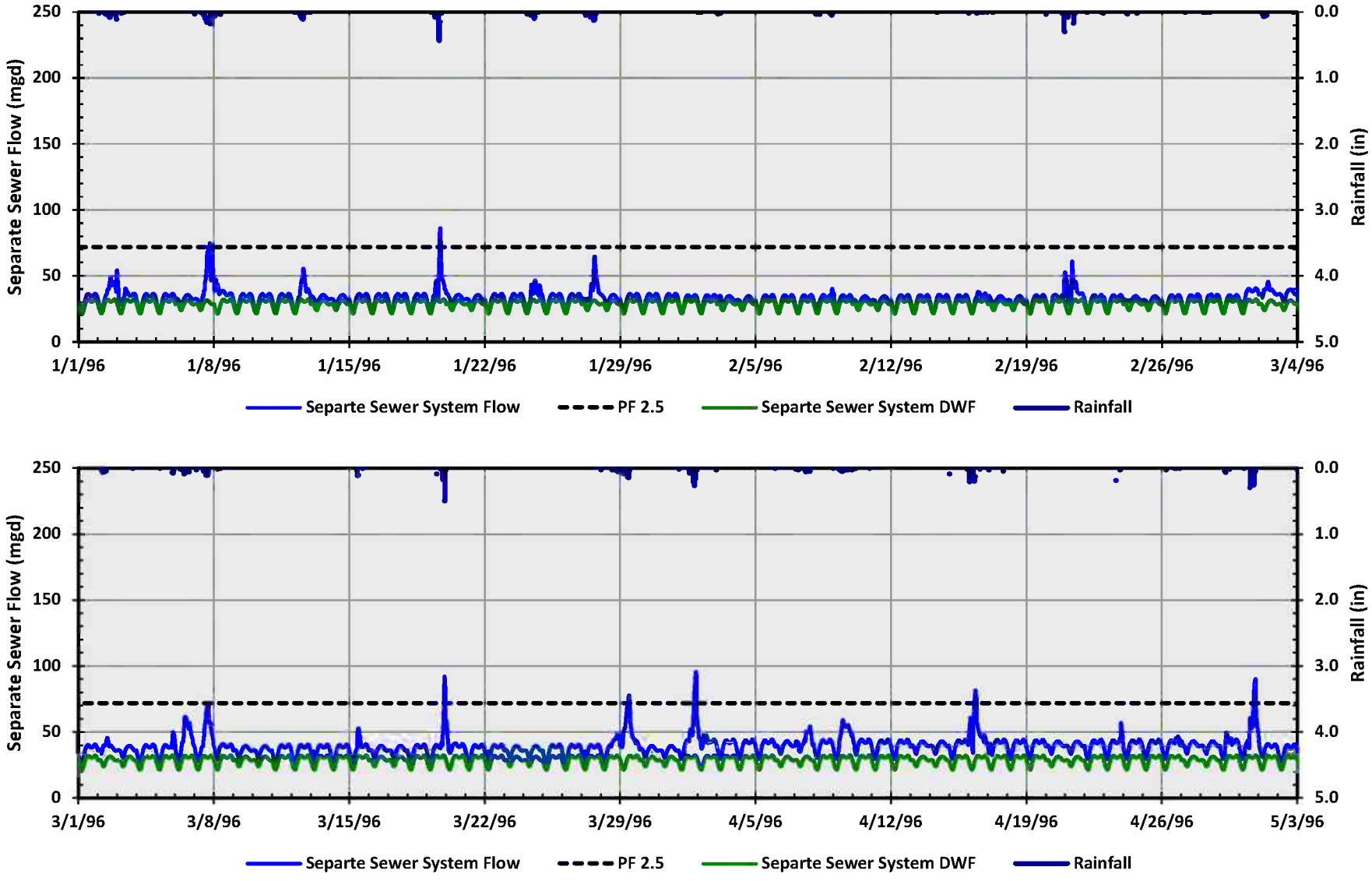

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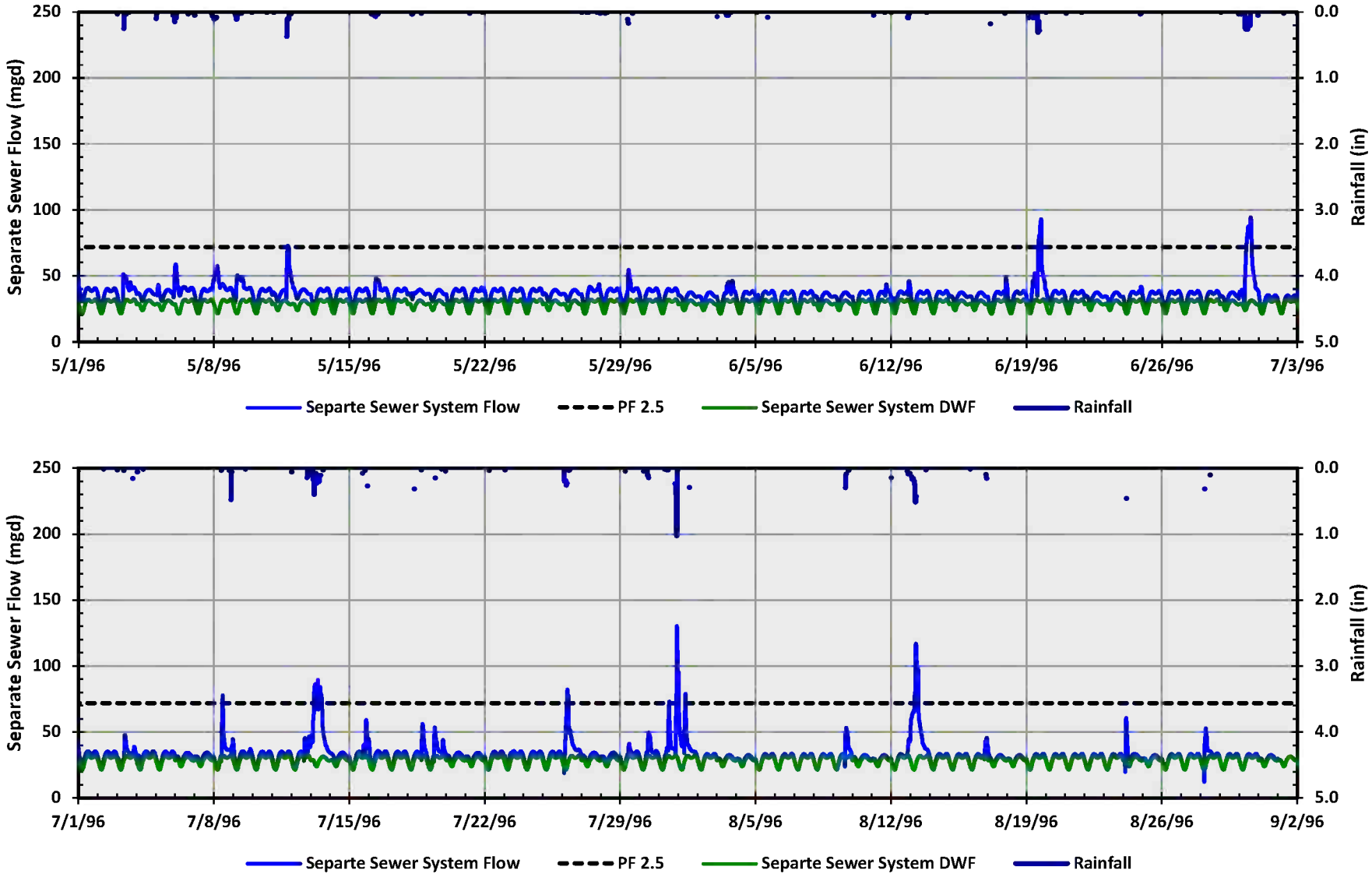

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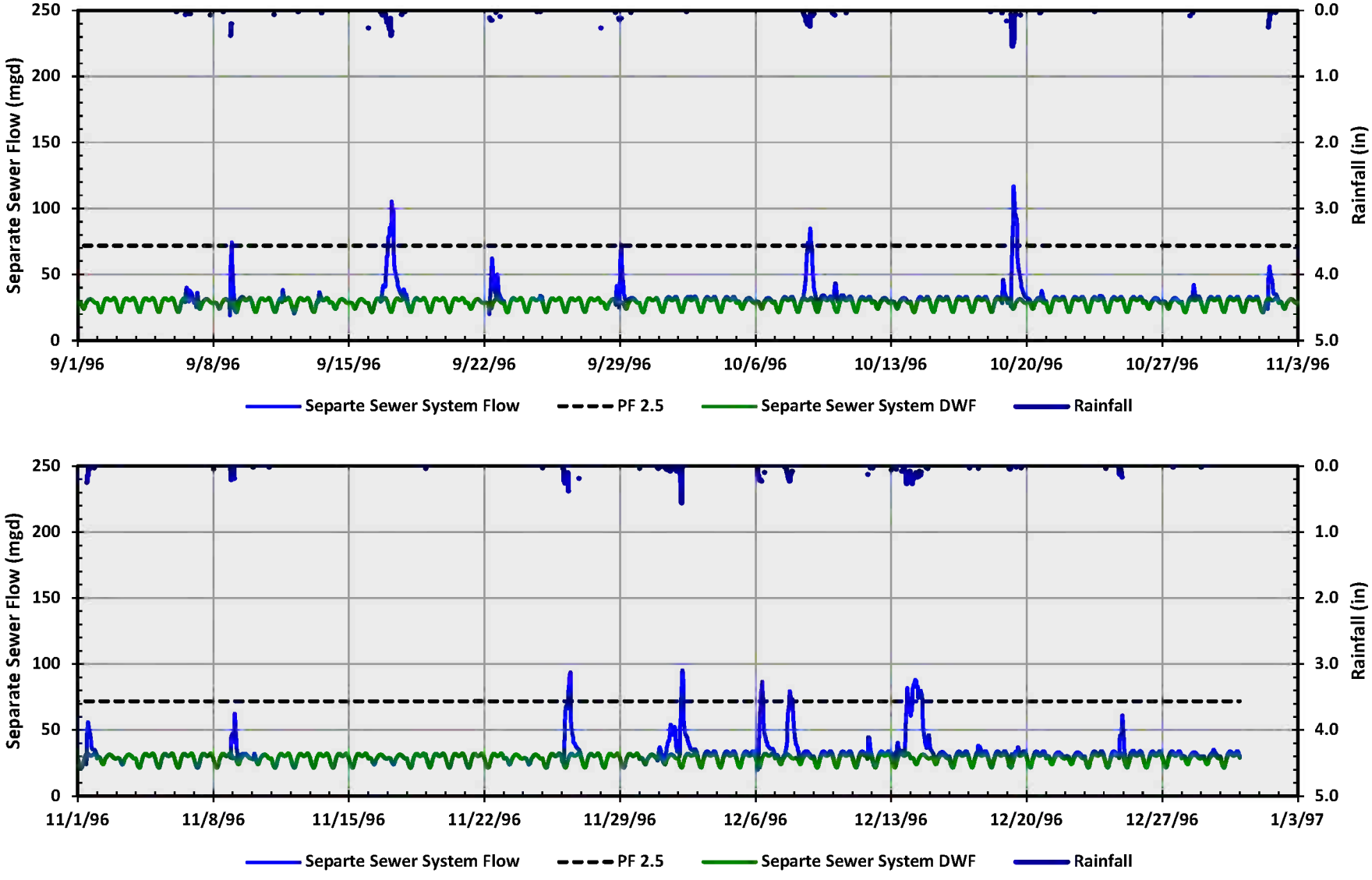

Finizio, Marlene

From: Hill, Margaret A. <mhill@blankrome.com>
Sent: Thursday, August 17, 2017 10:59 AM
To: DiSantis, Michael; Charles Hurst PE* (hurstc@delcora.org); Cronin, Edward; Hope, Michael; Finizio, Marlene
Subject: FW: DELCORA/DRAFT FCA
Attachments: FW: TM for Precedents for DELCORA's FCA Methodology

Importance: High

FYI

From: Hill, Margaret A.
Sent: Thursday, August 17, 2017 10:57 AM
To: 'Yeany, Philip' <Yeany.Philip@epa.gov>
Cc: 'Baptista, Chrisna' <Baptista.Chrisna@epa.gov>; 'Duer, Donna (ENRD)' <Donna.Duer@usdoj.gov>; 'Gelles, William H' <wgelles@pa.gov>
Subject: RE: DELCORA/DRAFT FCA
Importance: High

Phil
As discussed, I am sending relevant information to support DELCORA's approach to the Draft FCA which was submitted to EPA.

We would appreciate your review, and as previously requested, the opportunity to meet with EPA as soon as you are available to discuss this submission.

This is a follow-up to our continued dialogue following the May 22nd meeting.

Regards, Peg

From: Hill, Margaret A.
Sent: Tuesday, July 11, 2017 5:49 PM
To: 'Yeany, Philip' <Yeany.Philip@epa.gov>
Cc: Baptista, Chrisna <Baptista.Chrisna@epa.gov>; Duer, Donna (ENRD) <Donna.Duer@usdoj.gov>; Gelles, William H <wgelles@pa.gov>
Subject: RE: DELCORA
Importance: High

Phil

Since our call on June 23rd, we have been reviewing several FCAs prepared for or by other POTWs. We are preparing some relevant information related to how the FCAs were prepared by those entities in light of our discussions related to: DELCORA's draft FCA and EPA's FCA Guidance (1997 and 2014). We will be submitting a memorandum to you for your review as soon as we have finalized our review of the FCAs. There is clearly a varied pattern and practice in how the FCAs have been prepared.
Regards, Peg

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SANITARY SEWER IMPROVEMENTS AGREEMENT, DATED MARCH 2016

SANITARY SEWER IMPROVEMENTS AGREEMENT

This **SANITARY SEWER IMPROVEMENTS AGREEMENT** (this "Agreement") is made and entered into this ___ day of March, 2016, by and between **BROOKHAVEN ACQUISITION LP**, a Pennsylvania limited partnership, ("Brookhaven Acquisition"), and **THE DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY**, a municipal authority organized and existing under and pursuant to the laws of the Commonwealth of Pennsylvania ("Delcora").

BACKGROUND

WHEREAS, Brookhaven Acquisition is the owner of that certain parcel of real property located within the jurisdictional limits of the Borough of Brookhaven, Delaware County (the "Borough") and more fully described by metes and bounds on **Exhibit A** attached hereto (the "Brookhaven Acquisition Parcel"); and

WHEREAS, on April 6, 2015, Borough Council of the Borough granted Conditional Final Subdivision and Land Development Approval with regard to subdivision and development of the Brookhaven Acquisition Parcel (the "Brookhaven Acquisition Land Development Approval"); and

WHEREAS, pursuant to the Brookhaven Acquisition Land Development Approval, Brookhaven Acquisition is presently developing the Brookhaven Acquisition Parcel as a retail center known as The Shoppes at Brookhaven, together with certain public, quasi-public and private improvements with regard thereto (collectively, the "Brookhaven Acquisition Development"); and

WHEREAS, Delcora is the municipal authority having jurisdiction and responsibility over and for sanitary sewage collection, conveyance and treatment within the geographic region in which the Borough is located; and

WHEREAS, Brookhaven Acquisition contemplates that sanitary sewage effluent from the Brookhaven Acquisition Development will flow from the Brookhaven Acquisition Parcel to the Delcora Western Regional Wastewater Treatment Facility (the "Delcora Wastewater Treatment Facility") through infrastructure owned and maintained by Delcora (the "Delcora Wastewater Conveyance Infrastructure"); and

WHEREAS, the tapping fee for connection to the Delcora Wastewater Conveyance Infrastructure and treatment of sanitary sewage effluent at the Delcora Wastewater Treatment Facility as of the date of this Agreement is One Thousand and 00/100 Dollars ($1,000.00) per EDU (the "Delcora Tapping Fee"); and

WHEREAS, the Brookhaven Acquisition Development requires eighty-five (85) EDUs, such that the Delcora Tapping Fee applicable to the Brookhaven Acquisition Development is Eighty-Five Thousand and 00/100 Dollars ($85,000.00) (the "Brookhaven Acquisition Development Tapping Fee"); and

WHEREAS, the Delcora Wastewater Conveyance Infrastructure is a combined sewer system within the bed of Blossom Avenue between East Parkway Avenue and East Avon Avenue within the jurisdictional limits of the City of Chester, Delaware County (the "City"), as the existing condition thereof is such that stormwater flowing from properties within the Borough enters into the Delcora Wastewater Conveyance Infrastructure and intermixes with sanitary sewage effluent flowing through the Delcora Wastewater Conveyance Infrastructure; and

WHEREAS, Delcora requested that, in conjunction with each of the Brookhaven Acquisition Development and the Radio Park Development (as hereinafter defined), Brookhaven Acquisition and Radio Park (as hereinafter defined), respectively, complete the separation of the existing sanitary sewer line from the existing stormwater conveyance line within the bed of Blossom Avenue between East Parkway Avenue and East Avon Road within the jurisdictional limits of the City, all as more fully depicted on that certain plan by Catania Engineering Associates entitled Storm Sewer Separation for Delcora Blossom Ave – E. Avon to E. Parkway, dated October 15, 2015, and attached hereto as **Exhibit B** (the "Blossom Avenue Wastewater Conveyance Infrastructure Improvements"), in order to disconnect the flow of some stormwater from such portion of the Delcora Wastewater Conveyance Infrastructure and, thereby, preclude to a limited extent intermixing of stormwater and sanitary sewage effluent, as aforesaid, while increasing the hydrological capacity at the Delcora Wastewater Treatment Facility (the "Delcora Sewer Separation Requests"); and

WHEREAS, pursuant to that certain Letter of Intent dated April 29, 2015, by and between Hartford Properties, LLC ("Hartford Properties"), Daniel Schempp ("Schempp") and Delcora (the "Letter of Intent"), those parties contemplated the division amongst them of the responsibilities and obligations with regard to the Delcora Sewer Separation Requests; and

WHEREAS, Brookhaven Acquisition is the successor-by-assignment of Hartford Properties' right, title, and interest, duties, responsibilities, and obligations in, to, and under the Letter of Intent; and

WHEREAS, Radio Park is the successor-by-assignment of Schempp's right, title, and interest, duties, responsibilities, and obligations in, to, and under the Letter of Intent; and

WHEREAS, though Schempp executed the Letter of Intent, Radio Park is presently unable to perform the financial obligations which Shempp undertook pursuant to the Letter of Intent; and

WHEREAS, notwithstanding Radio Park's inability to perform the financial obligations which Shempp undertook pursuant to the Letter of Intent, on and subject to the terms, conditions and provisions expressly set forth in this Agreement, Brookhaven Acquisition is willing to complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements; and

WHEREAS, notwithstanding Radio Park's present inability to perform the financial obligations which Shempp undertook pursuant to the Letter of Intent, on and subject to the

express terms, conditions, and provisions set forth in that certain Sanitary Sewer Cost Sharing Agreement dated March ____, 2016, by and between Brookhaven Acquisition and Radio Park (the "Cost Sharing Agreement"), Brookhaven Acquisition is willing to allow Radio Park to participate in the benefits arising out of this Agreement and Brookhaven Acquisition's performance of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements; and

WHEREAS, Brookhaven Acquisition is, and shall be, entitled to a credit against the Brookhaven Acquisition Development Tapping Fee on a dollar-for-dollar basis for eighty-two and five-tenths percent (82.5%) of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements Cost (as hereinafter defined) (the "Brookhaven Acquisition Development Tapping Fee Credit").

NOW, THEREFORE, for and in consideration of the mutual promises set forth in this Agreement and other good and valuable consideration, the receipt and legal sufficiency of which is hereby acknowledged, Brookhaven Acquisition and Delcora hereby agree as follows:

1. Incorporation of Recitals. The recitals set forth in the Background Section of this Agreement are incorporated herein as if here set forth in their entirety.

2. Incorporation of Exhibits. All Exhibits attached to this Agreement are incorporated herein by reference.

3. Completion of Improvements. Under and pursuant to the terms, conditions and provisions expressly set forth in this Agreement, Brookhaven Acquisition shall complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements.

4. Grant of Permission to Perform Work. Delcora heretofore reviewed the plans and specifications with regard to the Blossom Avenue Wastewater Conveyance Infrastructure Improvements, and hereby confirms that it heretofore granted to Brookhaven Acquisition all necessary right and authority to access and modify that portion of the Delcora Wastewater Conveyance Infrastructure as necessary in order to complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements. Delcora hereby acknowledges Brookhaven Acquisition's receipt from the City of that certain Permit for Street Opening No. 11386 dated January 21, 2016, a true, correct, and compete copy of which is attached hereto as **Exhibit C** (the "City Permit"), and that no further permits or approvals are necessary for Brookhaven Acquisition to complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements.

5. Confirmation of Satisfaction of Requests. Delcora hereby confirms and acknowledges that execution and delivery of this Agreement by Brookhaven Acquisition constitutes full and complete satisfaction by Brookhaven Acquisition of the Delcora Sewer Separation Requests. Furthermore, Delcora hereby confirms and acknowledges that, unless and until Radio Park satisfies its obligations under and pursuant to the Cost Sharing Agreement including, without limitation, the obligation to remit the Radio Park Share (as hereinafter defined) to Brookhaven Acquisition, Radio Park shall not, and shall not be deemed to have, satisfied the Delcora Sewer Separation Requests.

6. Brookhaven Acquisition to Complete Work; Radio Park to Reimburse.

A. Completion of Work. Brookhaven Acquisition shall complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements, for which Brookhaven Acquisition heretofore entered into a construction contract with N. Abbonizio Contractors, Inc., a Pennsylvania corporation ("N. Abbonizio"), and, pursuant the Cost Sharing Agreement, Radio Park is and shall be responsible to, *inter alia*, pay over to Brookhaven Acquisition certain amounts as more fully set forth therein.

B. Costs. The cost of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements (the "Blossom Avenue Wastewater Conveyance Infrastructure Improvements Cost") does and shall include all sums payable by Brookhaven Acquisition to N. Abbonizio, or otherwise, for or towards completion of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements, and shall also include, but shall not necessarily be limited to, (i) the cost(s) paid or payable by Brookhaven Acquisition for negotiation of this Agreement, (ii) the cost(s) paid or payable by Brookhaven Acquisition with regard to the City Permit, (iii) the cost(s) payable by Brookhaven Acquisition of any and all insurance carried by Brookhaven Acquisition with regard to the Blossom Avenue Wastewater Conveyance Infrastructure Improvements; (iv) the cost(s) payable by Brookhaven Acquisition of any fees or other premiums charged to Brookhaven Acquisition for any inspection or financial security required to be posted to secure completion of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements; and (v) the cost(s) for which Brookhaven Acquisition is, or may become, responsible arising out of or in any manner or form related to Brookhaven Acquisition's enforcement of this Agreement including, without limitation, attorneys' fees and court costs.

C. Developer Agreement. Declora acknowledges that Brookhaven Acquisition heretofore entered into an agreement with the City establishing the terms, conditions and provisions pursuant to which Brookhaven Acquisition shall complete the Blossom Avenue Wastewater Conveyance Infrastructure Improvements (as the same may be executed and amended from time to time, the "Blossom Avenue Wastewater Conveyance Infrastructure Improvements Developer Agreement"). In furtherance, and not in limitation, of Section 6.A. of this Agreement, Radio Park acknowledges that the Blossom Avenue Wastewater Conveyance Infrastructure Improvements Cost does and shall include any and all expenses arising out of or in any manner or form related to the Blossom Avenue Wastewater Conveyance Infrastructure Improvements Agreement and Brookhaven Acquisition' discharge of its duties, responsibilities and obligations under and pursuant to the Blossom Avenue Wastewater Conveyance Infrastructure Improvements Developer Agreement.

7. Radio Park.

A. Identification of Radio Park; Radio Park Development. Each of Brookhaven Acquisition and Delcora acknowledges that (i) that Radio Park, L.P., a Pennsylvania limited partnership ("Radio Park"), is the owner of those certain parcels of real property located within the jurisdictional limits of the Borough and more fully described by metes and bounds on **Exhibit D** attached hereto (collectively, the "Radio Park Parcels"), and (ii) that Radio Park (or,

as applicable, its successor) intends to develop the Radio Park Parcels as an eighteen (18) townhouse development known as Society Hill at Brookhaven, together with certain public, quasi-public and private improvements with regard thereto (collectively, the "Radio Park Development").

B. Sanitary Sewer Needs; Tapping Fee. Each of Brookhaven Acquisition and Delcora acknowledges (i) that Radio Park contemplates that sanitary sewage effluent from the Radio Park Development will flow from the Radio Park Parcels to the Delcora Wastewater Treatment Facility through the Delcora Wastewater Conveyance Infrastructure, and (ii) that the Radio Park Development requires eighteen (18) EDUS (the "Radio Park Capacity"), such that the Delcora Tapping Fee applicable to the Radio Park Development is Eighteen Thousand and 00/100 Dollars ($18,000.00) (the "Radio Park Development Tapping Fee").

C. Possible Credit for Radio Park Tapping Fee. Delcora acknowledges that if, and only if, Radio Park fully complies with its obligations under and pursuant to the Cost Sharing Agreement and Brookhaven Acquisition provides to Delcora written confirmation of such compliance, Radio Park shall be entitled to a credit against the Radio Park Development Tapping Fee for an amount not to exceed Eighteen Thousand and 00/100 Dollars ($18,000.00) and to be applied on a dollar-for-dollar basis for monies actually paid by Radio Park to Brookhaven Acquisition pursuant to the Cost Sharing Agreement (the "Radio Park Development Tapping Fee Credit").

D. Radio Park Not Intended Third-Party Beneficiary. Notwithstanding anything to the contrary set forth in this Agreement, each of Brookhaven Acquisition and Delcora acknowledges that Radio Park is not, and shall not for any intents or purposes whatsoever be deemed to be, an intended third-party beneficiary of this Agreement.

8. Reservation of Capacity; Purchase of Capacity; Administration of Credit.

A. Reservation. Prior to its execution of this Agreement, Brookhaven Acquisition did pay over to Delcora the sum of Eight Thousand Five Hundred and 00/100 Dollars ($8,500.00) (the "Capacity Reservation Fee"), the receipt of which Delcora acknowledged pursuant to that certain letter dated October 21, 2015, attached hereto as **Exhibit E**, such that, as of the execution of this Agreement, the remaining outstanding amount of the Brookhaven Acquisition Development Tapping Fee is, and for all intents and purposes whatsoever shall be deemed to be Seventy-Six Thousand Five Hundred and 00/100 Dollars ($76,500.00). Delcora does reserve, and for all intents and purposes whatsoever shall be deemed to have reserved, for Brookhaven Acquisition eighty-five (85) EDUs of capacity at the Delcora Wastewater Treatment Facility (the "Brookhaven Acquisition Capacity"), which such Brookhaven Acquisition Capacity is, and for all intents and purposes whatsoever shall be deemed to be, reserved to and for the benefit of the Brookhaven Acquisition Development.

B. Purchase of Capacity. Simultaneously with its full execution and delivery of this Agreement, Brookhaven Acquisition does purchase, and for all intents and purposes whatsoever shall be deemed to have purchased, from Delcora the Brookhaven Acquisition Capacity, and Delcora does and shall take any and all steps necessary to record in its records

such purchase and ownership by Brookhaven Acquisition of the Brookhaven Acquisition Capacity. Delcora hereby represents and warrants to Brookhaven Acquisition that no further approvals or actions whatsoever are necessary for such purchase and ownership to be final and complete for all intents and purposes whatsoever.

C. Representation of Ability to Sell EDUs and Permit Discharge of Effluent. Notwithstanding anything to the contrary set forth in this Agreement, or elsewhere, Delcora does hereby represent and warrant to Brookhaven Acquisition that Delcora has all legal approval, authority and ability necessary to sell to Brookhaven Acquisition the Brookhaven Acquisition Capacity for use at the Brookhaven Acquisition Development, and that there are no legal or factual impediments whatsoever to the issuance to Brookhaven Equities, or anyone claiming by, through or on behalf of Brookhaven Equities, any and all such permits as may be necessary to permit the discharge of eighty-five (85) EDUs worth of sanitary sewage effluent from the Brookhaven Acquisition Development through the Delcora Wastewater Conveyance Infrastructure for treatment at the Delcora Wastewater Treatment Facility and that, upon presentation to Delcora of applications with regard to such permits, Delcora shall issue the same without delay or condition.

D. Administration of Credit. Brookhaven Acquisition is and shall be entitled to the Brookhaven Acquisition Development Tapping Fee Credit to be applied on dollar-for-dollar basis against the Brookhaven Acquisition Development Tapping Fee. If, upon and within thirty (30) days following completion of the Blossom Avenue Wastewater Conveyance Infrastructure Improvements, it shall be determined that the amount of the Brookhaven Acquisition Development Tapping Fee Credit shall have exceeded the amount of the Brookhaven Acquisition Development Tapping Fee, Brookhaven Acquisition shall, within thirty (30) days of receipt of written demand from Delcora, remit to Delcora an amount equal to the difference between the amount of the Brookhaven Acquisition Development Tapping Fee Credit and the Brookhaven Acquisition Development Tapping Fee. Notwithstanding anything to the contrary set forth in this Agreement, however, in the event that the amount of the Brookhaven Acquisition Development Tapping Fee Credit shall exceed the amount of the Brookhaven Acquisition Development Tapping Fee, Brookhaven Acquisition shall not be entitled to any refund or other credit, or to purchase from Delcora any capacity at the Delcora Wastewater Treatment Facility in excess of the Brookhaven Acquisition Capacity.

9. Radio Park Purchase of Capacity; Administration of Credit.

A. Requirement to Pay. Notwithstanding anything to the contrary set forth in this Agreement, or elsewhere, Radio Park is not, and shall not, be entitled to purchase from Delcora (and Delcora shall not sell to Radio Park, or otherwise for use at the Radio Park Parcels) any EDUs, and Delcora shall not issue any permits as may be necessary to permit the discharge of sanitary sewage effluent from the Radio Park Parcels through the Delcora Wastewater Conveyance Infrastructure for treatment at the Delcora Wastewater Treatment Facility without, in each instance, ten (10) Business Days' (as hereinafter defined) prior written notice to Brookhaven Acquisition, and either (i) Brookhaven Acquisitions' written confirmation to Delcora that Radio Park shall have paid to Brookhaven Acquisitions such sums as shall by then have become due and payable under and pursuant to the Cost Sharing Agreement or (ii) the

passage of such ten (10) Business Days' without notice from Brookhaven Acquisitions that Radio Park shall have failed to pay the Radio Park Share.

B. Administration of Credit. If, as and when Radio Park (or, as applicable, its successor or assign) shall seek to purchase EDUs from Delcora with regard to the Radio Park Development (which such purchase is, and shall be, subject to the provisions of Section 9.A. of this Agreement and the Cost Sharing Agreement), Delcora shall apply the Radio Park Development Tapping Fee Credit on dollar-for-dollar basis against the Radio Park Development Tapping Fee provided, however, that it shall be determined that the amount of the Radio Park Development Tapping Fee Credit shall exceed the amount of the Radio Park Development Tapping Fee, Delcora shall require Radio Park (or, as applicable, its successor or assign) to remit to Delcora an amount equal to the difference between the amount of the Radio Park Development Tapping Fee Credit and the Radio Park Development Tapping Fee, the obligation for which Radio Park acknowledges by its execution of this Agreement. Notwithstanding anything to the contrary set forth in this Agreement, however, in the event that the amount of the Radio Park Development Tapping Fee Credit shall exceed the amount of the Radio Park Development Tapping Fee, Delcora shall not allow any refund or other credit against the Radio Park Development Tapping Fee, or allow Radio Park to purchase from Delcora any capacity at the Delcora Wastewater Treatment Facility in excess of the Radio Park Capacity.

10. Notices. Any and all notices required or desired to be given pursuant to this Agreement shall be sent via hand delivery or via first-class mail or via a nationally recognized courier service guaranteeing next Business Day delivery, in any event to the addresses set forth below or such other address(es) as the recipient(s) may designate from time to time:

if to Brookhaven Acquisition:

Brookhaven Acquisition, L.P.
c/o Retail Sites, LLC
Tall Oaks Corporate Center
1000 Lenola Road
Building Two, Suite 100
Maple Shade, New Jersey 08052
Attn: Mr. Robert M. Hill

with a required copy in all instances to:

Buckley, Brion, McGuire & Morris LLP
118 West Market Street
West Chester, Pennsylvania 19382
Attn: Joseph E. Brion, Esquire
Michael S. Gill, Esquire

if to Delcora:

The Delaware County Regional Water Quality Control Authority
100 East Fifth Street
Post Office Box No. 999
Chester, Pennsylvania 19013
Attn: Robert J. Willert, Executive Director

with a required copy in all instances to:

McNichol, Byrne & Matlawski , PC
1223 North Providence Road
Media, Pennsylvania 19063
Attn: J. Adam Matlawski, Esquire

All such notices, requests and other communications shall be deemed to have been sufficiently given for all purposes hereof as follows: if made by hand delivery then upon such delivery, if made by overnight delivery then on the next Business Day following deposit thereof properly addressed and delivery fees paid with a nationally recognized courier guaranteeing overnight delivery and providing package tracking capability and, if made by first-class mail then on the fifth (5^{th}) Business Day following deposit thereof with the United States Postal Service properly addressed and postage prepaid. When used in this Agreement, the term "Business Day" does and shall mean any day other than a Saturday, Sunday or legal holiday in the Commonwealth of Pennsylvania.

11. No Joint Venture, Partnership or Other Association. Except as expressly set forth in this Agreement, nothing set forth in this Agreement or elsewhere shall, or shall be deemed to, create any joint venture, partnership or other association by or between Brookhaven Acquisition and Delcora.

12. Governing Law. This Agreement shall be interpreted and construed in accordance with the laws of the Commonwealth of Pennsylvania without regard to principles of conflicts of law.

13. Jurisdiction; Venue. Jurisdiction for any dispute arising out of or in any manner or form related to this Agreement shall be with the courts of the Commonwealth of Pennsylvania. Initial venue for any such dispute is and shall lay with the Court of Common Pleas of Delaware County.

14. Entire Agreement. This Agreement embodies and constitutes the entire understanding between the parties with respect to the subject matter hereof and all prior or contemporaneous agreements, understandings, representations and statements, oral or written, are merged into this Agreement. Neither this Agreement nor any provision hereof may be waived, modified, amended, discharged or terminated except by an instrument in writing signed by the party against which the enforcement of such waiver, modification, amendment, discharge or termination is sought, and then only to the extent set forth in such instrument.

15. Provisions Severable. In case any one or more of the provisions contained in this Agreement shall, for any reason, be held invalid, illegal or unenforceable in any respect by a court of competent jurisdiction such invalidity, illegality or unenforceability shall not affect any other provision of this Agreement, and this Agreement shall be construed as if the invalid, illegal or unenforceable provision had never been contained herein.

16. Radio Park Acknowledgment. Radio Park does and shall execute this Agreement in the space provided below for the purpose of acknowledging the terms, conditions, and provisions hereof including, without limitation, Section 6. of this Agreement, Section 7. of this Agreement, and Section 9. of this Agreement.

[*REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK*]

IN WITNESS WHEREOF, the parties hereto executed this Agreement the day and year first above written.

BROOKHAVEN ACQUISITION LP,
a Pennsylvania limited partnership

By: Brookhaven Acquisition GP LLC,
a Pennsylvania limited liability company
its General Partner

By: Brookhaven Managing Member, LLC,
a Pennsylvania limited liability company
its Managing Member

By: Brookhaven Equities LLC,
a Pennsylvania limited liability company
its Managing Member

By: _____
Name: Robert M. Hill
Title: Managing Member

THE DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY,
a municipal authority organized and existing under and pursuant to the laws of the Commonwealth of Pennsylvania

By:
Name: Robert Willert
Title: Executive Director

Radio Park does and shall execute this Agreement in the space provided below for the purpose of acknowledging the terms, conditions, and provisions hereof including, without limitation, Section 6. of this Agreement, Section 7. of this Agreement, and Section 9. of this Agreement.

RADIO PARK LANE, L.P.,
a Pennsylvania limited partnership

By: ECO Development and Construction Group LLC,
a Pennsylvania limited liability company
its sole general partner

Daniel S. Schrupp
Member

By: _____
Name: SIMON EASTMOND
Title: MEMBER

~~COMMONWEALTH OF PENNSYLVANIA~~ State of New Jersey :

ss

COUNTY OF ~~CHESTER~~ Camden :

On this, the 28th day of March, 2016, before me, a Notary Public, the undersigned officer, personally appeared **ROBERT M. HILL**, who acknowledged himself to be the Managing Member of Brookhaven Equities, LLC, a Pennsylvania limited liability company, the Managing Member of Brookhaven Managing Member, LLC, a Pennsylvania limited liability company, the Managing Member of Brookhaven Acquisition GP LLC, a Pennsylvania limited liability company, the General Partner of **BROOKHAVEN ACQUISITION LP**, a Pennsylvania limited partnership, and that he as such Managing Member, being authorized to do so, executed the foregoing instrument for the purposes therein contained by signing the name of Brookhaven Equities, LLC, by himself as Managing Member.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

DONNA L. ZANETICH
NOTARY PUBLIC OF NEW JERSEY
ID # 2411517
My Commission Expires 8/16/2016

NOTARY PUBLIC

My Commission Expires:

COMMONWEALTH OF PENNSYLVANIA :

ss

COUNTY OF DELAWARE :

On this, the _____ day of March, 2016, before me, a Notary Public, the undersigned officer, personally appeared **STANLEY R. KESTER**, who acknowledged himself to be the Chairman of the Board of Directors of **THE DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY**, a municipal authority organized and existing under and pursuant to the laws of the Commonwealth of Pennsylvania, and that he, as such Chairman, being authorized to do so, executed the foregoing instrument for the purposes therein contained by signing the name of **THE DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY,** by himself as such Chairman.

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

_____

NOTARY PUBLIC

EXHIBIT A

[INSERT METES AND BOUNDS DESCRIPTION OF BROOKHAVEN ACQUISITION PARCEL]

CONTROL POINT ASSOCIATES, INC.
traditional methods | modern approaches

New Britain Corporate Center
1600 Manor Drive, Suite 210
Chalfont, PA 18914
Tel. 215.712.9800
Fax. 215.712.9802
www.cpasurvey.com

May 12, 2015
Revised November 2, 2015
B02-120208-01

METES AND BOUNDS DESCRIPTION
PROPOSED LOT 2
SHOPPING CENTER,
PART OF FOLIO 05-00-00428-00 & FOLIO 05-00-00429-00
LANDS NOW OR FORMERLY
CHESTER WATER AUTHORITY
BOROUGH OF BROOKHAVEN, DELAWARE COUNTY
COMMONWEALTH OF PENNSYLVANIA

BEGINNING AT A POINT ON THE SOUTHWESTERLY LEGAL RIGHT-OF-WAY LINE OF EDGMONT AVENUE (A.K.A. S.R. 0352, A.K.A. L.R. 132, A.K.A. MIDDLETOWN, A.K.A. NEW EDGMONT ROAD, A.K.A. EDGMONT AVENUE, VARIABLE WIDTH RIGHT-OF-WAY), AT ITS INTERSECTION WITH THE NORTHWESTERLY LEGAL RIGHT-OF-WAY LINE OF COEBOURN BOULEVARD (65 FOOT WIDE RIGHT-OF-WAY), AND FROM SAID POINT OF BEGINNING RUNNING, THENCE,

1. ALONG THE NORTHWESTERLY LEGAL RIGHT-OF-WAY LINE OF COEBURN BOULEVARD, SOUTH 54 DEGREES - 31 MINUTES - 41 SECONDS WEST, A DISTANCE OF 912.91 FEET TO A POINT, THENCE;

2. ALONG THE COMMON DIVIDING LINE BETWEEN PROPOSED LOT #2; PROPOSED LOT #3; AND PROPOSED LOT #4, NORTH 38 DEGREES - 11 MINUTES - 08 SECONDS WEST, A DISTANCE OF 1,200.33 FEET TO A POINT, THENCE;

3. ALONG THE DIVIDING LINE BETWEEN PROPOSED LOT #2 AND PROPOSED LOT #1, NORTH 53 DEGREES - 42 MINUTES - 10 SECONDS EAST, A DISTANCE OF 912.37 FEET TO A POINT ON THE SOUTHWESTERLY LEGAL RIGHT-OF-WAY LINE OF EDGMONT AVENUE, THENCE;

4. ALONG SOUTHWESTERLY LEGAL RIGHT-OF-WAY LINE OF EDGMONT AVENUE, SOUTH 38 DEGREES - 11 MINUTES - 08 SECONDS EAST, A DISTANCE OF 1,213.49 FEET TO THE POINT AND PLACE OF BEGINNING.

CONTAINING 1,100,555 SQUARE FEET OR 25.265 ACRES

THIS PROPERTY SUBJECT TO RESTRICTIONS, COVENANTS AND/OR EASEMENTS EITHER WRITTEN OR IMPLIED.

THIS DESCRIPTION WAS WRITTEN BASED UPON A MAP ENTITLED "FINAL LAND DEVELOPMENT PLANS, FOLIO #05-00-00429-00 & FOLIO #05-00-00428-00, EDGMONT AVENUE, EAST DUTTON MILL RD. & COEBURN BLVD., BOROUGH OF BROOKHAVEN, DELAWARE COUNTY, COMMONWEALTH OF PENNSYLVANIA," DATED 7/1/2014, LAST REVISED 9/29/15, PROJECT NO. PV110758.

CONTROL POINT ASSOCIATES, INC.

11/2/15

JAMES F. HENRY, P.L.S. DATE
COMMONWEALTH OF PENNSYLVANIA
PROFESSIONAL LAND SURVEYOR # SU056807

MFD/JLA/agh:
S:\12\CP12208-RetailSites-Brookhaven-PA-JFH\CP12208.01-RetailSites-Brookhaven Borough-PA-JFH\M&B\M&B_Proposed Lot 2_6.15.15.docx
PREPARED BY: JLA
REVIEWED BY: MFD

EXHIBIT B

[INSERT PLANS AND DESCRIPTION OF BLOSSOM AVENUE WASTEWATER CONVEYANCE INFRASTRUCTURE IMPROVEMENTS]

PA ONE CALL No. 20152233123

CALL BEFORE YOU DIG!
PENNSYLVANIA LAW REQUIRES
3 WORKING DAYS NOTICE FOR
CONSTRUCTION PHASE AND 10 WORKING
DAYS IN DESIGN STAGE – STOP CALL 8-1-1

Pennsylvania One Call System, Inc.
1-800-242-1776
8-1-1 (WITHIN PA.)

THE LOCATIONS OF ALL UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE AND MUST BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL CONTACT PA ONE-CALL AT 811 AT LEAST 3-DAYS BEFORE PROCEEDING WITH ANY EXCAVATION. IT IS ALSO THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ACCURATE FIELD LOCATIONS OF ALL EXISTING UNDERGROUND AND AERIAL UTILITIES FROM BOTH THE UTILITY COMPANIES AND/OR BY TEST PITS PRIOR TO BEGINNING WORK. ALL UTILITY SERVICES WITHIN THE LIMITS OF WORK MUST ALSO BE FIELD LOCATED PRIOR TO EXCAVATION WORK. CONTRACTORS ARE TO IMMEDIATELY NOTIFY THE ENGINEER OF ANY DEVIATIONS FROM THE PLAN INFORMATION. THE CONTRACTOR SHALL BE RESPONSIBLE TO TAKE ALL PREVENTIVE MEASURES TO PROTECT THE LINES IN ACCORDANCE WITH THE PA ONE-CALL ACT. PA ONE-CALL SERIAL NUMBER 20152233123.

TEMPORARY SEEDING SPECIFICATIONS:

SEEDING: 100% COMMON RYEGRASS AT 5 LBS./1000 S.F.
FERTILIZER: 10-5-5 OR EQUAL AT 40 LBS./1000 S.F.
LIME: GROUND LIMESTONE AT 100 LBS./1000 S.F.

UNFORESEEN EROSIVE CONDITIONS

1. SHOULD UNFORESEEN EROSIVE CONDITIONS DEVELOP DURING CONSTRUCTION, THE CONTRACTOR SHALL TAKE ACTION TO REMEDY SUCH CONDITIONS AND TO PREVENT DAMAGE TO ADJACENT PROPERTIES AS A RESULT OF INCREASED RUNOFF AND/OR SEDIMENT. STOCKPILES OF WOODCHIPS, HAY BALES, CRUSHED STONE AND OTHER MULCHES SHALL BE HELD IN READINESS TO DEAL IMMEDIATELY WITH EMERGENCY PROBLEMS OF EROSION.
2. THE CONTRACTOR IS ADVISED TO BECOME THOROUGHLY FAMILIAR WITH THE PROVISIONS OF APPENDIX E-6, EROSION CONTROL RULES AND REGULATIONS, TITLE 25, PART I, DEPARTMENT OF ENVIRONMENTAL RESOURCES, SUB-PART C, PROTECTION OF NATURAL RESOURCES, ARTICLE III, WATER RESOURCES, CHAPTER 102, EROSION CONTROL.
3. PROTECTION TO EXISTING TREES AND SHRUBS SHALL BE TAKEN BY THE CONTRACTOR TO ELIMINATE UNNECESSARY DAMAGE.

PERMANENT SEEDING SPECIFICATIONS: GRASS AREAS

ALL AREAS DESIGNATED FOR GRASS COVER SHALL BE PREPARED AND SEEDED AS FOLLOWS AND THE MATERIALS SHALL BE APPLIED AT THE RATES INDICATED AND INCORPORATED INTO THE UPPER LAYER OF SOIL:

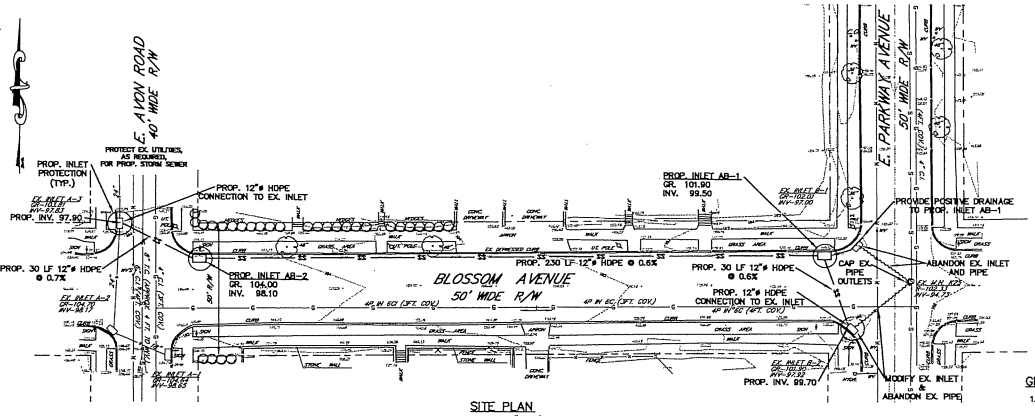
AGRICULTURAL GROUND LIMESTONE – 190 LBS./1000 S.F.
FERTILIZER – 9-20-20 FORMULA – 20 LBS./1000 S.F.
FERTILIZER – 10-5-5 FORMULA – 23 LBS./1000 S.F.

PREPARED AREAS SHALL BE SEEDED WITH A PERENNIAL RYEGRASS MIXTURE SOWN AT THE RATE OF 10 LBS./1000 S.F.OF SURFACE AREA AND ROLLED WITH A LIGHT WEIGHT ROLLER. (PERENNIAL RYEGRASS MIXTURE AS PREPARED BY THE SWEENEY SEED COMPANY, KING OF PRUSSIA, PA OR APPROVED EQUAL.)

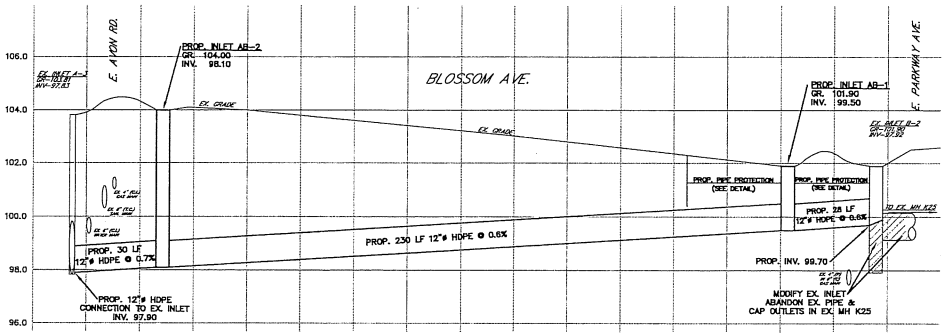
MULCH – HAY OR STRAW

ALL AREAS WHICH ARE SEEDED WITH EITHER TEMPORARY OR PERMANENT SEED MIXTURES SHOULD BE MULCHED. MULCH IS A LOOSE LAYER 3/4" TO 1" DEEP OF HAY OR STRAW. MULCH REDUCES SOIL EROSION, AIDS SEED GERMINATION, AND CONSERVES MOISTURE. HAY OR STRAW SHOULD NOT BE CHOPPED OR FINELY BROKEN DURING APPLICATION. MULCH SHOULD BE APPLIED AS FOLLOWS:

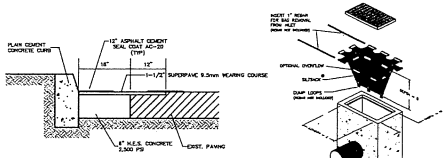
MULCH – 3 TONS PER ACRE, 140 LBS. PER 1000 S.F.



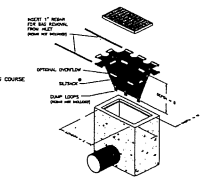
SITE PLAN
SCALE: 1"=20'



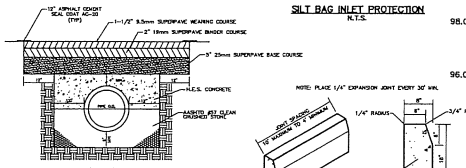
PROFILE
SCALE: 1"=20' HOR.
1"=2' VERT.



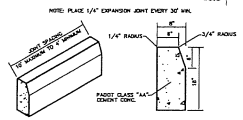
GUTTER RESTORATION
N.T.S.



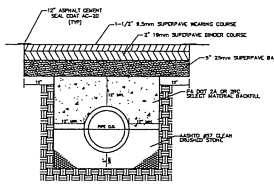
SILT BAG INLET PROTECTION
N.T.S.



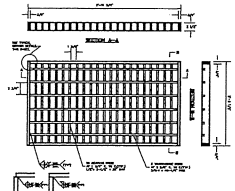
PIPE BEDDING AND PROTECTION
STORM SEWER
N.T.S.



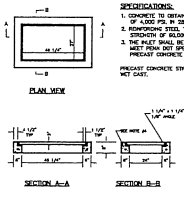
PLAIN CEMENT CONCRETE CURB
N.T.S.



STANDARD PIPE BEDDING AND RESTORATION
STORM SEWER
N.T.S.



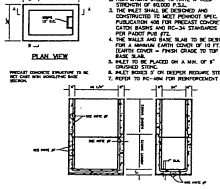
STRUCTURAL STEEL GRATE BICYCLE SAFE
N.T.S.



SPECIFICATIONS:
1. CONCRETE TO OBTAIN A STRENGTH OF 4,000 PSI IN 28 DAYS.
2. REINFORCING STEEL TO HAVE A YIELD STRENGTH OF 60,000 PSI.
3. THE INLET SHALL BE DESIGNED TO MEET HEAVY DUTY H-20 LOADING AND FOR PRECAST CONCRETE GATCH BASINS.

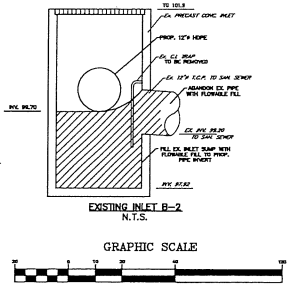
PRECAST CONCRETE STRUCTURE TO BE WET CAST.

PRECAST CONCRETE INLET TOP TYPE M
N.T.S.



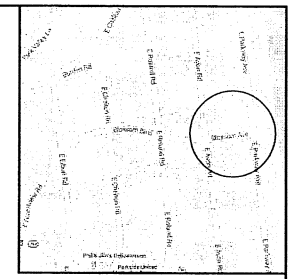
SPECIFICATIONS:
1. CONCRETE TO OBTAIN A STRENGTH OF 4,000 PSI IN 28 DAYS.
2. REINFORCING STEEL TO HAVE A YIELD STRENGTH OF 60,000 P.S.I.
3. THE INLET SHALL BE DESIGNED AND CONSTRUCTED TO MEET PENNDOT SPEC. PUBLICATION 408 FOR PRECAST CONCRETE INLETS AND PENNDOT RC-34 STANDARDS FOR PRECAST PIPE.
4. THE WALLS AND BASE SLAB TO BE DESIGNED FOR A MINIMUM EARTH COVER OF 10 FT. (EARTH COVER = FINISH GRADE TO TOP OF PIPE).
5. BASE SLAB PLACED ON A MIN. OF 6" CRUSHED STONE.
6. INLET BOXES 5' OR DEEPER REQUIRE STEPS.
7. REFER TO PC-604 FOR REINFORCEMENT SPECIFICATIONS.

PRECAST CONCRETE TYPE C & M STANDARD INLET BOX
N.T.S.



EXISTING INLET B-2
N.T.S.

GRAPHIC SCALE
(IN FEET)
1 inch = 20 ft.



LOCATION MAP
SCALE: 1" = 500'

LEGEND

- EX. SPOT ELEVATION
- EX. SANITARY SEWER
- EX. GAS MAIN
- EX. WATER MAIN
- EX. STORM SEWER
- PROP. STORM SEWER
- PROP. INLET PROTECTION

GENERAL NOTES:

1. STRUCTURES AND PIPES AS SHOWN ON THE PLANS ARE GRAPHICAL DEPICTIONS ONLY. ACTUAL SIZE, CONFIGURATIONS, AND LOCATIONS OF MANHOLES, INLETS, AND STRUCTURES ARE THE CONTRACTOR'S RESPONSIBILITY.
2. CONTRACTOR TO BE RESPONSIBLE FOR COORDINATION OF ALL UTILITY CROSSINGS. PROTECTION OF HOUSE SERVICES DURING CONSTRUCTION TO BE THE CONTRACTOR'S RESPONSIBILITY. UTILITIES HAVE BEEN NOTIFIED OF PENDING CONSTRUCTION BY THE PA ONE CALL SYSTEM. LOCATIONS OF UTILITIES ARE APPROXIMATE AND ARE PLOTTED FROM RECORDS OBTAINED FROM THE UTILITY COMPANIES. CONTRACTOR TO VERIFY HORIZONTAL AND VERTICAL LOCATIONS OF ALL UTILITIES AND REPORT ANY DISCREPANCIES TO THE ENGINEER PRIOR TO ANY CONSTRUCTION.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY FOR PROTECTING AND PREVENTING DAMAGE TO ALL EXISTING (OVERHEAD AND UNDERGROUND) UTILITIES AND ADJACENT PRIVATE PROPERTY.
4. THE CONTRACTOR SHALL PROTECT THE PROPOSED STORM SEWER PER THE PIPE BEDDING AND PROTECTION DETAIL UNTIL A MINIMUM 2 FT. COVER IS PROVIDED.
5. CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL REQUIRED LICENSE AND PERMITS FOR THE PROPOSED WORK, AS REQUIRED BY THE CITY OF CHESTER.
6. TRAFFIC MAINTENANCE AND WORK ZONE PROTECTION TO BE THE RESPONSIBILITY OF THE CONTRACTOR. ALL CONSTRUCTION AREAS TO BE SECURED AND PROPERLY BARRICADED FROM VEHICULAR AND PEDESTRIAN TRAFFIC. ALL OPEN TRENCHES SHALL BE PROPERLY SECURED WITH HIGH VISIBILITY ORANGE SAFETY FENCE AND LIGHTED BARRICADES. ALL CONSTRUCTION AREAS INCLUDING STAGING AND MATERIAL STORAGE AREAS SHALL BE CONFINED TO THE LIMITS OF THE RIGHT-OF-WAY, AND BE PROPERLY PROTECTED WITH LIGHTED BARRICADES. CONTRACTOR MUST MAINTAIN ACCESS TO ALL RESIDENTS' DRIVEWAYS THROUGH THE PROGRESS OF WORK. ACCESS TO FIRE HYDRANTS, MAIL BOXES, ETC. SHALL ALSO BE MAINTAINED.
7. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL OR BETTER CONDITION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL NECESSARY RESTORATION WORK, AS REQUIRED, FOR THE PROPER COMPLETION OF THE WORK. ANY CURB OR SIDEWALK DAMAGED AS A RESULT OF THIS WORK SHALL BE REPLACED BY THE CONTRACTOR.
8. THE PROJECT SITES SHALL BE KEPT IN CLEAN AND ORDERLY CONDITION. ALL DEBRIS AND EXCESS MATERIALS SHALL BE REMOVED FROM SITE ON A DAILY BASIS. ALL STREETS TO BE BROOM SWEPT AS NECESSARY TO PREVENT EXCESS DUST NUISANCE TO RESIDENCE. FAILURE TO PROPERLY MAINTAIN SITES CAN RESULT IN DELAY OF WORK UNTIL AREAS ARE PROPERLY CLEANED.
9. KEEP ALL ROADWAYS, ADJACENT PROPERTIES, DRAINAGE FACILITIES AND WATER COURSES FREE FROM ALL DEBRIS, DROPPINGS AND SEDIMENT. IMMEDIATELY REMOVE ANY SUCH OCCURRENCES.
10. TEMPORARY INLET PROTECTION SHALL BE PROVIDED AT EACH INLET AND SHALL BE MAINTAINED BY THE CONTRACTOR UNTIL PERMANENT RESTORATION IS COMPLETED. WHEN FINAL RESTORATION IS COMPLETED, CONTRACTOR MUST REMOVE INLET PROTECTION FROM INLETS.
11. PROTECTION OF EXISTING TREES AND SHRUBS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO ELIMINATE UNNECESSARY DAMAGE.
12. ALL RESIDENTIAL PROPERTY BORDERS ARE APPROXIMATE AND NOT INTENDED FOR LEGAL PURPOSES.

INFORMATION SHOWN ON THIS PLAN IS THE RESULT OF PROFESSIONAL SERVICES RENDERED BY CATANIA ENGINEERING ASSOCIATES, INC. REPRODUCTION OF THIS PLAN FOR THE PURPOSE OF CREATING ADDITIONAL COPIES OR REVISING PLAN WITHOUT APPROVAL OF CATANIA ENGINEERING ASSOCIATES, INC. IS PROHIBITED. CERTIFICATION FOR THE WORK CONTAINED HEREIN IS LIMITED TO THE ENTITY FOR WHOM THE WORK WAS PERFORMED, AS OF THE DATE SHOWN ON THE PLAN.

NO.	DATE	REVISION	DWN. BY	CHD. BY
1.	10-15-15	EX. UTILITIES PER PADC	D.J.A.	C.J.C.

CATANIA ENGINEERING ASSOCIATES, INC.
Consulting Engineers
320 WEST MacDADE BOULEVARD
WILMONT PARK, PA. 19033-3311
TEL. (610) 532-2884
FAX. (610) 532-2923

STORM SEWER SEPARATION FOR DELCORA

BLOSSOM AVE. – E. AVON TO E. PARKWAY

CITY OF CHESTER DELAWARE COUNTY, PA

DWN. BY	J.M.D.	DSG. BY		FIELD BOOK/PAGE		SCALE	1" = 20'	DRAWING NO. 81600 – 2007-3A
CHD. BY	C.J.C.	D.J.A.		RP		DATE	7-29-15	SHEET 1 OF 1 SHEETS

EXHIBIT C

[INSERT CITY PERMIT]

02 SF012216 01/22/2016 LAND FND 6.92
4.03
CHECK

FUND

CITY OF CHESTER
ACCOUNTS AND FINANCE

11584 11584
RECEIPT NUMBER 4002000184775

Date 1-21-16

RECEIVED FROM Streets & Public Improvements

Blossom Avenue Storm Sewer Separation file# PDCCP026 Acct#81

The Sum of $6,924.03 Their Check No. 1519 Dated 1-20-16

For Services Rendered: Installing two new inlets on Blossom Avenue also installing new curbs. Fees are included with the check.

Brookhaven Acquisition LP

1000 Lenola Road CODE: LAND FUND FUND # 81

Building 2, Suite 100
Maple Shade, NJ 08052

Received by:
Irene M. Tucker
City Accountant

TREASURER'S OFFICE COPY

2

CITY OF CHESTER

CHESTER, PA.

CITY OF CHESTER

Permit for Street Opening

PAID

LICENSEE'S PERMIT

JAN 21 2016

DEPT. OF STREETS & PUBLIC IMPTS.

PER 11386 Date 1-21-16

Brookhaven Acquisition LP has been granted permission to excavate in install two new for inlets and new curbs at opposite House No. ..... on ..... side, or about Blossom Avenuewstorm Sewer Separation Blossom Av bet E.Parkway Av & Avon Rd of

Charge $6,924.03

Robert Hill

856-275-9366

Signed

Declaration of Size of Excavation

.....width.....length.....sq. ft.....sq. yds.

Kind of surface.....Kind of base.....

Work to start.....Work to be finished.....

Plumbing Permit No.....

Restoration on ALL Streets shall be in accordance with Penn Dot Form M-945B and City of Chester Specifications.

ALL WORK AND MATERIALS SHALL BE IN ACCORDANCE WITH THE PA. DEPT. OF TRANSPORTATION SPECIFICATION FORM 408, PERMIT FORM 945 AND/OR THE ADOPTED ORDINANCES OF THE CITY OF CHESTER"

Side

NO TUNNELING

Received Payment

(Original)

5

CITY OF CHESTER

CHESTER, PA.

CITY OF CHESTER

Permit for Street Opening

PAID

JAN 21 2016

LICENSEE'S FOREMAN'S PERMIT

DEPT. OF STREETS & PUBLIC IMPTS.

PER 11386 Date 1-21-16

Brookhaven Acquisition LP has been granted permission to excavate in Blossom Av bet E.Parkway Av & Avon Road

between installing two inlets and curb and Storm sewer separation

Work Starts.....Work to be Finished.....

$6,924.03

Signed

THIS COPY OF PERMIT TO be surrendered to Police upon request. Permit liable to revocation if not on operation at actual time of actual work.

Absolutely NO TUNNELING

MEMO

TRENCH MUST BE COVERED WITH ONE HALF (½) INCH STEEL PLATE TO ALLOW UNINHIBITED TRAFFIC FLOW UNTIL FINAL RESTORATION AND INSPECTION

Received Payment

(Duplicate)

Retail Sites LLC

Via Federal Express

January 20, 2016

City of Chester
1 Fourth Street
Chester, PA 19013-4400

Attn: City Engineer

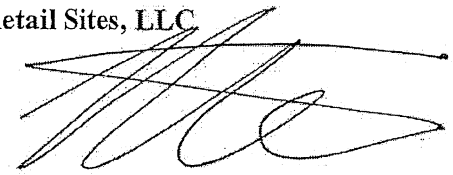
Re: City of Chester
Blossom Avenue Storm Sewer Separation
File #PDCCP026, Account #81

Dear Sir/Madam:

Enclosed please find check #1519 in the amount of $6,924.03 on behalf of Brookhaven Acquisition LP for the inspection escrow for the Blossom Avenue Storm Sewer Separation work in Brookhaven, PA, as set forth in the October 2, 2015 review letter from Michael Galante to Retail Sites, LLC (attached).

Sincerely,

Retail Sites, LLC



Robert Hill
President

Enclosure: Check #1519

cc: M. Galante

October 2, 2015

Retail Sites, LLC
Tall Oaks Corporate Center
100 Lenola Road
Building Two, Suite 100
Maple Shade, NJ 08052

Attn: Robert Hill
President

Re: City of Chester
Blossom Avenue Storm Sewer Separation
Our File #PDCCP026 (First Review)

Dear Mr. Hill:

At your request, our office has received the following submission materials for the above referenced plan submission:

- Storm Sewer Separation Plan – Blossom Avenue, One (1) sheet1 prepared by Catania Engineering Associates, Inc., Milmont Park, PA dated 7/29/2015.

I. Submission Information

Owner & Applicant:	Robert hill, President Retail Sites, LLC 1000 Lenola Road Building Two, Suite 100 Maple Shade, NJ 08052 856-778-4900
Engineer:	Catania Consulting Engineers 520 West MacDade Boulevard Milmont Park, PA 19033-3311 610-532-2884 Fax 610-532-2923
Proposal:	The Applicant proposes to separate the storm sewer from the sanitary sewer system at Blossom Avenue between East Parkway Avenue and Avon Road. The proposed improvements will be owned and operated by the City of Chester when completed and the Developer is completing these improvements in accordance with an agreement with Delcora.

Based on our review, we have the following comments that must be addressed by the design professional. Please note that underlined statements are items that must be addressed by the design professional prior to final plan approval.

II. Engineering Comments

1. The applicant is proposing to utilize 12" HDPE Pipe. The size and material of the pipe shall be modified to 15" Reinforced Concrete Pipe.

2. The applicant is proposing to connect into an existing stormwater inlet at the Northeast corner of E. Avon Road. The application shall upgrade the inlet by adding a PENNDOT Approved bicycle safe grate and the applicant shall clean and parge the interior of the inlet. A detail shall be provided on the plans.

3. The applicant is proposing to modify the existing inlet located at the Southwest corner of East Parkway Avenue. The applicant shall clean and parge the inlet and fill the bottom of the inlet with concrete to the proposed pipe invert. This shall be detailed on the plans.

4. The applicant is proposing the abandon inlet at the Northwest corner of East Parkway Avenue. This inlet represents a low point and if the inlet is removed the street will not drain adequately. Therefore, the applicant shall consider keeping this inlet and connecting it into the proposed inlet.

5. The proposed pipe location along Blossom Avenue will most likely require new curb. A curb detail shall be added to the plans. Additionally, the pipe is located within close proximity to street trees and the applicant shall provide written justification that there will be no impacts to existing street trees.

6. The applicant shall provide a detail and type for the two (2) proposed inlets on Blossom Avenue.

7. All abandoned pipe shall be capped and both ends and filled with flowable fill.

8. Prior to construction, it is recommended that the applicant coordinate potential utility conflicts to ensure an efficient construction schedule and reduce impacts to the local residents.

9. The applicant shall perform a half mill and pave the roadway.

10. A road opening permit is required for all work.

11. Prior to the start of construction, the applicant shall enter into a developer's agreement with the City and pay all engineering review and inspection fees incurred by the City.

Our approval is contingent upon the design professional addressing and responding to each underlined item in the letter by return correspondence using the same numbering. Should you have any questions please feel free to contact me directly at (610) 940-1050, extension 3002.

Very truly yours,
Remington, Vernick & Beach Engineers

Michael Galante, PE, PP, CME, LEED GA
City Engineer

cc:

Catania Engineering Associates, Inc., Plan Preparer
Portia West, Councilwoman
Ronald Starr, Chief of Staff
Christoper Fazio, PE, Regional Manager
Thomas F. Beach, P.E., RV&B, Executive Vice President

BROOKHAVEN ACQUISITION LP
1000 LENOLA RD
BUILDING 2, SUITE 100
MAPLE SHADE, NJ 08052

1519

3-7568/2360
246

CHECK ARMOR

DATE 1/20/16

PAY TO THE ORDER OF City of Chester $ 6,924.03

six thousand nine hundred twenty four & 03/100 DOLLARS

Security Features Details on Back

Beneficial BANK

1-888-742-2265 • thebeneficial.com

FOR Bldg. 5 Ave Storm Sewer Sep. - Escrow
File # PDCC026 ACCT. #81

MP

⑈001519⑈ ⑆236075689⑆ 9500182952⑈

EXHIBIT D

[INSERT METES AND BOUNDS DESCRIPTIONS OF RADIO PARK PARCELS]

First American Title™	Commitment for Title Insurance
	ISSUED BY **First American Title Insurance Company**
Exhibit A	

File No. **PAFA15-3034 MC**

ALL THOSE CERTAIN lots or parcels of land and the buildings thereon situate in Brookhaven Borough, Delaware County, Pennsylvania, as more particularly described as follows:

PREMISES "A"

ALL THAT CERTAIN lot or piece of ground with the buildings and improvements thereon erected, Hereditaments and Appurtenances, SITUATE in the Brookhaven Borough, County of Delaware and State of Pennsylvania, bounded and described according to a Plan of property of Simon Carman prepared by G.D. Houtman & Son, Civil Engineers and Land Surveyors, dated December 8th, 1960 and last revised August 10th, 1978 as follows, to wit:

BEGINNING at a point in the title line at or near the centerline of Brookhaven Road (33 feet wide), the said point being 336.08 feet North 54 degrees 39 minutes 40 seconds East from the point of intersection of the title line at or near the center line of Brookhaven Road with the centerline of Edgmont Avenue; thence from said point of beginning and along the title line at or near the centerline of Brookhaven Road North 44 degrees 39 minutes 40 seconds East 137.66 feet to a point; thence leaving Brookhaven Road South 38 degrees 48 minutes 20 seconds East 368.86 feet to a pipe; thence South 52 degrees 35 minutes 40 seconds West 107.2 feet to a point; thence along Lot No. 1 North 43 degrees 37 minutes 44 seconds West 351.83 feet to the first mentioned point and place of beginning.

PREMISES "B"

ALL THAT CERTAIN lot or piece of ground with the buildings and improvements thereon erected, Hereditaments and Appurtenances, SITUATE at Brookhaven, in Brookhaven Borough (formerly Chester Township), County of Delaware and State of Pennsylvania, bounded and described as follows, to wit:

BEGINNING at a point in the center line of Brookhaven Road, a corner of lands now or late of Theodore R. Dix; thence by the center line of the said Brookhaven Road, North 48 degrees, 8 minutes East, 101.35 feet to a point, a corner of other lands now or late of Wallace R. Michaels, Jr. and wife; thence by the last mentioned lands, South 32 degrees, 31 minutes East, 387.77 feet, more or less, to a point in line of lands now or late of John P. Crozer, deceased; thence by the last mentioned lands, South 58 degrees, 10 minutes West, 100.01 feet to a point, a corner of said mentioned lands of the said Theodore R. Dix; thence by last mentioned lands, North 32 degrees, 31 minutes West, 370.01 feet, more or less, to the center line of the said Brookhaven Road , the point or place of beginning.

PREMISES "C"

ALL THAT CERTAIN lot or piece of land, Hereditaments and Appurtenances, SIUATE in the Borough of Brookhaven, formerly the Township of Chester, County of Delaware and State of Pennsylvania, and bounded and described according to survey thereof made by Joseph S, White, of Philadelphia on August 5th, 1947, as follows to wit:

BEGINNING at a point in the center line of Brookhaven Road, a corner of lands now or late of George M. Merchant, et ux; extending thence along the center line of said Brookhaven Road, North 48 degrees, 8 minutes East 65.35 feet to a point a corner of lands of Wallace R. Michaels, Jr. et ux, about to be conveyed to Frank H. Bozman, et ux; thence along said lands, South 32 degrees 5 minutes East 399.09 feet to a point in line of lands now or late of the Estate of John P. Crozer deceased; thence along last mentioned lands, South 58 degrees, 10 minutes West 61.37 feet to a corner of lands now or late of said George M. Merchant, to ux; and thence along last mentioned lands, North 32 degrees, 31 minutes West 387.77 feet to the center line of said Brookhaven Road, the first mentioned point and place of beginning.

EXCEPTING THEREFROM AND THEREOUT FROM PREMISES C:

ALL THAT CERTAIN lot or piece of land, Situate in the Borough of Brookhaven, County of Delaware and State of Pennsylvania, and bounded and described in accordance with a "Preliminary/Final Record Plan", prepared for Harvin Properties, LLC, dated July 15th, 2005, last revised October 11th, 2006 prepared by R&T Associates, LLC, Chaddsford, Pennsylvania, being more fully described as follows, to wit:

BEGINNING at a point on the easterly right-of-way of Brookhaven Road (60 feet wide), said point being the common corner of lands nor or formerly of Lot 19 and lands now or formerly of Harvin Properties, LLC; THENCE extending along the easterly right-of-way of Brookhaven Road (60 feet wide), North 44 degrees 39 minutes 9 seconds East, 64.60 feet to a point, a common corner of Lot 19 and lands now or formerly of Business and Industrial Plant and Office Investors, South 38 degrees 28 minutes 20 seconds East, 147.08 feet to a point; THENCE leaving said line of lands and extending along the common line of lands between Lot 19 and lands now or formerly of Harvin Properties, LLC, South 53 degrees 38 minutes 33 seconds West 63.12 feet to a point; THENCE continuing along a common line of lands of Lot 19 and lands now or formerly of Harvin Properties, LLC North 38 degrees 48 minutes 20 seconds West 138.01 feet to a point on the easterly right-of-way of Brookhaven Road (60 feet wide), the first mentioned point and place of BEGINNING.

AND NOW AS TO RESIDUE OF PARCEL C BEING DESCRIBED AS: DESCRIPTION OF PROPERTY KNOWN AS PREMISES "C" RESIDUE NOW OR FORMERLY OF HAM/1N PROPERTIES, LLC (SOURCE OF TITLE DEED RECORD BOOK 3477, PAGE 549), LOCATED AT SOCIETY HILL AT BROOKHAVEN, AND MORE PARTICULARLY SHOWN ON A PLAN FOR WILMINGTON SAVINGS FUND SOCIETY PREPARED BY TRANSITION ENGINEERING SURVEYING LLC, DATED AUGUST 8TH, 2014, REVISED THROUGH AUGUST 25TH, 2014, PROHECT NO. WSFS: 033.54.08. SITUATED IN BROOKHAVEN BOROUGH, DELAWARE COUNTY, PENNSYLVANIA.

BEGINNING at a point in line lands known as #125 Brookhaven Road now or formerly of Business and Industrial Plant and Office Investors (Deed Book 1564, Page 13999), said point being a common corner for the (residue) parcel herein described and Lot No. 19 known as #123 Brookhaven Road now or formerly of Robert P. Martin and Brenda J. Martin (Deed Record Book 4020, Page 59), and further located along the division line between Lot No. 19 known as #123 Brookhaven Road and said lands known as #125 Brookhaven Road, S 44° 43' 40" E (State Plan bearing), S 38° 28' 20" E (Society Hill at Brookhaven plat bearing), and crossing over a capped rebar set at 28.94', a total distance of 148.07 from its point of intersection thereof with the title line at or near the centerline of Brookhaven Road at 60' wide THENCE from said point of beginning, along said lands known as #125 Brookhaven Road, S 44° 43' 40" E (State Plane bearing), a distance of 250.61' to a point (iron pipe found) in the rear line of lands known as #246 Radio Park Lane now or formerly of Clara N. Williams (Deed Book 4813, Page 262); THENCE by the same, in part, and along the rear line of lands known as #244 Radio Park Lane now or formerly of Kenneth Ulerick and Deborah Ulerick (Deed Book 4531, Page 1331), S 46° 09' 05" W (State Plane bearing), and crossing over a found rebar at 26.07', a total distance of 61.88' to a point (metal post found at grade), a corner of Premises "B" known as #121 East Brookhaven Road now or formerly Harvin Properties LLC (Deed Record Book 3286, Page 865); THENCE by the same, N 45° 03' 40" W (State Plane bearing), a distance of 252.00' to a point, a rear corner for said Lot No. 19 known as #123 Brookhaven Road;

THENCE along the rear lot line of said Lot No. 19 known as #123 Brookhaven Road, N 47° 23' 13" E (State Plane bearing), a distance of 63.38' to a point in said line of lands known as #125 Brookhaven Road, the first mentioned point and place of beginning.

CONTAINGING with said described metes and bounds 0.3612 acre of land, be the same more or less.

File No. **PAFA15-3034 MC**

PREMISES "D"

ALL THAT CERTAIN parcel of ground, Hereditaments and Appurtenances, SITUATE in Brookhaven Borough, County of Delaware and State of Pennsylvania, and described according to a field survey performed by G.D. Houtman & Son, Inc., Civil Engineers and Land Surveyors dated November 15th, 2004, as follows, to wit:

BEGINNING at a found pipe on the Northwesterly Right-of-Way Line of Radio Park Lane (50 feet wide), the aid found pipe being measured 304.68 feet along the said Right-of-Way Line South 44 degrees, 21 minutes, 0 seconds West, from a point of curve; the said point of curve being measured along an arc of a circle to the right of radius of 50 feet an arc distance of 78.55 feet from a point of tangency on the Northeasterly Right-of-Way Line of Williams Avenue (50 feet wide); thence from the point of beginning and along the Northwesterly Right-of-Way Line of Radio Park Lane, South 44 degrees, 21 minutes, 0 seconds West, 73.20 feet to a point; thence North 41 degrees, 9 minutes, 12 seconds West, 147 feet to a point; thence along lands now or late of Harvin Properties, LLC, North 52 degrees, 35 minutes, 40 seconds East, 62.32 feet to a found iron pin; thence along lands now or late of Carmen and Karen Lombardo, South 45 degrees, 39 minutes, 0 seconds East, 137.62 feet to a found pipe on the Northwesterly Right-of-Way Line of Radio Park Lane, being the first mentioned point and place of beginning.

ALSO BEING DESCRIBED AS TO THE WHOLE in a Plan by the Transition Engineering Survey dated August 8th, 2014, Project #WSFS:033.54.08, as:

DESCRIPTION OF THE OVERALL BOUNDARY OF THE SUBDIVISION OF SOCIETY HILL AT BROOKHAVEN (RESIDUE) CONSISTING OF PREMISES "A", PREMISES "B", PREMISES "C" RESIDUE AND PREMISES "D" NOW OR FORMERLY OF HARVIN PROPERTIES, LLC, LOCATED AT SOCIETY HILL AT BROOKHAVEN, AND MORE PARTICULARLY SHOWN ON A PLAN FOR WILMINGTON SAVINS FUND SOCIETY PREPARED BY TRANSITION ENGINEERING SURVEYING LLC, DATED AUGUST 8TH, 2014, PROJECT NO. WSFS: 033.54.08. SITUATED IN BROOKHAVEN BOROUGH, DELAWARE COUNTY, PENNSYLVANIA.

BEGINNING at a point in the title line at or near the center line of Brookhaven Road at 60' wide, said point being a common corner for the lands herein being described and lands now or formerly of Marie Carman and Bohdan Carman (Deed Book 753, Page 1276), and further located along the said title line at or near the centerline of Brookhaven Road, in a northeasterly direction, a distance of 336.08' from its point of intersection thereof with the centerline of Edgemont Avenue.

THENCE from the said point of beginning, continuing along the said title line at or near the centerline of Brookhaven Road, the two following described courses and distances:

1. N 38° 27' 47" E (State Plane bearing), 137.16' to an angle point; and,

2. N 35° 39' 02" E (State Plane bearing), 101.56' to a point, a corner for Lot No. 19 known as #123 Brookhaven Road now or formerly of Robert P. Martin and Brenda J. Martin (Deed Book 4020, Page 59);

THENCE by the same, the two (2) following described courses and distances:

1. S 45° 03' 40" E (State Plane bearing), and crossing over an iron pipe found on a line at 31.13', a total distance of 134.86' to a point; and,

2. N 47° 23' 13" E, a distance of 63.38' to a point in line of lands known as #125 Brookhaven Road now or formerly of Business and Industrial Plant and Office Investor (Deed Book 1564, Page 1399);

THENCE by the same, S 44° 43' 40" E, a distance of 250.61' to a point (iron pipe found) in the rear line of lands known as #246 Radio Park Lane now or formerly Clara N. Williams (Deed Book 4813, Page 262);

THENCE by the same, in part, and along the rear line of lands known as #244 Radio Park Lane now or formerly of Kenneth Ulerick and Deborah Ulerick (Deed Book 4531, Page 1331), S 46° 09' 05" W (State Plane bearing) and crossing over a rebar found at 2607', and a metal post found at grade at 61.88', a total distance of 94.78' to a point (rebar found),

THENCE still along said lands known as #244 Radio Park Lane, S 52° 05' 35" E (State Plane bearing), a distance of 137.61' to a point in the northwesterly side of Radio Park Lane at 50' wide;

THENCE by the same, S 37° 54' 25" W (State Plane bearing), a distance of 73.20' to a point, a corner for the remaining part of #24 Radio Park Lane now or formerly Brookhaven First Church of God (Deed Book 1605, Page 40);

THENCE by the same, the two (2) following described courses and distances:

1. N 47° 35' 47" (State Plane bearing), a distance of 147.00' to a point; and,

2. S 46° 09' 05" W (State Plane bearing), and crossing over a lath set at 4.33', a total distance of 112.09' to a point (iron pipe found), a corner for said lands shown as #115 Brookhaven Road;

THENCE by the same, N 49° 49' 44" W (State Plane bearing) and crossing over a mag nail set at 316.16', a total distance of 351.83' to a point in the said title line at or near the centerline of Brookhaven Road, the first mentioned point and place of beginning.

CONTAINING with said described metes and bounds 2.4568 acres of land, be the same more or less.

SUBJECT to any easements, agreements and restrictions of record.

BEIGN Know as 4000-4020 Grady Collier Lane, Society Hill at Brookhaven

05-00-00506-50 (Lot 1, Street #4013) 05-00-00506-51 (Lot 2, Street #4011) 05-00-00506-52 (Lot 3, Street #4009) 05-00-00506-53 (Lot 4, Street #4007) 05-00-00506-54 (Lot 5, Street #4005) 05-00-00506-55 (Lot 6, Street #4003) 05-00-00506-56 (Lot 7, Street #4001) 05-00-00506-57 (Lot 8, Street #4020) 05-00-00506-58 (Lot 9, Street #4018) 05-00-00506-59 (Lot 10, Street #4016) 05-00-00506-60 (Lot 11, Street #4014) 05-00-00506-61 (Lot 12, Street #4012) 05-00-00506-62 (Lot 13, Street #4010) 05-00-00506-63 (Lot 14, Street #4008) 05-00-00506-64 (Lot 15, Street #4006) 05-00-00506-65 (Lot 16, Street #4004) 05-00-00506-66 (Lot 17, Street #4002) 05-00-00506-67 (Lot 18, Street #4000)

NOTICE: Lots 20-23 are open space and do not have separate folio/assessments.

NOTICE: Grady Collier Lane does not have a separate folio/assessment.

First American Title™	Commitment for Title Insurance
	ISSUED BY **First American Title Insurance Company**
Exhibit A (Cont.)	

File No. **PAFA15-3034 MC**

BEING THE SAME PREMISES WHICH Wilmington Savings Fund Society, FSB a Federally Chartered Savings Bank, by Deed of Confirmation dated 10/9/2014 and recorded 10/22/2014 in Delaware County, Pennsylvania in Record Book 5562, page 116, conveyed unto Wilmington Savings Fund Society, FSB, a Federally Chartered Savings Bank, in fee.

EXHIBIT E

[INSERT CAPACITY RESERVATION LETTER]

DELAWARE COUNTY REGIONAL WATER QUALITY CONTROL AUTHORITY
P.O. Box 999 • Chester, PA 19016-0999

October 21, 2015

Robert Hill
President
Retail Sites
Tall Oaks Corporate Center
1000 Lenola Road
Building 2, Suite 100
Maple Shade, NJ 08052

RE: The Shoppes at Brookhaven
Edgmont Avenue & Coebourn Blvd.
Brookhaven Borough, PA

Dear Mr. Hill:

Per your request in letter dated October 15, 2015, this letter will acknowledge the receipt of your check #1269 on behalf of Brookhaven Equities, LLC in the amount of $8,500.00 for 85 EDUs for the Shoppes at Brookhaven.

Thank you.

Sincerely,

Robert J. Willert
Executive Director

cc: E. Bothwell
File – Agreement (Hartford Properties-Schempp-DELCORA)
File – sewer planning module #2014-0818

ADMINISTRATION
☐610-876-5523
☐FAX: 610-876-2728

CUSTOMER SERVICE/BILLING
☐610-876-5526
☐FAX: 610-876-1460

PURCHASING & STORES
☐610-876-5523
☐FAX: 610-497-7959

PLANT & MAINTENANCE
☐610-876-5523
☐FAX: 610-497-7950

RIGHT TO KNOW REQUEST SUBMITTED TO RIDLEY PARK BOROUGH

pennsylvania
OFFICE OF OPEN RECORDS

Standard Right-to-Know Law Request Form

Good communication is vital in the RTKL process. Complete this form thoroughly and retain a copy; it may be required if an appeal is filed. You have 15 business days to appeal after a request is denied or deemed denied.

SUBMITTED TO AGENCY NAME: Ridley Borough Park, Attn: Right to Know Officer

Date of Request: May 5, 2020 Submitted via: Email

PERSON MAKING REQUEST:

Name: Thomas T. Niesen, Esquire,
Thomas, Niesen & Thomas, LLC
Attorney for Aqua Pennsylvania Wastewater, Inc.

Mailing Address: Suite 302, 212 Locust Street

City: Harrisburg State: PA Zip: 17101 Email: tniesen@tntlawfirm.com

Telephone: 717-255-7641 Fax: 717-236-8278

How do you prefer to be contacted if the agency has questions? Email

RECORDS REQUESTED: *Be clear and concise. Provide as much specific detail as possible, ideally including subject matter, time frame, and type of record or party names. RTKL requests should seek records, not ask questions. Requesters are not required to explain why the records are sought or the intended use of the records unless otherwise required by law. Use additional pages if necessary.*

Agreement dated November 26, 1952, between Central Delaware County Authority and Borough of Morton, Borough of Prospect Park, Borough of Ridley Park, Borough of Rutledge, Borough of Swarthmore, Township of Nether Providence Township of Ridley, Township of Springfield

DO YOU WANT COPIES? ☐ Yes, printed copies (*default if none are checked*)
X Yes, electronic copies preferred if available
☐ No, in-person inspection of records preferred (*may request copies later*)

Do you want certified copies? ☐ Yes (*may be subject to additional costs*) X No

RTKL requests may require payment or prepayment of fees. See the Official RTKL Fee Schedule for more details.

Please notify me if fees associated with this request will be more than ☐ $100 (or) X $ 25.00.

ITEMS BELOW THIS LINE FOR AGENCY USE ONLY

Tracking: _____ Date Received: _____ Response Due (5 bus. days): _____

30-Day Ext.? ☐ Yes ☐ No (If Yes, Final Due Date: _____) Actual Response Date: _____

Request was: ☐ Granted ☐ Partially Granted & Denied ☐ Denied Cost to Requester: $_____

☐ Appropriate third parties notified and given an opportunity to object to the release of requested records.

NOTE: In most cases, a completed RTKL request form is a public record.
More information about the RTKL is available at https://www.openrecords.pa.gov

Form updated Feb. 3, 2020

RIGHT TO KNOW REQUEST SUBMITTED TO ROSE VALLEY BOROUGH (ITEMS 32 AND 33)

pennsylvania
OFFICE OF OPEN RECORDS

Standard Right-to-Know Law Request Form

Good communication is vital in the RTKL process. Complete this form thoroughly and retain a copy; it may be required if an appeal is filed. You have 15 business days to appeal after a request is denied or deemed denied.

SUBMITTED TO AGENCY NAME: Rose Valley Borough, Attn: Right to Know Officer

Date of Request: May 6, 2020 Submitted via: Email

PERSON MAKING REQUEST:

Name: Thomas T. Niesen, Esquire,
Thomas, Niesen & Thomas, LLC
Attorney for Aqua Pennsylvania Wastewater, Inc.

Mailing Address: Suite 302, 212 Locust Street

City: Harrisburg State: PA Zip: 17101 Email: tniesen@tntlawfirm.com

Telephone: 717-255-7641 Fax: 717-236-8278

How do you prefer to be contacted if the agency has questions? Email

RECORDS REQUESTED: *Be clear and concise. Provide as much specific detail as possible, ideally including subject matter, time frame, and type of record or party names. RTKL requests should seek records, not ask questions. Requesters are not required to explain why the records are sought or the intended use of the records unless otherwise required by law. Use additional pages if necessary.*

1. Agreement, including all exhibits, dated October 12, 1960 between the Borough of Rose Valley and Township of the Township of Nether Providence regarding a Sanitary Sewer Collection System.
2. Agreement, including all exhibits, dated May 3, 1966 between the City of Chester and the Borough of Rose Valley regarding sewage disposal.

DO YOU WANT COPIES? ☐ Yes, printed copies (*default if none are checked*)
X Yes, electronic copies preferred if available
☐ No, in-person inspection of records preferred (*may request copies later*)

Do you want certified copies? ☐ Yes (*may be subject to additional costs*) X No

RTKL requests may require payment or prepayment of fees. See the Official RTKL Fee Schedule for more details.

Please notify me if fees associated with this request will be more than ☐ $100 (or) X $ 25.00.

ITEMS BELOW THIS LINE FOR AGENCY USE ONLY

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NOTE: In most cases, a completed RTKL request form is a public record.
More information about the RTKL is available at https://www.openrecords.pa.gov

Form updated Feb. 3, 2020

LIST OF CONTRACTS

DELCORA - CONTRACT LISTING						
Contracts		Project Name	Awarded	2019 Annual Spend	YTD20 Spend	Contract Period
1	P2020-01	LAWN MOWING & MAINTENANCE	DEERFIELD MOWING & PROPERTY, INC.	[redacted]		
2	P2020-02	SEWER LATERAL CLEANING SERVICE PART A/B)	MOR CONSTRUCTION SERVICES, INC.			
3	P2019-03	GREASE CONCENTRATOR SPARE PARTS	EASTERN ENVIRONMENTAL, INC.			
4	P2019-06	DRY ASH HAULING	ADVANCED DISPOSAL, INC.			
5	P2019-09	REPLACEMENT BELTS FOR A BELT FILTER PRESS	GSM FILTRATION, INC.			
6	P2019-11	JANITORIAL SERVICES	CNS CLEANING CO., INC.			
7	P2019-13	UNIFORM RENTAL SERVICES	UNIFIRST, INC.			
8	P2019-14	PRIMARY CLARIFIER PARTS	EASTERN ENVIRONMENTAL, INC.			
9	P2019-15	DELINQUENCY NOTICE PROCESSING	AUTO BOYZ DELIVERY			
10	P2019-16	UNLEADED GASOLINE & DIESEL FUEL W/TRACKING SYSTEM	PHL GAS CONVENIENCE, INC. (WEX BANK)			
11	P2018-12	GRIT/SCREENINGS, RELOCATION: REMOVAL, HAULING & DISPOSAL	J & K TRASH REMOVAL			
Chemicals						
12	P2019-04	POLYMER FLOCC(DEWATERING)	POLYDYNE, INC.			
13	P2019-05	POLYMER FLOCC(SLUDGE THICKENING)	POLYDYNE, INC.			
14	P2019-07	SODIUM BISULFITE (38%)	GEORGE C. COYNE CHEMICAL, CO.			
15	P2019-12	PHOSPHORIC ACID (85%)	GEORGE C. COYNE CHEMICAL, CO.			
16	P2019-18	LIQUID CHLORINE IN ONE TON CYLINDER	JCI JONES CHEMICAL, CO.			
17	P2019-19	LIQUID CAUSTIC SODA	KUEHNE CHEMICAL CO., INC.			
Various Service/Lease Agreements						
18		ADMIN BUILDING - LAWN MAINTENANCE	EXTREME LANDSCAPING, LLC.			
19		ARMORED CAR SERVICE	GARDA CL ATLANTIC, INC.			
20		CEMS - RATA OF CEM SYSTEMS	ARROW ENVIRONMENTAL CONSULTING, LLC			
21		CEMS - MAINTENANCE AGREEMENT	TRACE ENVIRONMENTAL SYSTEMS, INC.			
22		COMMERCIAL RENTALS - FLOOR MATS	HEALTH MATS COMPANY			

DELCORA - CONTRACT LISTING						
Contracts		Project Name	Awarded	2019 Annual Spend	YTD20 Spend	Contract Period
23		COMMUNICATIONS TOWER LEASE	NEWTOWN SQUARE TOWER LP	[redacted]		
24		COPIER FLEET - LEASING AGREEMENT	DE LAGE LANDEN PUBLIC FINANCE			
25		COSTARS	XYLEM DEWATERING SOLUTIONS, INC.			
26		COSTARS	XYLEM WATER SOLUTIONS U.S.A., INC.			
27		COSTARS - SUPPLIES	FASTENAL COMPANY			
28		DELAWARE RIVER COALITION	MANKO, GOLD, KATCHER & FOX LLP			
29		ELECTRICAL MAINTENANCE	PHILIPS BROS ELECTRICAL INC			
30		ELEVATOR MAINTENANCE	WYATT ELEVATOR COMPANY			
31		ENERGY CONTRACT	DIRECT ENERGY BUSINESS			
32		ERP SOFTWARE SOLUTION	INFOR (US), INC.			
33		FIRE ALARM SERVICE	GENERAL FIRE EQUIP CO., INC.			
34		FLOW METERING	CSL SERVICES, INC.			
35		GENERATOR MAINTENANCE	MARDINLY INDUSTRIAL POWER, LLC.			
36		GPS	VERIZON WIRELESS			
37		HEALTH AND SAFETY	CINTAS FIRST AID & SAFETY			
38		HOSTING SOLUTIONS/SOFTWARE	TYLER TECHNOLOGIES			
39		HVAC	DWD MECHANICAL CONTRACTOR, INC			
40		INCINERATOR MAINTENANCE	INDUSTRIAL FURNACE COMPANY			
41		LAB SERVICES - PCB LAB ANALYSIS	CAPE FEAR ANALYTICAL, LLC.			
42		LEASE AGREEMENT	AMERICAN TOWER CORPORATION			
43		METERING CALIBRATIONS	SMITH INSTRUMENTS COMPANY, INC			
44		OUTSOURCE MAILOR AGREE.	INFOSEND, INC.			
45		PAVING	A.F. DAMON & SONS, INC			

DELCORA - CONTRACT LISTING						
Contracts		Project Name	Awarded	2019 Annual Spend	YTD20 Spend	Contract Period
46		POSTAGE	PITNEY BOWES INC.	[redacted]		
47		POSTAGE MACHINE - LEASE AGREEMENT	PITNEY BOWES PURCHASE POWER			
48		SEWER MAINTENANCE	A.J. JURICH			
49		WATER TREATMENT- SERVICE AGREEMENT	CASCADE WATER SERVICES (AQUIRED BY NALCO COMPANY, LLC.)			
50		WATER TREATMENT- SERVICE AGREEMENT	NALCO COMPANY, LLC.			
Professional Services						
51		PROFESSIONAL SERVICES - CONSULTANT	ARENA STRATEGIES, LLC			
52		PROFESSIONAL SERVICES - GIS SERVICES	POWER ENGINEERING			
53		PROFESSIONAL SERVICES - PEST CONTROL	TRI-COUNTY PEST CONTROL, INC			
Various Service/Lease Agreements						
54		CONCRETE & STRUCTURAL REHAB	QUINN CONSTRUCTION, INC.			
55		SCADA/CIMPLICITY SUPPORT	GE GLOBAL (ADVENT ELECTRIC)			
56		SERVICE CONTRACT - KIP PRINTER	MARCH IMAGING SYSTEMS			
57		SOFTWARE SERVICES - MAINTENANCE - LAB	LINKO TECHNOLOGY, INC.			
58		WATER COOLER/WATER SERVICE AGREEMENT	READY REFRESH BY NESTLE'			
59		WEBSITE DESIGN	MARKITECTS, INC.			
			TOTALS			

CERTIFICATE OF SERVICE

I hereby certify that I have this 7th day of May, 2020, served a true and correct copy of the foregoing Letter and Additional Information, upon the persons and in the manner set forth below:

VIA ELECTRONIC MAIL

Sean Donnelly, P.E., Supervisor
Water/Wastewater Section
Bureau of Technical Utility Services
Pennsylvania Public Utility Commission
sdonnelly@pa.gov

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Erin L. Gannon
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Thomas T. Niesen
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